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COLLECTING INSECTS BY AIRPLANE IN SOUTHERN TEXAS
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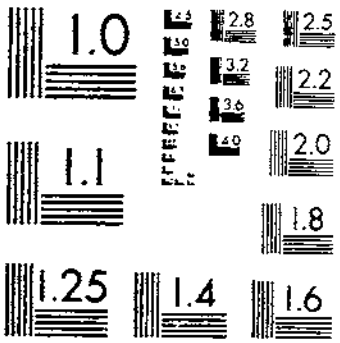

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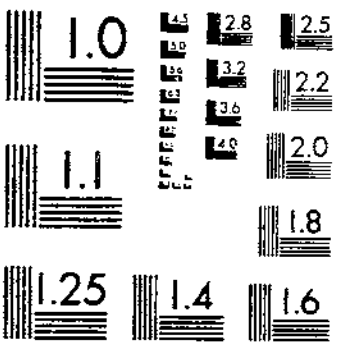

MICROCOPY RESOLUTION TEST CHART
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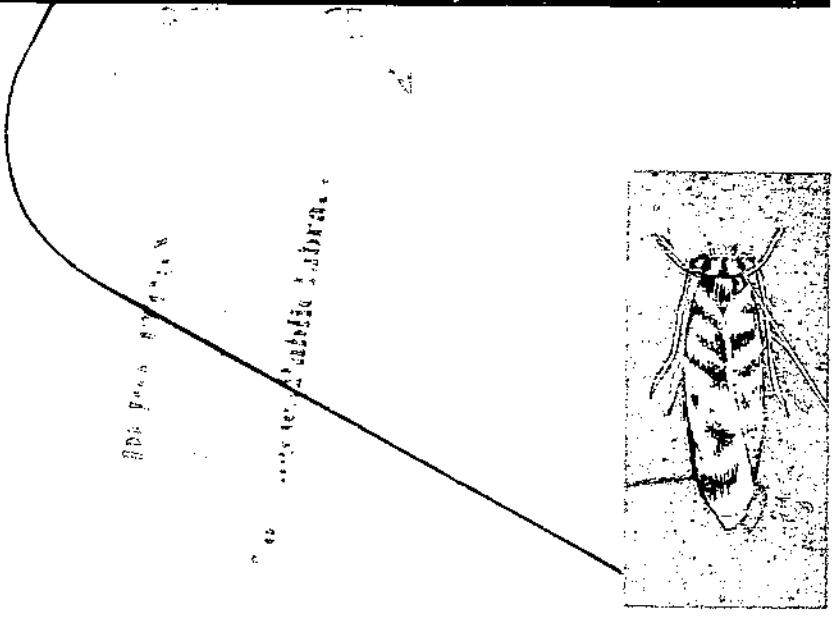
Collecting Insects

BY AIRPLANE in Southern Texas



By Perry A. Glick, Entomologist
Agricultural Research Service

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Contents

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Collecting Insects

BY AIRPLANE
In Southern Texas

Perry A. Glick, *entomologist, Entomology Research Branch, Agricultural Research Service* [1] [2]

Insects are generally disseminated in two ways: They may be carried in any of the various vehicles of transportation, or they may move through the atmosphere in flight. Their spread through transportation in airplanes, boats, trains, or automobiles has long been established, but less is known about flight as a means of distribution.

The movement of insects across the Mexican border is particularly important to any efforts to prevent the introduction of new pests. The boll weevil, the Mexican bean beetle, the pink bollworm, the citrus blackfly, and some fruit flies came into the United States from Mexico. Although quarantine measures have greatly retarded their advance through transportation, there is no known method by which man can prevent the entry of insects by flight.

In 1928 a number of airplane flights were made in Mexico primarily to study pink bollworm migration, but the collections included insects in ten orders (Glick 4, p. 133).[3] Pink bollworms were found as high as 3,000 feet. In the summer of 1954 similar studies were made in the lower Rio Grande Valley and King Ranch areas of Texas to obtain information on the aerial activity of this pest, as well as many other insects of economic importance.

EXPERIMENTAL PROCEDURE

A Piper Cub plane was used for this work. Insect traps used by the writer in Louisiana from 1926 to 1931 were installed under each wing of the plane (fig. 1). The screens were lightly coated with an adhesive made of a saturated solution of castor oil and resin so that any insects coming in contact with them would not be "washed" off.

The flights were made from August 18 to September 3—37 over the lower Rio Grande Valley between Brownsville and Harlingen, and 9 over the King Ranch area between Norias and Falfurrias (fig. 2). The plane was kept at the International Airport in Brownsville and

[1] In cooperation with the Texas Agricultural Experiment Station.

[2] Arthur Gieser, of the Aircraft and Special Equipment Center, Plant Pest Control Branch, was the plane pilot during these flights. The following persons also gave assistance in this project: F. C. Bishopp of the Oscar Johnston Cotton Foundation; J. P. Hollingsworth, Agricultural Engineering Research Branch; S. E. Jones and C. N. Husman, Entomology Research Branch; and the staff of the International Airport at Brownsville, Tex.

[3] Italic numbers in parentheses refer to Literature Cited, p. 27.

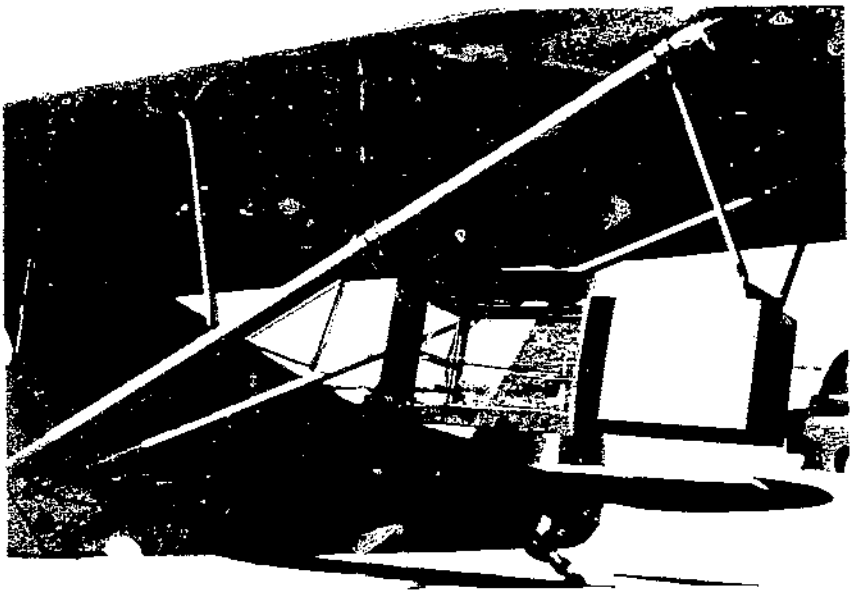

FIG. 1. Insect trap placed on struts of Piper Cub plane. A screen is pulled from closed compartment with a control wire running to cabin of plane. Five screens are used in the trap and are pulled out by individual wires at designated altitude, and returned by a leading wire. Brownsville, Tex., 1955.

serviced from that base. Four flights a day were made when conditions permitted, usually at 5 and 10 a. m., and 6 and 9 p. m., with occasional flights at mid-day. Altitudes flown during the day were 100, 200, 500, 1,000, and 5,000 feet, with a few flights at 2,000 feet. The night flights included altitudes of 500, 1,000, 2,000, and 5,000 feet. One screen in each trap was exposed for 10 minutes at each altitude. The average speed of the plane when insects were being collected was 50 miles per hour.

Meteorological records were made at each altitude at the time the traps were exposed. These included temperature, relative humidity, dew point, and condition of the atmosphere. Upper air data (wind direction and velocity) were obtained through the courtesy of the U. S. Weather Bureau Office at the International Airport, Brownsville, and while they were not always for the exact time the flights were made, the air conditions did not vary greatly and they were accordingly applicable.

AREA COVERED

The lower Rio Grande Valley is almost completely under cultivation, with extensive acreages of cotton, orange groves, and vegetables. However, some of the land is in mesquite, or interwoven with numbers of beautiful winding resacas that were formerly courses of the Rio Grande, and interspersed with irrigation ditches, canals, and storage reservoirs. Beyond this irrigated country the vegetation is sparse and the area is more or less arid, occupied with mesquite, ebony trees, cacti, yucca, and other desert flora native to lower Texas. Ecologically it is known as the mesquite chaparral (Tharp *11*, p. 10) (fig. 3).

Immediately across the Rio Grande in Mexico the land for many miles is also under cultivation with great acreages of cotton and some vegetables. This area supports a large insect population, particularly cotton insects.

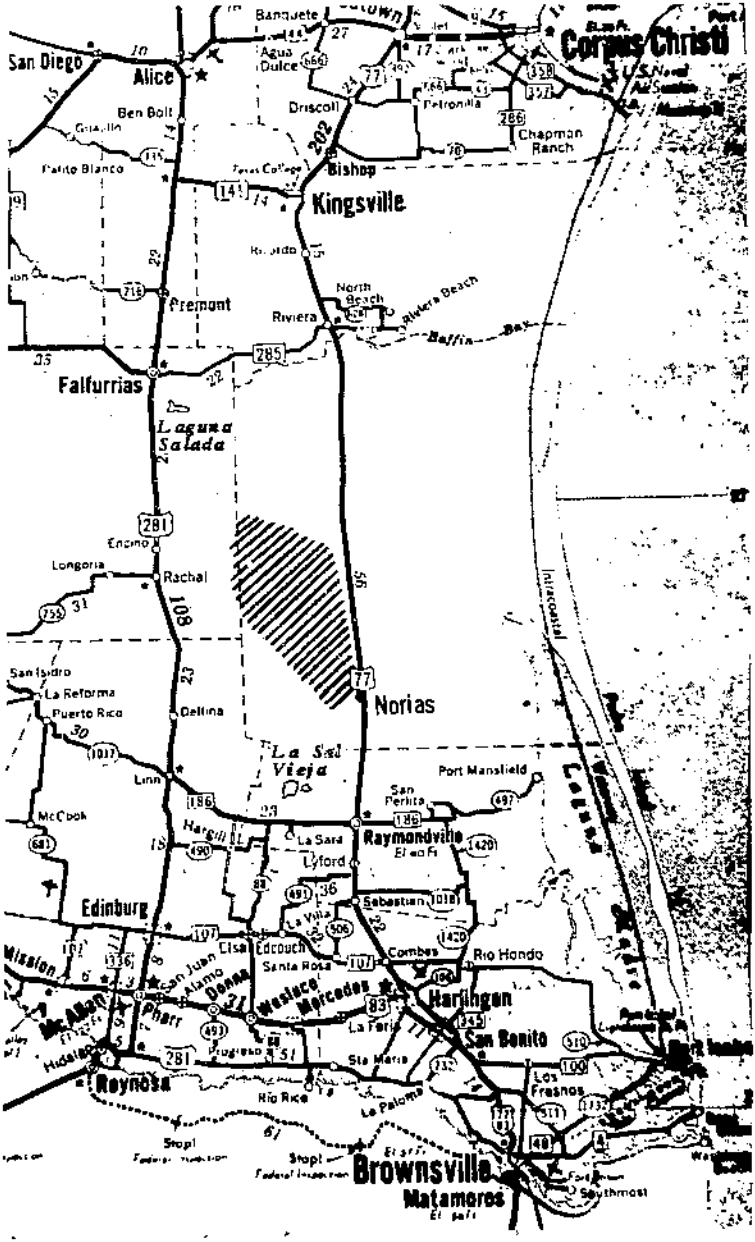

FIGURE 2.—Road map showing the lower Rio Grande Valley area, and up to Corpus Christi. The area covered by diagonal lines between Norias and Falfurrias is in the King Ranch country over which nine flights were made. The flights in the Valley covered the area between Brownsville, San Benito, Harlingen, and Los Fresnos, Tex.

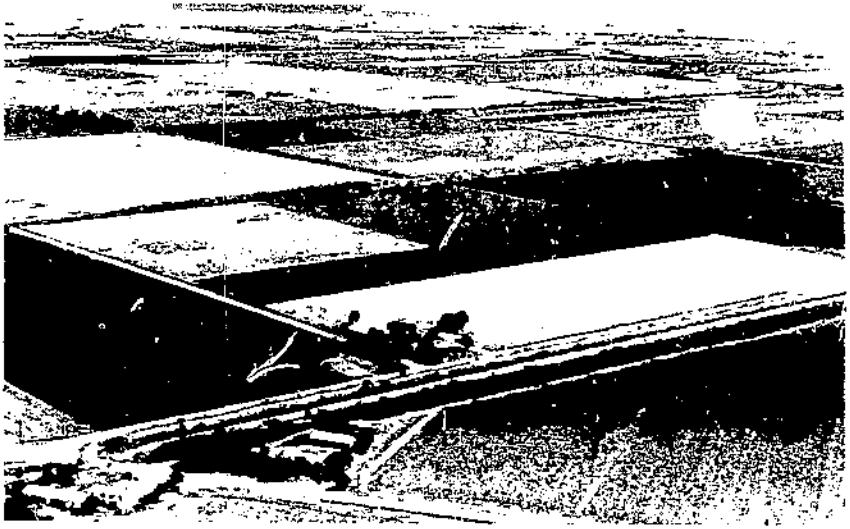

FIGURE 3.—Agricultural area near Brownsville, Tex., taken from 500-foot altitude. This rich farming country is typical of the lower Rio Grande Valley over which flights were made for the pink bollworm migration studies.

ALTITUDINAL DISTRIBUTION OF INSECTS AND SPIDERS

In the rather restricted cultivated area of the lower Rio Grande Valley, under semiarid conditions and with the Gulf of Mexico on the eastern side, one would expect a limited insect population as compared with a country covered with extensive swamps, forests, and luxuriant vegetation. In flying over the Valley, the writer often wondered how any insects could ever be taken on the two square feet of exposed screens filtering such a small portion of the air over the vast space, particularly over the sparsely vegetated, semiarid area. Yet, surprisingly, there were slightly more insects taken in flights over the Valley (6.27 insects per 10-minute exposure of the screens) than in flights over the heavily vegetated and cultivated area of Louisiana (5.23 insects per 10-minute exposure).

At the lower altitudes the numbers of insects taken per 10-minute exposure of the screens were relatively high (27.0 at 100 feet, and 10.7 at 200 feet). The number taken then dropped off abruptly at 500 feet (3.8 insects per 10 minutes of exposure), diminishing rapidly thereafter. Most organisms disperse near the ground, although dispersion probably occurs within a 25-foot elevation (Wolfenbarger *12*, p. 134). However, the long-distance dispersion would probably occur at high altitudes, for insects are subject to the strong convectional air currents and are carried upward to great heights where they may enter the strata and drift far with the prevailing winds.

A number of flights started early in the morning, the 1,000- and 5,000-foot altitudes being flown first or in darkness, while the flights at the lower levels were made after daybreak. In the evenings the lower altitudes were flown first while it was still light, and the higher altitudes in more or less darkness.

There were 1,373 insects taken during the 2,411 minutes of exposure of the screens. Spiders (Araneida) and representatives of nine orders of insects—Psocoptera, Ephemeroptera, Thysanoptera, Hemiptera, Homoptera, Coleoptera, Lepidoptera, Hymenoptera, and Diptera—were taken. Diptera led in numbers taken, with Homoptera, Coleoptera, and Hymenoptera following in that order. Only a few specimens of the other orders were collected. Notes on the occurrence and relative abundance of the orders and their respective families, genera, and species follow (table 1).

TABLE 1.—*Insects and spiders collected by airplane, according to altitudes, Rio Grande Valley and King Ranch areas, Texas, Aug. 18 to Sept. 3, 1954*[1]

Order, family, genus, and species	Number collected at altitudes of—						Total taken
	100 feet	200 feet	500 feet	1,000 feet	2,000 feet	5,000 feet	
ARANEIDA (spiders):							
Theridiidae:							
Theridion sp. (juv.)	0	0	1	0	0	0	1
Linyphiidae:							
Meioneta sp. (female)	0	0	1	0	0	0	1
Ceraticelus minutus Emerton (female)	0	1	0	0	0	0	1
Linyphiidae indt. spp. (imm.)	0	1	0	0	0	0	1
Argiopidae:							
Neoscona sp. (juv.)	0	1	0	0	0	0	1
Neoscona sp. (imm.)	0	0	0	1	0	0	1
Mangora sp. (juv.)	0	1	0	0	0	0	1
Araneus sp. (juv.)	0	0	1	1	0	0	2
Thomisidae:							
Misumenops dubius Keyserling (female)	0	0	1	0	0	0	1
Misumenops sp. (imm.)	1	0	0	1	0	0	2
Anyphaenidae:							
Aysha gracilis Bentz (juv.)	1	0	0	1	0	0	2
Clubionidae:							
Castianeira sp. (imm.)	1	0	0	0	0	0	1
Lycosidae:							
Pardosa sp. (juv.)	3	1	1	3	0	0	8
Pardosa sp. (imm.)	0	0	2	0	0	0	2
Salticidae:							
Habronattus sp. (juv.)	1	1	0	0	0	0	2
Habronattus sp. (imm.)	0	1	0	0	0	0	1
Icius sp. (imm.)	0	1	0	0	0	0	1
Spiders: Undetermined spp	0	0	0	4	0	0	4
Total	7	8	7	11	0	0	33
EPHEMEROPTERA:							
Caenidae:							
Caenis sp.	0	1	0	0	0	0	1
Brachycercus sp. (female)	0	0	1	0	0	0	1
Baetidae:							
Callibaetis sp. (female)	0	1	0	0	0	0	1
Total	0	2	1	0	0	0	3

[1] Determinations of insects by staff of Insect Identification and Parasite Introduction Section, Entomology Research Branch, and spiders by Willis J. Gertsch of The American Museum of Natural History, Department of Insects and Spiders.

TABLE 1.—*Insects and spiders collected by airplane, according to altitudes, Rio Grande Valley and King Ranch areas, Texas, Aug. 18 to Sept. 3, 1954*—Continued

Order, family, genus, and species	Number collected at altitudes of—						Total taken
	100 feet	200 feet	500 feet	1,000 feet	2,000 feet	5,000 feet	
PSOCOPTERA:							
Liposcelidae:							
Liposcelis bostrychophilus complex (female)	0	0	1	0	0	0	1
Peripsocidae:							
Ectopsocus pumilis (Banks, 1920) sp. (female)	1	1	0	0	0	0	2
Ectopsocus sp	3	0	0	0	0	0	3
Lachesillidae:							
Lachesilla rena Somm. 1946:							
(males)	5	4	0	0	0	0	9
(females)	0	5	0	0	0	0	5
Total	9	10	1	0	0	0	20
THYSANOPTERA:							
Thysanoptera undt. spp	0	0	1	0	0	1	2
HEMIPTERA:							
Pentatomidae:							
Cydnus obliquus (Uhler)	0	0	0	1	0	0	1
Cercidae:							
Arfcius impressicollis Stal	1	1	0	0	0	0	2
Nebidae:							
Alcinisus multispinanus (Ashm.)	0	1	0	1	0	0	2
Lygaeidae:							
Geocoris punctipes (Say)	0	0	2	1	0	0	3
Geocoris uliginosus (Say)	0	2	0	0	0	0	2
Geocoris lividipennis Stal	2	3	2	0	0	0	7
Cligenes modesta Barber	1	1	0	0	0	0	2
Eplochiomera confusa Barber	2	2	1	1	0	0	6
Nyssius raphanus Howard	0	0	0	1	0	0	1
Nyssius tenellus Barber	0	1	0	0	0	0	1
Reduviidae:							
Zelus renardii Kol	0	1	0	0	0	0	1
Sinea confusa Caudell	0	3	0	0	0	0	3
Mesoveliidae:							
Mesovelia mulsanti White	1	0	0	0	0	0	1
Anthocoridae:							
Orius insidiosus (Say)	1	0	0	0	1	0	2
Orius tristicolor (White)	1	1	1	0	0	0	3
Xylocoris californicus (Reuter)	0	1	0	0	0	0	1
Miridae:							
Psallus sunedae Knight	14	6	3	0	2	1	26
Psallus seriatus (Reuter)	4	1	0	0	0	0	5
Reuteroscopus ornatus (Reuter)	1	0	0	1	0	0	2
Rhinacloa forticornis Reuter	1	0	0	0	0	0	1
Total	29	24	9	6	3	1	72
HOMOPTERA:							
Cicadellidae:							
Aceratagallia calcaris Oman	10	5	5	3	0	0	23
Aceratagallia sp	0	1	0	0	0	0	1
Aceratagallia sp. (females)	1	0	2	0	0	0	3
Agalliinae sp	0	1	0	0	0	0	1

TABLE 1.—*Insects and spiders collected by airplane, according to altitudes, Rio Grande Valley and King Ranch areas, Texas, Aug. 18 to Sept. 3, 1954*—Continued

Order, family, genus, and species	Number collected at altitudes of—						Total taken
	100 feet	200 feet	500 feet	1,000 feet	2,000 feet	5,000 feet	
HOMOPTERA—Continued							
Cicadellidae—Continued							
Alconeura sp. (female)	1	0	0	0	0	0	1
Baldulus sp.	0	1	0	0	0	0	1
Carnecephala flaripes (Riley)	1	0	0	0	0	0	1
Carnecephala spp.	3	2	0	0	0	0	5
Carnecephala spp. (females)	1	2	0	1	0	0	4
Circulifer tenellus (Baker)	2	1	0	0	1	0	4
Deltocephalus sonorus Ball	37	11	10	2	2	0	62
Deltocephalus sp.	0	1	0	0	0	0	1
Deltocephalinae spp. (females)	1	0	0	1	0	0	2
Dracculacephala sp.	1	1	0	0	0	0	2
Dracculacephala spp. (females)	0	2	0	1	0	0	3
Empoasca abrupta DeL.[2]	1	1	0	0	0	2	4
Empoasca fabae (Harris)	0	0	1	0	0	0	1
Empoasca solana DeL.	11	2	1	3	0	0	17
Empoasca spp.	6	0	0	0	0	1	7
Empoasca spp. (females)	51	25	2	2	1	3	84
Erythroneurini spp. (females)	1	1	0	0	0	0	2
Erlianus critiosus (Uhler)	1	11	0	0	1	0	13
Graminella nigrifrons (Forbes)	0	2	0	0	0	0	2
Kunzella spp. (females)	0	0	0	2	0	0	2
Nesosteles spp. (females)	2	1	0	0	3	0	6
Ollarianus strictus Ball.	24	14	5	4	0	0	47
Scaphytopius albifrons Hepner	8	20	2	2	0	1	33
Scaphytopius spp. (females)	3	2	3	0	0	0	8
Scaphytopius sp. (nymph)	0	0	0	0	1	0	1
Scaphytopius sp.	1	0	0	0	0	0	1
Xestocephalus pulicarius VanD.	1	1	0	0	0	0	2
Xestocephalus sp. (females)	2	0	0	1	0	0	3
Zygina sp.	1	0	0	0	0	0	1
Cicadellidae undt. sp. (host)	0	0	0	0	0	1	1
Cixiidae:							
Haplaxius sp. (female)	0	1	0	0	0	0	1
Oecleus sp.	1	0	0	0	0	0	1
Cixiidae undt. spp.	1	1	2	0	0	0	4
Delphacidae:							
Delphacodes nigripennis (Cwfd.)	0	0	1	0	0	0	1
Delphacidae undt. spp.	2	2	1	0	0	0	5
Psyllidae:							
Aphalaroida sp.	3	0	0	0	0	0	3
Trioza diospyri (Ashm.)	3	1	1	1	0	0	6
Aphidae:							
Aphis sp. prob. *gossypii* Glov.	1	0	0	1	0	0	2
Total	182	113	36	21	9	8	372
COLEOPTERA:							
Carabidae:							
Carabidae undt. spp.	6	0	0	1	0	0	7
Hydrophilidae:							
Hydrophilidae undt. spp.	1	0	0	1	0	0	2

[2] Determinations by author.

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TABLE 1.—*Insects and spiders collected by airplane, according to altitudes, Rio Grande Valley and King Ranch areas, Texas, Aug. 18 to Sept. 3, 1954*—Continued

Order, family, genus, and species	Number collected at altitudes of—						Total taken
	100 feet	200 feet	500 feet	1,000 feet	2,000 feet	5,000 feet	
COLEOPTERA—Continued							
Staphylinidae:							
Oxytelinae:							
Platystethus spiculus Er.							
(males)	9	8	1	1	0	0	19
(females)	4	2	2	0	0	0	8
Carpelimus sp	2	0	0	0	0	0	2
Bledius sp	0	1	0	0	0	0	1
Aleocharinae undt. spp	1	1	0	0	0	0	2
Xantholininae:							
Leiolinus sp	1	2	1	0	0	0	4
Paederinae:							
Lobrathium sp	2	2	0	0	0	0	4
Staphylininae:							
Philonthus sp	1	0	1	0	0	0	2
Malachiidae:							
Collops sp	2	1	1	0	0	0	4
Mordellidae:							
Mordellistena sp	1	0	0	0	0	0	1
Pentaria sp	0	1	0	1	0	0	2
Anthicidae:							
Anthicidae undt. spp	3	3	3	1	0	0	10
Dryopidae:							
Dryopidae undt. spp	2	0	0	0	0	0	2
Nitidulidae:							
Carpophilus dimidiatus (F.)	2	3	5	0	0	0	10
Carpophilus spp	2	2	0	0	0	0	4
Rhizophagidae:							
Monotoma sp	1	0	0	0	0	0	1
Smicrips sp	0	1	0	0	0	0	1
Cucujidae:							
Silvaninae undt. sp	0	1	0	0	0	0	1
Mycetophagidae:							
Typhaea stercorea (L.)	1	0	0	0	0	0	1
Phalacridae:							
Phalacridae undt. spp	1	0	1	0	0	0	2
Lathridiidae:							
Melanophthalma sp	1	2	2	0	0	0	5
Melanophthalma, probably *distinguenda* (Com.)	1	2	0	1	0	0	4
Migneauxia sp	4	4	4	1	0	1	14
Coccinellidae:							
Scymnus (*Pullus*) *loewi* Muls	1	1	0	0	0	0	2
Coleomegilla maculata (Degeer)	1	0	0	0	0	0	1
Tenebrionidae:							
Palorus subdepressus (Wollaston)	1	0	0	0	0	0	1
Bostrichidae:							
Xylobiops sextuberculatus (Leconte)	1	2	1	0	0	0	4
Bostrichidae undt. spp	1	2	1	0	0	0	4
Chrysomelidae:							
Pachybrachis sp	4	6	1	0	1	0	12
Chaetocnema sp. near *pulicaria* Melsh	28	2	0	0	0	0	30

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	100 feet	200 feet	500 feet	1,000 feet	2,000 feet	5,000 feet	
COLEOPTERA—Continued							
Chrysomelidae—Continued							
Epitrix sp. prob. *hirtipennis* Melsh	1	1	0	0	0	0	2
Lactica infuscata Schffr	0	1	0	0	0	0	1
Bruchidae:							
Acanthoscelides, sp. near *longistylus* Horn	0	1	0	0	0	0	1
Curculionidae:							
Anthonomus grandis Boh	0	1	1	0	0	0	2
Microtychius sp	0	1	0	0	0	0	1
Smicronyx sp	0	0	0	1	0	0	1
Englenidae:							
Englenidae undt. spp	0	1	0	0	0	0	1
Total	86	55	25	8	1	1	176
LEPIDOPTERA:							
Gelechiidae:							
Pectinophora gossypiella:							
(Saund.) (males)	1	1	1	1	0	0	4
(Saund.) (females)	3	2	1	1	0	0	7
Pectinophora gossypiella (sex undt.)	0	0	0	1	0	0	1
Gnorimoschema spp	1	0	1	0	0	0	2
Chionodes ? sp	0	1	0	0	0	0	1
Keiferia sp	1	0	0	0	0	0	1
Lyonetiidae:							
Lyonetiidae undt. sp	0	0	0	0	0	1	1
Scythrididae:							
Scythrididae undt. sp	0	1	0	0	0	0	1
Cosmopterygidae:							
Ithome concolorella (Chamb.)	0	1	0	0	0	0	1
Cosmopterygidae undt. sp	0	0	0	0	1	0	1
Pyraustidae:							
Lozostege similalis (Guen.)	0	1	1	0	0	0	2
Amatidae:							
Scepsis fulvicollis (Hbn.)	1	0	0	0	0	0	1
Crambidae:							
Ommatopteryx ocellea (Haw.)	0	1	0	0	0	0	1
Total	7	8	4	3	1	1	24
HYMENOPTERA:							
Braconidae:							
Apanteles thurberiae Mues	2	0	2	0	0	0	4
Bracon platynotae (Cush.)	0	2	0	0	0	0	2
Chelonus cautus Cress	0	0	1	0	0	0	1
Chelonus cautus sp	1	0	0	0	0	0	1
Triaspis sp	1	0	0	0	0	0	1
Eulophidae:							
Horismenus sp. (male)	0	1	0	0	0	0	1
Horismenus sp. (females)	1	0	1	0	0	0	2
Derostenus sp. (female)	0	1	0	0	0	0	1
Tetrastichus racemariae Ashm. (female)	0	1	0	0	0	0	1

TABLE 1.—*Insects and spiders collected by airplane, according to altitudes, Rio Grande Valley and King Ranch areas, Texas, Aug. 18 to Sept. 3, 1954*—Continued

Order, family, genus, and species	Number collected at altitudes of—						Total taken
	100 feet	200 feet	500 feet	1,000 feet	2,000 feet	5,000 feet	
HYMENOPTERA—Continued							
Eulophidae—Continued							
Tetrastichus sp. (females)	1	0	2	0	0	0	3
Eulophidae undt. spp. (females	0	0	0	0	0	2	2
Elasmidae:							
Elasmus sp. (female)	0	0	1	0	0	0	1
Eutrichosomatidae:							
Eutrichosoma albipes Cwfd. (female)	0	1	0	0	0	0	1
Encyrtidae:							
Anagyrus sp. (females)	0	0	1	0	0	1	2
Mirini sp. (female)	0	1	0	0	0	0	1
Eupelmidae:							
Eupelmus popa (Grlt.) (females)	2	3	1	1	0	0	7
Eusandalum hubbardi (Ashm.) (female)	0	0	1	0	0	0	1
Perilampidae:							
Perilampus fulvicornis Ashm:							
(Males)	2	2	0	0	0	0	4
(Females)	0	2	0	0	0	0	2
Torymidae:							
Torymus sp. (males)	0	1	0	1	1	0	3
(females)	0	2	4	0	0	0	6
Pseuderimerus sp. (females)	2	0	0	0	0	0	2
Pteromalidae:							
Epipteromalus sp. (female)	0	0	1	0	0	0	1
Heterolaccus hunteri (Cwfd.) (female)	0	1	1	0	0	0	2
Heteroschema sp. (female)	0	0	0	0	1	0	1
Spalangia sp. (female)	1	0	0	0	0	0	1
Laelaps sp. (female)	0	0	1	0	0	0	1
Eurytomidae:							
Rileya sp. (? *cecidomyiae* Ashm.)	0	1	0	0	0	0	1
(Female)	0	1	0	0	0	0	1
Eurytoma sp:							
(Males)	1	1	1	0	0	0	3
(Females)	5	1	1	0	0	0	7
Chalcididae:							
Euchalcidia sp. (males)	1	0	1	0	0	0	2
CYNIPOIDEA: Eucoilinae:							
Eucoilidea sp. (female)	0	1	0	0	0	0	1
Scelionidae:							
Telenomus sp	0	1	3	0	0	1	5
Hadronotus sp	0	0	1	0	0	0	1
Ceratoteleia marlattii (Ashm.)	3	4	2	0	0	0	9
Bethylidae:							
Perisierola sp	1	0	0	1	0	0	2
Epyris sp	0	0	0	0	1	0	1
Holepyris sp	1	0	0	0	0	0	1
Pseudisobrachium sp	2	1	0	0	0	0	3
Dissomphalus xanthopus (Ashm.)	3	0	0	0	0	0	3
Bethylidae undt. sp	0	0	0	1	0	0	1

TABLE 1.—*Insects and spiders collected by airplane, according to altitudes, Rio Grande Valley and King Ranch areas, Texas, Aug. 18 to Sept. 3, 1954*—Continued

Order, family, genus, and species	Number collected at altitudes of—						Total taken
	100 feet	200 feet	500 feet	1,000 feet	2,000 feet	5,000 feet	
HYMENOPTERA—Continued							
Formicidae:							
Ponera trigona var. *opacior* Forel (female)	1	0	0	0	0	0	1
Ponera sp. (females)	2	3	0	1	0	0	6
Pheidole sp. (males)	2	0	0	0	0	0	2
Pheidole sp. (female)	0	1	0	0	0	0	1
Solenopsis xyloni McCook (female)	0	0	1	0	0	0	1
Solenopsis (*Diplorhoptrum*) sp. (female)	1	1	0	0	0	0	2
Solenopsis xyloni (male)	1	0	0	0	0	0	1
Solenopsis (*Solenopsis*) sp. (male)	1	1	0	0	0	0	2
Leptogenys elongata (Buckl.) (male)	2	0	0	0	0	0	2
Dorymyrmex sp. (males)	13	1	7	1	1	0	23
Crematogaster sp. (male)	0	1	0	0	0	0	1
Sphecidae:							
Cerceris kennicottii Cr.	1	0	0	0	0	0	1
Dryinidae:							
Dryinidae undt. sp. (male)	1	0	0	0	0	0	1
Halictidae:							
Halictus mesillensis Ckll.	0	0	0	0	0	1	1
Caenidae:							
Caenis sp.	0	1	0	0	0	0	1
Brachycercus sp. (female)	0	0	1	0	0	0	1
Baetidae:							
Callibaetis sp. (female)	0	1	0	0	0	0	1
Entrichosomatidae:							
Entrichosoma albipes Cwfd. (female)	0	1	0	0	0	0	1
HYMENOPTERA undetermined sp.	0	0	1	0	0	0	1
Total	55	37	35	6	4	5	142
DIPTERA:							
Culicidae:							
Culex quinquefasciatus Say (male)	1	0	0	0	0	0	1
Culex sp. (females)	2	1	1	0	0	0	4
Psophora confinnis (Lynch) (females)	0	1	1	0	0	0	2
Aedes taeniorhynchus (Wd.) (females)	0	0	1	0	0	0	1
Itonididae:							
Lestrenilini gen. sp.	12	22	6	3	1	0	44
Lasioptera sp.	1	0	0	1	0	0	2
Anaretella sp.	0	1	1	0	0	0	2
Porricondylini gen. sp.	1	1	0	0	0	0	2
Asphondylia sp.	0	1	0	0	0	0	1
Itonidini gen. sp.	1	0	0	0	0	0	1
Itonididae undt. spp.	0	2	0	1	0	0	3

TABLE 1.—*Insects and spiders collected by airplane, according to altitudes, Rio Grande Valley and King Ranch areas, Texas, Aug. 18 to Sept. 3, 1954*—Continued

Order, family, genus, and species	Number collected at altitudes of—						Total taken
	100 feet	200 feet	500 feet	1,000 feet	2,000 feet	5,000 feet	
DIPTERA—Continued							
Psychodidae:							
Psychoda alternata Say (fem.)	0	0	0	1	0	0	1
Phlebotomus sp. (female)	0	1	0	0	0	0	1
Bombyliidae:							
Phthiria sp.	1	0	0	0	0	0	1
Dolichopodidae:							
Chrysotus sp.	1	2	2	1	0	0	6
Thrypticus sp.	0	0	0	1	0	0	1
Dolichopididae undt. sp.	1	2	1	0	0	1	5
Empididae:							
Drapetis sp.	5	2	3	0	0	0	10
Phoridae:							
Megaselia sp.	3	2	3	1	0	0	9
Diploneura cornuta (Bigot)	2	0	0	0	0	0	2
Phoridae undt. sp.	1	0	0	0	0	0	1
Dorilaidae:							
Dorilaidae undt. spp.	2	1	2	1	0	0	6
Syrphidae:							
Mesograpta polita (Say)	0	0	1	0	0	0	1
Sarcophagidae:							
Sarcophagula occidua (F.)	1	0	0	0	0	0	1
Sarcophagidae undt. sp.	1	0	0	0	0	0	1
Anthomyzidae:							
Mumetopia occipitalis Mel.	1	0	1	0	0	0	2
Otitidae:							
Euxesta notata (Wied.)	1	0	0	0	0	0	1
Euxesta sp.	0	0	1	0	0	0	1
Tephritidae:							
Euaresta bella (Lw.)	0	0	1	0	0	0	1
Trupanea sp.	3	2	0	0	0	0	5
Lauxaniidae:							
Camptoprosopella sp.	1	0	0	0	0	0	1
Ephydridae:							
Paralimna sp.	1	2	1	1	0	0	5
Ceropsilopa sp.	3	5	5	1	0	0	14
Ephydra gracilis Pack.	1	4	2	1	0	0	8
Discocerina obscurella (Fallen)	0	3	0	0	0	0	3
Scatella stagnalis (Fallen)	0	1	0	0	0	0	1
Altissa sp.	1	0	0	0	1	0	2
Psilopa olga Cress.	1	0	0	0	0	0	1
Allotrichoma sp.	0	0	1	0	0	0	1
Chloropidae:							
Hippelates impressus Beck.	1	0	0	0	0	0	1
Hippelates pusio Leo.	3	2	0	0	0	0	5
Hippelates dissidens (Tuck.)	98	89	13	13	0	1	214
Oscinella carbonaria (Lw.)	0	1	0	0	0	0	1
Oscinella coxendix (Fitch)	0	2	0	0	0	0	2
Oscinella sp.	2	4	0	0	0	1	7
Madiza trigramma (Lw.)	0	1	0	1	0	0	2
Madiza parva (Adams)	1	0	0	0	0	0	1
Monochaetoscinella nigricarnis (Lw.)	1	0	0	0	0	0	1
Chloropidae undt. spp.	0	2	1	0	0	0	3
Asteiidae:							
Loewimpia n. sp.	0	0	0	1	0	0	1

TABLE 1.—*Insects and spiders collected by airplane, according to altitudes, Rio Grande Valley and King Ranch areas, Texas, Aug. 18 to Sept. 3, 1954*—Continued

Order, family, genus, and species	Number collected at altitudes of						Total taken
	100 feet	200 feet	500 feet	1,000 feet	2,000 feet	5,000 feet	
DIPTERA—Continued							
Trixoscelidae:							
Spilochroa ornata Johns.	2	0	0	0	0	0	2
Tendipedidae:							
Pelopia punctipennis (Mg.)	2	2	1	1	0	0	6
Pelopia sp.	0	1	1	0	0	0	2
Pentaneura sp.	0	1	0	0	0	1	2
Tendipes sp.	0	2	0	0	0	1	3
Procladius sp.	0	0	1	0	0	0	1
Coelotanypus sp.	3	3	0	0	0	0	6
Tendipedini undt. sp.	0	1	6	4	1	1	13
Tendipedidae undt. sp.	4	1	3	0	1	0	9
Heleidae:							
Forcipomyia squamipes (Coq.)	0	2	0	0	0	0	2
Forcipomyia sp.	1	1	0	0	0	0	2
Dasyhelea cincta (Coq.)	1	0	0	0	0	0	1
Dasyhelea sp.	0	0	1	0	0	0	1
Atrichopogon sp.	1	1	0	0	0	0	2
Sphaeromias sp.	0	1	0	0	0	0	1
Culicoides variipennis (Coq.)	2	0	2	1	0	1	6
Total	171	173	63	34	4	7	452
Unrecognizable insects	72	0	0	0	5	0	77
Grand total	618	430	182	92	27	24	1373
Total flying time in minutes	271	400	460	460	190	630	2411
Average number of insects per 10 minutes of flying time	22.8	10.75	3.96	2.0	1.42	0.38	5.69
In Rio Grande Valley area	27.0	10.7	3.8	1.9	0.87	0.49	6.27
In King Ranch area	10.7	7.4	4.2	2.3		0.08	3.40

Spiders (Araneida).—Thirty-three spiders were collected in the upper air at altitudes of 100 to 1,000 feet. Eight families, 12 genera, and 3 identified species were represented in the collections. Certain families have the habit of aerial dissemination. They spin webs from unobstructed objects and, cutting themselves loose, are carried in the upper air on their flimsy threads of silk. The spiders of the subfamilies Erigoninae and Linyphinae, including the sheet-web weavers (Linyphiidae) and the orb-weavers (Argiopidae), are particularly noted for this aeronautical habit. All families except the Anyphaenidae were represented in the Louisiana airplane collections.

Most of the spiders taken were the young, sometimes designated as juvenile or immature. Juvenile refers to young spiders in the very early stages, and immature to spiders in the process of becoming mature but not having fully attained that status. Generally the young spiders or spiderlings are the ones that have the tendency to be

carried on their silken threads in the upper air. However, it is evident that the adult spiders also take advantage of the aeronautic mode of dissemination as several adults were taken in the collections. Perhaps, of all invertebrates, and certainly of the Arthropoda, a spider can claim the record of reaching the greatest height in the upper air, as the writer recorded a spider collected at an altitude of 15,000 feet in his Louisiana flights (Glick 3, p. 87).

Psocoptera (Corrodentia).—This order was represented by 20 specimens taken in the upper air—9 at 100 feet, 10 at 200 feet, and 1 at 500 feet, including three families, three genera, and three identified species. A number of species are quite destructive to books, papers, and especially to insect collections, over which an eternal vigilance is necessary to avoid complete destruction.

Ephemeroptera.—Three specimens, representing three genera, were taken at altitudes of 200 and 500 feet. These mayflies become extremely abundant at times, and it is known that the emanations of the adults have caused an allergy, or hypersensitivity, in man (Glick 4, p. 96).

Thysanoptera.—Two specimens of Thysanoptera were taken in the collections, one at 500 and one at 5,000 feet. They were collected on noon and late-evening flights, respectively, the air being rough at noon and smooth in the evening. These small insects are easily carried upward in the convectional air currents. In the Louisiana airplane collections they were taken from 20 to 11,000 feet.

Hemiptera.—There were 72 specimens of this order taken. Eight families, 15 genera, and 20 identified species were represented. Five cotton fleahoppers, *Psallus seriatus* (Reut.), were taken, four at 100 and one at 200 feet. They were collected when the wind was in the northeast direction and the air usually rough. All were taken during the day flights. Twenty-six specimens of *P. smaedae* were collected at altitudes up to 5,000 feet. R. J. Sailer of the Insect Identification Section stated that he was surprised to find this species so numerous. Previously, so far as he knew, the species had not been reported east of Arizona.

Homoptera.—This order was second in numbers of insects collected, comprising 27 percent of the total insects taken. They were collected at all altitudes flown up to 5,000 feet, and included 5 families, 22 genera, and 15 identified species.

Of special interest were two species of cicadellids, the western potato leafhopper *Empoasca abrupta* DeL. and the potato leafhopper *E. fabae* (Harr.). These species are of considerable economic importance. *Abrupta* feeds on a number of vegetables. It occurs mostly in areas of low altitude and low relative humidity from Texas to Oregon, along the Mexican border, and the Pacific coast (Metcalf and Flint 7, p. 511). *Fabae* is also destructive to vegetables causing tipburn or hopperburn. Both species commonly occur on cotton and are reported to cause some damage. They have been collected by the writer in considerable numbers in sweepings of cotton in Texas, Louisiana, and Georgia, although each species varied in its relative abundance. *Fabae* occurred in the Louisiana airplane collections from 20 to 7,000 feet. However, only one specimen was taken in the Rio Grande Valley, that at 500 feet on August 20, in an early morning flight when the atmosphere was smooth. The four specimens of *abrupta* were collected at night at altitudes of 100, 200, and 5,000 feet. One of these was taken at 100

feet over the arid area of the King Ranch. Seventeen specimens of the southern garden leafhopper *E. solana* DeL., were collected at altitudes up to 1,000 feet. Ninety-one specimens of *Empoasca* spp., mostly females, were also collected from 100 to 5,000 feet.

Coleoptera.—Of the eight orders of insects taken, Coleoptera appeared third in numbers collected in the upper air. They were taken at all altitudes from 100 to 5,000 feet. Twenty families, 27 determined genera, and 13 species were represented. Beneficial species from the families Carabidae, Malachiidae, Lathridiidae, Phalacridae, and Coccinellidae were included. A very small beetle, *Melanophthalma distinguenda* (Com.), known to be predaceous on bollworm eggs (Ewing and Ivy, 2, p. 604), was taken at 100-, 200-, and 1,000-foot altitudes.

Two boll weevils were collected at 200 and 500 feet. This destructive cotton curculionid was also taken in the Louisiana airplane collections as high as 2,000 feet. Late in the season the weevil becomes very active, flying from cottonfield to cottonfield, often causing a sudden infestation in fields where little or no previous infestation was evident.

The flea beetles *Chaetocnema pulicaria* Melsh. and *Epitrix hirtipennis* (Melsh.) were collected at altitudes of 100 and 200 feet. The 30 specimens of *C. pulicaria* were collected mostly at 100 feet. These destructive chrysomelids do considerable damage to corn and tobacco, respectively.

Several specimens, *Melanothalma distinguenda* (Com.), belonging to the family Lathridiidae were taken at altitudes of 100 and 500 feet. The small beetle is known to be predaceous on eggs of the bollworm moth. This family was also represented by 14 specimens belonging to the genus *Migneauxia*. Miss Walkley of the Insect Identification and Parasite Introduction Section, who determined the specimens, stated that this appears to be the first record for this genus in the Nearctic region.

Lepidoptera.—Twenty-four specimens belonging to the order Lepidoptera were taken in the upper air at altitudes of 100 to 5,000 feet, and included six families, eight genera, and five known species. Two specimens of the garden webworm moth were collected at 200 and 500 feet. This species often causes appreciable damage to cotton plants, as well as garden and field crops.

Twelve pink bollworm moths were taken at altitudes of 100 feet (4), 200 feet (3), 500 feet (2), and 1,000 feet (3). Of these specimens, six were females, five were males, and one was undetermined (Glick 5, p. 767).

In all instances, the six female moths were collected when the air was smooth, possibly indicating that the females are not too active when convection is very strong. The females are heavier than the males, particularly if they are gravid, and remain close to the ground. This was found true in the light trap collections. More female moths were taken in the traps placed from 2 to 8 feet above the cotton, and more males were taken from 10 to 14 feet (Glick 6).

The males were taken when the atmosphere was turbulent or rough. The males appear to be more active than the females and are more abundant in the air, particularly in the early morning. In the light trap collections the greater percent of the total males taken were collected from 2:00 to 4:00 a. m., the number dropping off gradually until sunrise.

The relation of the moths to the condition of the air, or amount of convection, when they were taken in the lower Rio Grande Valley was strikingly similar to conditions when the airplane collections were made at Tlahualilo, Durango, Mexico, in September 1928. In the airplane colections at Tlahualilo, two pink bollworm moths were taken at 20 and 100 feet, respectively, at daybreak; two were found in the later morning collections at 1,000 and 3,000 feet, respectively; and three specimens were taken at 20 feet at sunset. These few specimens were collected at daybreak and sunset, close to the ground in the absence of convection, and at high altitudes in the morning when convection is greatest (Glick *4*, p. 87).

There was no apparent correlation of the pink bollworm moth collections in the Brownsville area with other meteorological conditions. The temperature ranged from 77° to 90° F., with other factors varying slightly. Wind velocity is a factor affecting the abundance of moths taken in the light traps. Few were collected when the velocity was over 6 miles per hour. However, the moths in the airplane traps were taken when the wind was calm to 20 miles per hour. In the early days of the pink bollworm investigations, according to Coad (*1*, p. 749), there appeared to be a close correlation between pink bollworm infestation in West Texas and the amount of wind in the Laguna District of northern Mexico, particularly during the month of September.

Noble (*10*, p. 6) reports that trap plots became infested 35 to 65 miles from the nearest cotton. None of the plots became infested until near the end of the growing season or in September. From this evidence of aerial distribution, it is imperative that cooperation continue between the United States and Mexico in the enforcement of quarantines and cultural control. Even if it were possible to eradicate the pink bollworm from the United States, if this cotton pest continued to thrive across the border, even down as far as the Laguna District, there would still be a source of infestation from which moths could be carried by wind into the United States.

To obtain additional information on the activity of the pink bollworm moth in the air, light traps equipped with 15-W black-light fluorescent lamps were used. One trap was placed at 100 feet on a water tower, one on the roof of a hotel in Brownsville, and one at the 85-foot catwalk level on a lighthouse at Port Isabel. The trap on the lighthouse was equipped with a black-light blue fluorescent lamp in order to avoid confusion to navigation. During the summer 159 moths were taken in the trap located on the hotel, 7 on the water tower, but none on the lighthouse. Undoubtedly the factor of convection was important in aiding the moths to reach the trap on the hotel, since the surrounding pavement generates considerable radiation at night. The water tower, by contrast, is located in an open area where little radiation is present. Port Isabel, where the lighthouse stands, is on a promontory extending into the Gulf of Mexico, which would, in part, account for no recovery of moths in this trap.

Hymenoptera.—One hundred and forty-two specimens belonging to the order Hymenoptera were collected in the upper air at all altitudes flown. Twenty families, 41 determined genera, and 16 species were represented. The families, in general, included many important parasitic and predaceous species, although in some instances (as occur in the Formicidae), they may be beneficial and injurious.

The Braconidae included several important parasitic forms. One of special interest was *Bracon* (*Microbracon*) *platynotae* (Cushman), which is known to attack the pink bollworm (Muesebeck, Krombein, and Townes *9*, p. 167). It is also known to be parasitic on larvae of the goldenrod gall moth *Gnorimoschema gallaesolidaginis* (Riley).

A number of ants were taken at altitudes of 100 to 2,000 feet. These were winged adults. A female southern fire ant, *Solenopsis xyloni* McCook, was taken at 500 feet. Five other *Solenopsis* spp. were also collected. Twenty-three males of the genus *Dorymyrmex* were taken at altitudes up to 2,000 feet.

Diptera.—This order contributed the greatest number of specimens of any order, 452 occurring at all altitudes, comprising 33 percent of the total specimens taken. Several of the families represented included important economic species. The Culicidae included several species of mosquitoes, and while only eight specimens were taken, the three determined species are worthy of comment. A male southern house mosquito (*Culex quinquefasciatus* Say) was collected at 100 feet on a late evening flight. This mosquito, while not recorded as of great importance in the United States as a health menace, is however, a carrier of *Filariasis* causing elephantiasis. Four female *Culex* spp. were also taken at 100, 200, and 500 feet in the late evening and early morning flights. Two of the dark ricefield mosquito (*Psorophora confinis* (Lynch)) were taken at 200 and 500 feet on a noon flight. This mosquito is a serious pest of cattle and other warm-blooded animals, as well as man. One female of the common salt-marsh mosquito (*Aedes taeniorhynchus* (Wd.)) was collected at 500 feet at night. It is very abundant in the marsh areas along the coast of Texas. It is a serious pest of livestock and is known to be a carrier of equine encephalomyelitis.

The family Chloropidae included several species of economic importance such as *Hippelates impressus* Beck, *pusio* Lw., and *dissidens* (Tuck.). *H. pusio*, known as the eye gnat, hovers about the eyes of man and other animals, often causing conjunctivitis. Five specimens of *pusio* were taken at altitudes of 100 and 200 feet. Two hundred and fourteen specimens of *dissidens* were taken at all altitudes except 2,000 feet. *H. dissidens* is one of a group of species that are not true "eye gnats," and are not annoying as is *pusio*.

The family Heleidae was represented by several species taken in the upper air. *Culicoides variipennis* (Coq.), the sand flies, or one of the no-see-ums, were taken at altitudes from 100 to 5,000 feet. In the Louisiana airplane collections this species was taken up to 5,000 feet, and *Culicoides* spp. from 7,000 to 13,000 feet. *C. variipennis* is known to be a vector of the blue tongue disease of sheep in Texas, and probably also in Mexico and some of the Western States. *Culicoides* are most annoying to man, and their bite is certainly disagreeable. Some people are apparently allergic to these small flies, and suffer from frequent sneezing, as well as severe headaches (Glick *4*, p. 96).

METEOROLOGICAL DATA

A thorough evaluation of meteorological data in reference to the airplane collections of insects cannot be attempted as too few flights were made. While the occurrence and numbers of insects in the air vary from time to time, it is often difficult or impossible to determine the controlling factor or factors affecting their distribution. Mills

(8, p. 425) considers that insects are so responsive to their meteorological environment that we must have a knowledge of its effects if we are to understand, extend, or improve control measures. Outbreaks of insect pests are often closely associated with sudden changes in weather conditions. Many insects are carried long distances with the aid of wind currents. Invasions of mosquitoes are occasionally attributed to change in wind direction, the condition to be relieved only with the reverse of the wind. Accordingly, the knowledge obtained, in making these dissemination studies, of the species of insects in the air and the meteorological conditions associated with their occurrence, gives one a better understanding of the part that weather plays in insect activity, which will indirectly aid us in our control efforts.

Since the collections were made from August 18 to September 3, or during a 16-day period, there were no seasonal changes to be considered. However, where conditions are more or less regular, a trend in insect activity might be evident in some instances.

Temperature.—Only a single temperature recording was made at the surface. However, at each altitude flown the temperature was taken, and some relation was shown in the number of insects collected in the upper air for given temperatures recorded at the respective altitudes. At temperatures of 75° to 79° F., the average for all altitudes was 19.3 insects per 10 minutes of exposure of the screens. At 80° to 84° the average decreased to 10.4; and at 85° to 89° the number continued to decrease to 7.9. At altitudes of 100, 200, and 500 feet temperature did not appear to be the controlling factor as the collections were irregular in numbers taken, or with slight variance. However, at 1,000 feet the relation was apparent, the maximum numbers (6.6 specimens in 10 minutes' flying time) being taken at temperatures of 80° to 84°, and considerably fewer at 85° to 94° (table 2).

TABLE 2.—*Insects and spiders collected by airplane in 10-minute exposure of the screens at different altitudes as related to the temperatures at the respective altitudes, lower Rio Grande Valley and King Ranch areas, Texas, 1954*

Altitude (feet)	Average number taken at temperatures of—			
	75°–79° F.	80°–84° F.	85°–89° F.	90°–94° F.
100	61.33	18.33	17.17	19.13
200	10.20	12.50	8.37	11.50
500	4.25	4.18	3.40	3.67
1,000	1.43	6.61	2.71	2.50
Average	19.30	10.40	7.91	9.20

Dew point.—The dew point was calculated from the temperature readings for each altitude flown. In the Louisiana collections, a relation was apparent between dew point and the number of insects collected when the surface dew point was between 60° and 70° F. In the Brownsville collection averages for all altitudes flown, an increase was shown in the number of insects and spiders taken when

the surface dew point increased from 60° to 74° F., an average of 5.2 being collected per 10-minute exposure of the screens at 60°, 8.3 at 65° to 69°, and 11.2 at 70° to 74°, but the number collected decreased to 6.4 at 75° to 79° F. There were few recordings of dew point over 80° above 100 feet (table 3).

TABLE 3.—*Insects and spiders collected by airplane in 10-minute exposure of the screens at different altitudes as related to the dew point at ground level, lower Rio Grande Valley and King Ranch areas, Texas, 1954*

Altitude (feet)	Average number taken at dew points of				
	60°–64° F.	65°–69° F.	70°–74° F.	75°–79° F.	80°–84° F.
100	11.10	14.00	27.51	13.75	11.10
200	3.00	12.33	10.93	7.40	
500		4.75	4.10	2.55	
1,000	1.50	2.29	2.32	1.75	
Average	5.20	8.34	11.22	6.36	

Relative humidity.—There was no apparent relation between the individual collection, or collections as a whole, and the percent of relative humidity.

Wind direction.—Since the direction of the wind often determines the number and types of insects in the air at any given time, it was of interest to know what part this factor contributed to the insect distribution in the lower Rio Grande Valley. The prevailing wind was from the southeast. A source of insect supply is most limited for the lower Rio Grande Valley from this direction as the Gulf of Mexico is on the eastern and southeastern boundary. The greatest number of insects were collected when the wind was from the north, 20.4 insects being taken per 10 minutes of flying time. The number of insects taken decreased rapidly as the wind direction changed from the north. There were 5.8 insects taken when the wind was from the northeast, 4.4 from the east, 1.3 from the southeast, and 1.2 from the south. There were no data when the wind was from a westerly direction. It may be added that undoubtedly there is an occasional drift-in of insects over the Gulf from Yucatan or from the lower east coast of Mexico, which at times may account for the sudden appearance of the cotton leafworm moth (*Alabama argillacea* (Hbn.)) in the lower Rio Grande Valley or the Texas Gulf Coast area (fig. 4).

Wind velocity.—Wind velocity is a definite factor in insect distribution in the upper air. At times, when the velocity exceeded 6 miles per hour, few pink bollworm moths would be taken in the light traps (Glick *6*). In the airplane collections at all altitudes flown in the Valley and King Ranch areas, a definite trend was shown in the effect of near-surface wind velocity, maximum numbers (10.7 insects) being collected when the air was calm, decreasing slightly as wind velocity increased to 10 miles per hour, and with very few insects in the air when the surface wind velocity was beyond 18 miles per hour (fig. 5).

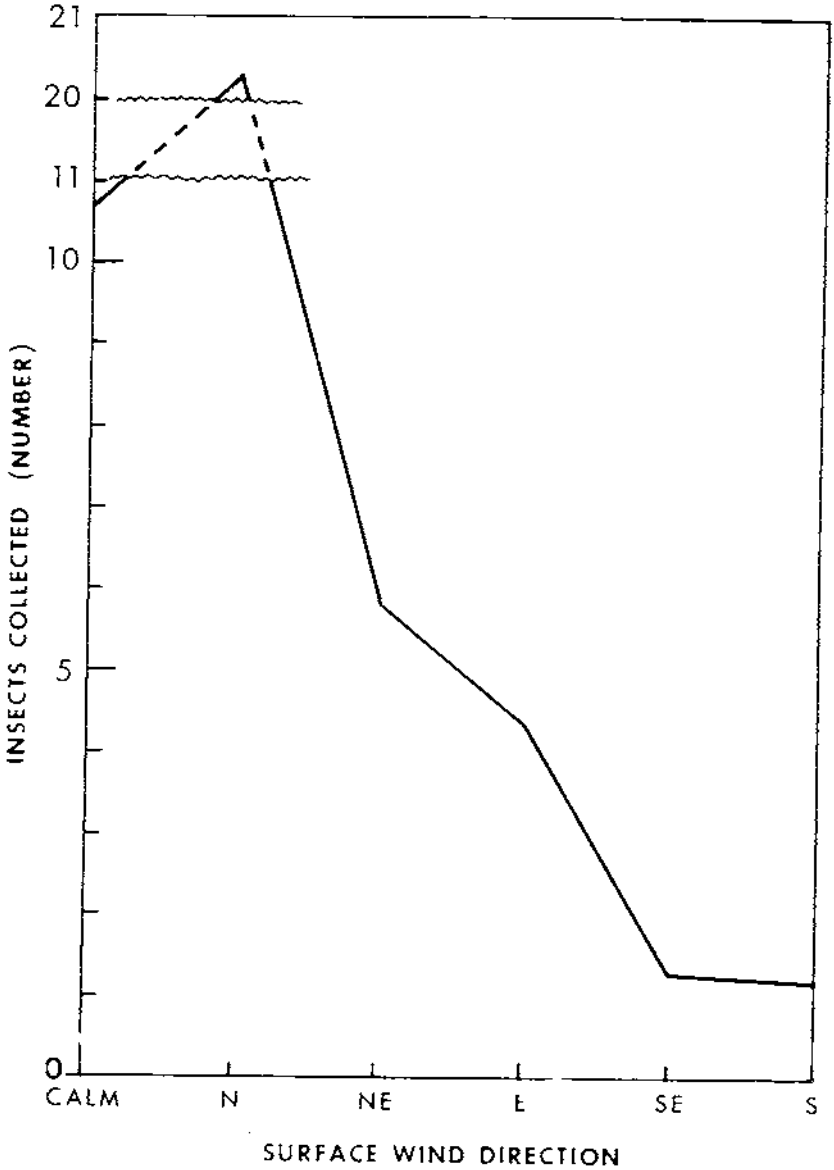

FIGURE 4.—Average number of insects collected by airplane in a 10-minute period of flying time, as related to surface wind direction. Rio Grande Valley and King Ranch areas, Texas, 1954.

There was also a relation between the numbers of insects and spiders taken at given altitudes and the wind velocities recorded at the respective altitudes. At the 100-foot altitude, or lowest altitude flown, little relation was evident as convectional currents appeared to offset this factor. At 200 feet most insects were collected when the wind velocity was 5 to 6 miles per hour (14.9 insects), the number decreasing thereafter as the wind increased in velocity, with 13.2 insects collected at

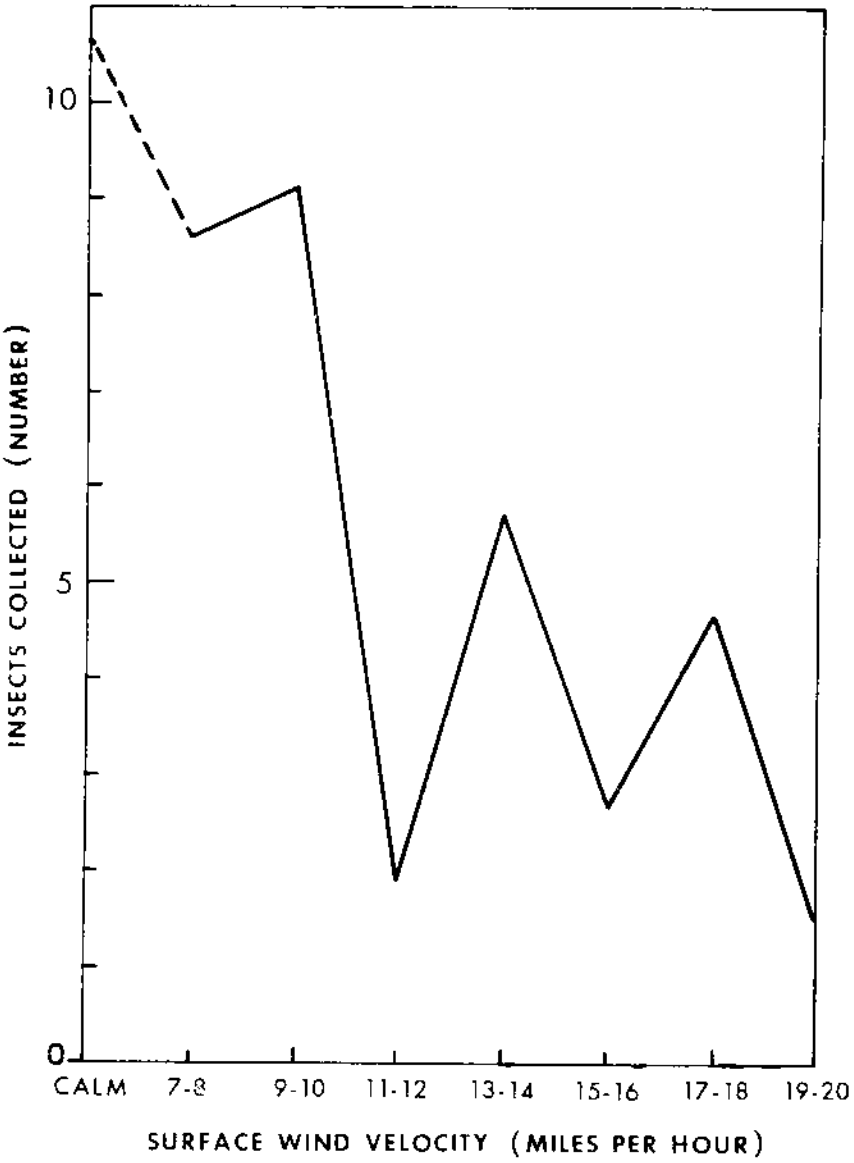

FIGURE 5.—Average number of insects collected by airplane in 10 minutes of flying time for all altitudes, as related to surface wind velocity, Rio Grande Valley and King Ranch areas, Texas, 1954.

9 to 10 miles per hour, 6.3 at 13 to 14 miles, 4.4 at 15 to 16 miles, and 2.2 at 17 to 20 miles per hour. At 500 feet there was an average of 6 insects taken when the wind velocity was 7 to 8 miles per hour, the number decreasing rapidly as the wind velocity increased. At 1,000 feet there was an average of 9.7 insects taken at 7 to 8 miles per hour, the numbers collected also greatly decreasing as the wind increased in velocity (fig. 6).

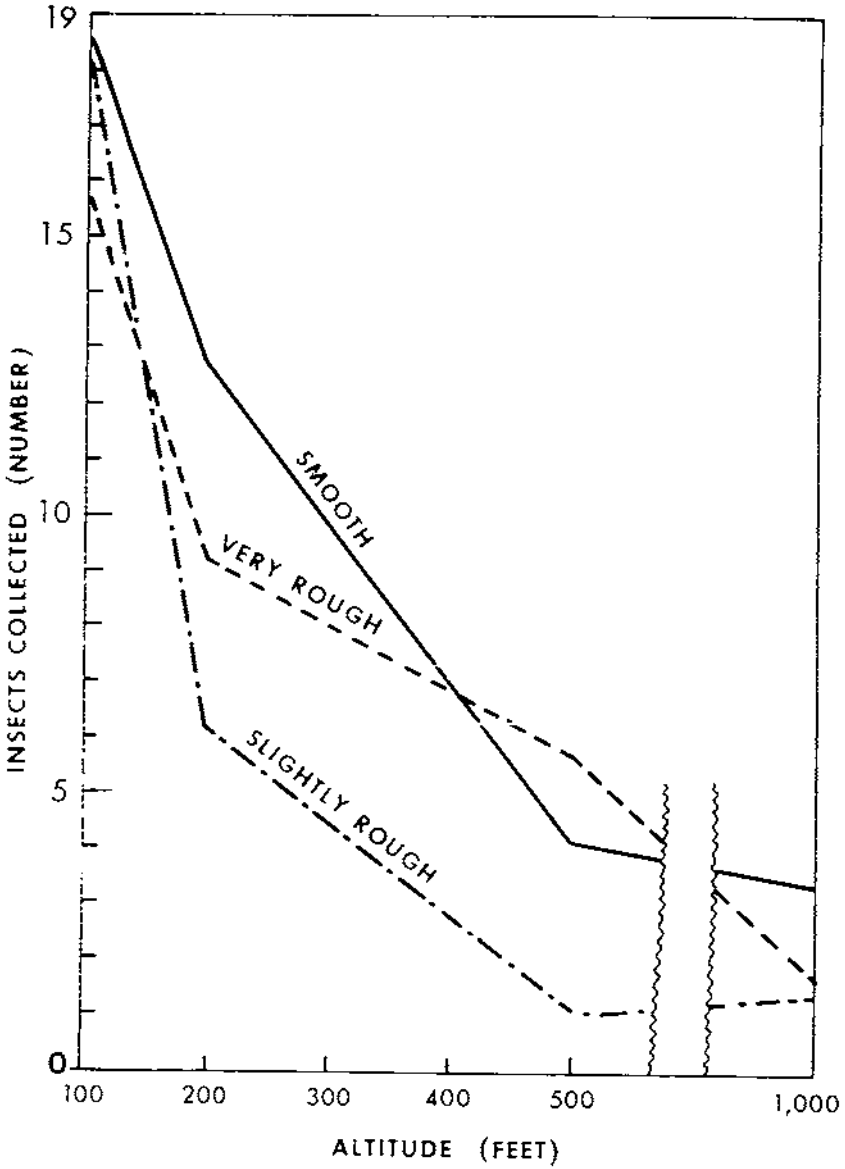

FIGURE 6.—Average number of insects collected by airplane in 10 minutes of flying time, as related to the wind velocity recorded at altitudes of 200, 500, and 1,000 feet, Rio Grande Valley and King Ranch areas, Texas, 1954.

Convection.—Thermal convection, or heated air radiating from the earth's surface, may contribute directly to the numbers and species of insects to be found at any given time in the upper air. Those insects with considerable buoyancy, or with great wing expanse in proportion to their body weight and size, will be carried upward.

The effects of convection were considered in the studies of insect dissemination and migration in the Brownsville collections. The

variation in the amount of convection was determined or estimated by the "feel" of the air when flying; that is, whether it was smooth, slightly rough, or very rough.

Although the numbers of insects taken decreased progressively at altitudes from 100 to 1,000 feet, the effect of the convectional currents of air on the insect collections was evident. At 100 feet, when the air was smooth or slightly rough, the numbers of insects collected were about the same. At 200 feet more insects were taken when the air was smooth, and at 500 feet more were collected when the air was very rough than when it was smooth or slightly rough. At 1,000 feet the effect of convection was not too evident, although more insects were taken when the air was smooth than when it was slightly rough or very rough (fig. 7).

Light intensity.—Light intensity refers in part to the amount of light from daybreak to dark and, correlated with meteorological conditions, determines the activity of many species of insects, as well as for most biota. However, the light during the day is so variable that insects may be found in their maximum abundance at any given hour.

For the 16-day period the flights were made, a correlation was shown between the numbers of insects taken and the time of day, or the amount of light from daybreak to night. On most flights, at 100 feet the greatest numbers of insects were taken at daybreak, or from 5 to 6 o'clock. The average was 39.5 insects collected in 10 minutes' exposure of the screens, the numbers diminishing rapidly as altitude increased. At 200 and 500 feet the maximum numbers of insects were taken from 8:30 to 9:30 in the morning. At 1,000 feet the numbers collected were about the same, with an average of 3.7 insects throughout the morning until noon, dropping off considerably thereafter. At 2,000 and 5,000 feet the numbers taken varied little and became more or less stabilized for the 24-hour period (fig. 8).

KING RANCH AREA

In order to determine if the pink bollworm moth could be taken in the upper air over a semi-arid area, as well as to compare insect populations with those over the more cultivated area of the lower Rio Grande Valley, permission was obtained to fly over the great King Ranch, 55 miles north of Brownsville. Nine flights were made in Kenedy County from Norias, 21 miles north of Raymondville, northwest toward Falfurrias for approximately 25 miles (fig. 2, shaded area). The plane was reserviced and insects were removed from the screens at the Fox Airport at Raymondville.

The area over which the flights were made was mostly desolate, with no land in cultivation, and used only as a cattle range. Here and there were small lakes or ponds that were gradually drying up. Vegetation appeared to be sparse, consisting of cacti, mesquite, grasses, yucca, Texas ebony, and other species of plants which comprise the chaparral. A few flights were made along the edge of the coastal sand dunes where thickets of scrub live oak were interspersed with mesquite. The shifting sand dunes at the south end of the King Ranch near Red Fish Bay are characterized by a high water table, wet sand occurring usually within one inch of the surface. Ponds in the process of formation and extinction occur among the active sand hills. As a result of this curious situation, willow (*Salix* sp.) is the dominant, if not the exclusive, woody plant on these dunes. Mesquite

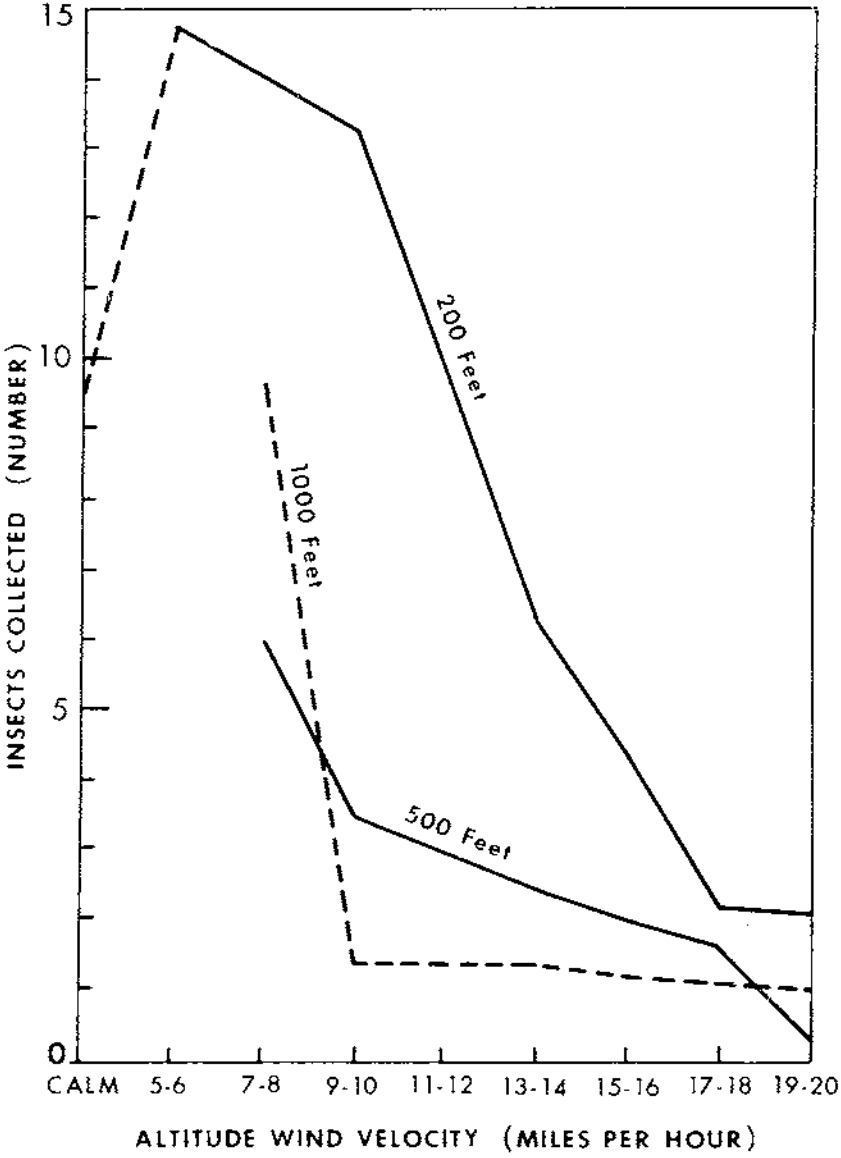

FIGURE 7.—Average number of insects collected by airplane in 10 minutes of daylight flying, showing the relation between the altitude reached by the insects and the condition of the air, Rio Grande Valley and King Ranch areas, Texas, 1954.

groves grow on the more level areas of low elevation surrounding the sand hills. Here and there water tanks were seen, connected by long roads of white sand that continue over the extensive area. The ranch covers some one million acres in two or more counties, and there appeared to be no end to this vista. In the late evenings numerous herds of deer, packs of javelinas, many flocks of wild turkey, jack rabbits, and a few coyotes were seen (fig. 9).

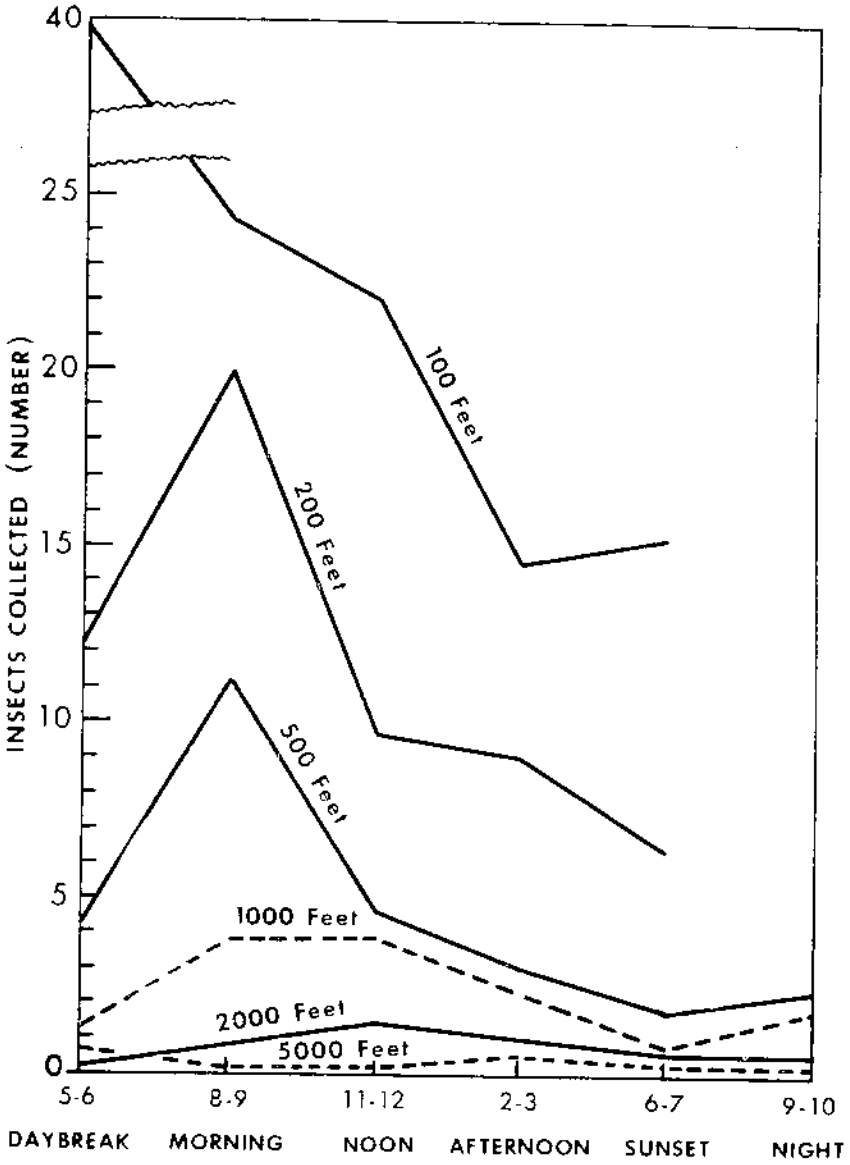

FIGURE 8.—Average number of insects collected per 10 minutes of flying time at altitudes of 100 to 5,000 feet, in relation to time of day, Rio Grande Valley and King Ranch areas, Texas, 1954.

The insect population was, of course, much less than over the lower Rio Grande Valley. In the 46 flights, nearly twice as many insects were collected per 10-minute exposure of the screens over the Valley (6.3 insects) as over the King Ranch (3.4 insects). At 100 feet, 10.7 insects were taken as compared with 27.0 insects collected over the Valley. At 200 feet, 7.4 insects were taken as compared with 10.7 over the lower Rio Grande Valley. At the higher altitudes there appeared to be a drift-in of insects from the cultivated areas (table 1).

FIGURE 9. Country over the great King Ranch between Norias and Falfurrias, Tex. Nine flights were made in this area. The long white sandy roads run over semi-desert area for many miles, disappearing in the distant horizon. At upper right of picture one of the airplane insect traps may be seen with control wires blowing in the air stream.

One spider, an immature specimen belonging to the family Linyphiidae, was taken over the King Ranch.

Few Coleoptera appeared in the collections. They were taken mostly in one flight, and included the chrysomelids *Pachybrachis* sp. at 200 feet, an *Epitrix* sp., probably *hirtipennis* (Melsh.), at 500 feet, and one species of Phalacridae at 200 feet. One *Melanophthalma* (*Cortilena*) sp. was taken at 1,000 feet. When the air was calm on the surface, the upper air was more or less rough, with considerable convection.

Numbers of cicadellids, among them two specimens of *Empoasca abrupta*, were taken at 100 feet when the air was quite rough and convection was strong.

The other insects taken were mostly the smaller Hymenoptera and Diptera. Numbers of *Hippelates dissidens* were collected at 100 to 1,000 feet, most of them in one flight between 7 and 10 a. m., at which time convection was very strong, with little or no wind velocity. On this same flight 81 insects were taken, 3 at 5,000 feet including a Dolichopodidae sp. (Diptera), a *Testrastichus* sp. (Hymenoptera), and a female *Empoasca* sp. (cicadellid).

One sand fly, *Culicoides variipennis*, was taken at 100 feet in an early morning flight (6:04 a. m.) when the air was smooth and calm.

The nearest cotton to the area over which the flights were made was toward Kingsville and Raymondville, some 10 to 15 miles distant. One male pink bollworm moth was taken at 1,000 feet, as mentioned previously. The wind was in the southeast direction, the air quite rough, and convection strong.

While the semi-arid region supports many insects, wind currents are undoubtedly an important factor in aiding their migration. With the strong convectional currents in this area, many insects may be picked up to be transported in the upper air.

SUMMARY

A Piper Cub airplane was equipped with two insect traps, and 46 flights were made over the lower Rio Grande Valley and the King Ranch areas of Texas from August 18 to September 3, 1954.

The flights were made to study particularly the migration and dissemination of the pink bollworm moth, with other miscellaneous insects and spiders considered.

Meteorological data and observations, both on the surface and in the upper air, were recorded at the time the flights were made in order to make any correlation with the collections. Upper air readings (wind direction and velocity) were obtained through the courtesy of the U. S. Weather Bureau Office at the International Airport at Brownsville, Tex.

Altitudes flown in the daytime ranged from 100 to 5,000 feet, and night flights from 500 to 5,000 feet. The screens (one square foot in size, and five for each trap) were exposed for 10 minutes at each altitude.

A total of 1,373 insects were caught. The following numbers were collected at the several altitudes: 100 feet, 618; 200 feet, 430; 500 feet, 182; 1,000 feet, 92; 2,000 feet, 27; and 5,000 feet, 24 insects.

The number of specimens of each order was: Psocoptera 20, Ephemeroptera 3, Thysanoptera 2, Hemiptera 72, Homoptera 372, Coleoptera 176, Lepidoptera 24, Hymenoptera 142, Diptera 452, Araneida (the order of spiders) 33, and unrecognizable insects 77.

Twelve pink bollworm moths were taken: 4 at 100 feet, 3 at 200 feet, 2 at 500 feet, and 3 at 1,000 feet, of which there were 5 males, 6 females, and 1 undetermined.

The male pink bollworm moths were collected when the atmosphere was rough or convection strong, while the female moths were collected when the air was smooth, possibly indicating the females remain close to the ground or in the cotton when convection is strong.

One male pink bollworm moth was taken over the King Ranch at 1,000 feet on a noon flight when the air was rough and convection strong. The nearest cotton was 10 to 15 miles distant.

Three light traps were used—one at 100 feet on a water tower, one on the roof of an eight-story hotel in Brownsville, and one on the catwalk at the 85-foot level of the Port Isabel lighthouse, to supplement the lower altitudes of 100 feet or less. During the summer season when these traps were in operation, 7 moths were taken on the water tower, 159 on the hotel, and none in the lighthouse trap.

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