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# REVIEW OF COLLECTIONS OF LEPIDOPTERA BY AIRPLANE

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It has long been established that many species of Lepidoptera are migrants and are carried by air currents far out to sea or across continents. With the continuing aid of air currents they can be carried over mountain barriers and descend in the leeward currents into the valleys below, where if conditions are favorable they can perpetuate themselves. The writer has observed butterflies drifting or flying at altitudes over 14,000 feet in the Rockies, especially the less common satyrid, *Erebia magdalena* Strecker; the pierid, *Colias meadii elis* Strecker; and a papilionid, *Parnassius* sp.

The height to which a butterfly, moth, or other insect may be carried by air currents is related to its size, weight, and buoyancy. This relationship may be expressed in terms of the aerostatic or lighter-than-air coefficient (Glick, 1939). The aerostatic coefficient varies directly with the area of the insect which is exposed perpendicular to the pull of gravitation and inversely with the weight of the insect per unit of exposed area; and therefore, the lighter the insect the greater the aerostatic coefficient, and the heavier the insect the less the aerostatic coefficient or actual buoyancy.

The vertical lift of an insect may be represented by the equation: $Ac = K\frac{R}{W}$. $Ac$ is the aerostatic coefficient, $R$ equals the area in metric units exposed perpendicular to gravity, $W$ represents the weight in milligrams of the insect exposed to gravity, and $K$ equals the constant or insect involved. Thus, any insects, particularly the more fragile butterflies and moths, occur at very high altitudes because of their relative size and weight, or buoyancy. Under the same given conditions of wind velocity and convection, a heavily built insect with small wing expanse will not

[1] In cooperation with the Texas Agricultural Experiment Station. Mention of trade names herein does not necessarily imply their endorsement by the U.S.D.A.

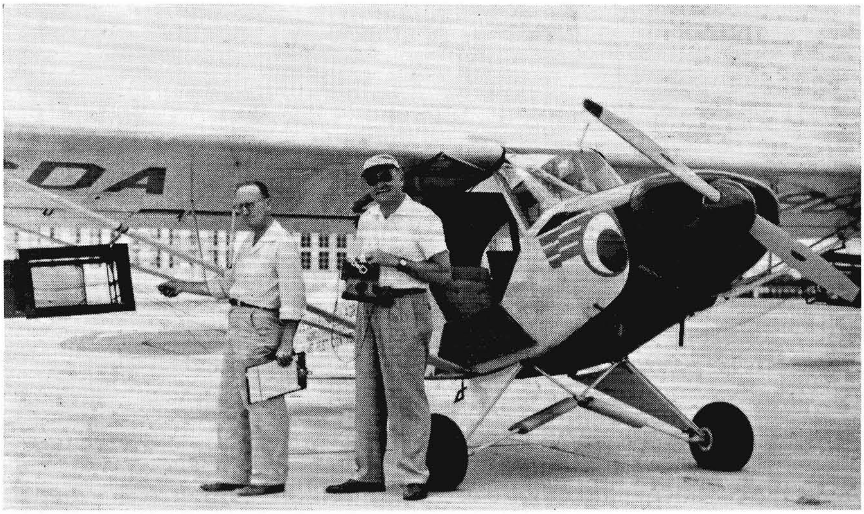

Fig. 1. Piper Cub plane equipped with insect traps placed beneath wings with control wires running from traps to cabin. A screen is partly pulled out of closed compartment for exposure as when in operation (Glick, 1955).

be carried as high as a very light insect with relatively greater wing expanse.

Most butterflies find it difficult to fly in a strong wind because their wings offer a broad surface to the air. However, certain species may even find it easier to fly directly into a strong wind, with the wings vertically closed and opened alternately so as to offer the sharpest edge to the resistance of the wind. Such a butterfly does not appear to propel itself, but to be driven forward by the action of the wind eddying against the undersurface of the wing presented to it, but how this is done is not easy to demonstrate (Tutt, 1902).

Micros are more or less at the mercy of air currents when in flight, particularly if the wind is above 6–10 miles per hour. Glick *et al.* (1956) determined that pink bollworm moths, *Pectinophora gossypiella* (Saunders), were collected in greater numbers in light traps when the wind velocity was three miles per hour or less and their flight was directly into the wind. During strong winds butterflies tend to remain close to vegetation and even the strong fliers seldom venture forth.

The writer in past years, and more recently from 1954 to 1957, made a comprehensive study of insect dissemination and distribution, with emphasis on the more important economic species (Glick, 1939, 1955, 1957, 1960, & Glick and Noble, 1961). This study, conducted with airplanes, involved some 1,552 flights. More than 1,286 hours were spent in actual

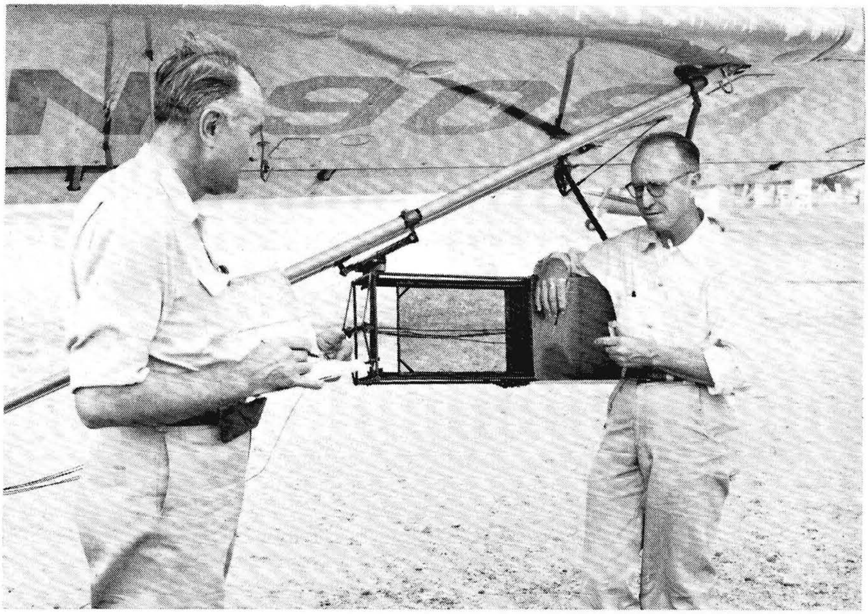

Fig. 2. Insect-collecting trap, as shown under wing of plane, with screen pulled out of closed compartment to enable removal of insects and transferring them to alcohol in vials. The pilot, Arthur Gieser (left), is recording data.

collecting with screens or nets exposed. The flights were made from altitudes near ground surface to 16,000 feet and resulted in the collection of 35,826 insects.

## Procedures and Area Covered

The first airplane insect traps used in these extensive upper air insect collections were operated from 1926 to 1931 in northeast Louisiana and in Mississippi across the Mississippi River from Tallulah, Louisiana. The writer designed the original three-compartment trap, which was placed between the wings of an old JN6H Army training ship and on DeHaviland H1 Army biplanes (Glick, 1939, 1941, & 1942). These traps were also adapted for a Stinson Detroiter SM1 monoplane. In 1930 the trap was redesigned by the late G. C. McGinley to consist of two compartments. This latter type trap was used on a Piper Cub PA Super Cruiser (Figs. 1 & 2) in flights at Brownsville, Texas, in 1954, and at College Station, Texas; Shreveport, Louisiana; and Texarkana, Arkansas in 1956. In 1957 another type of trap, designed by C. N. Husman, was used in flights over northeast Louisiana, Mississippi, Illinois, and Indiana. This trap was equipped with a series of nets and operated from the plane cabin (Fig. 3).

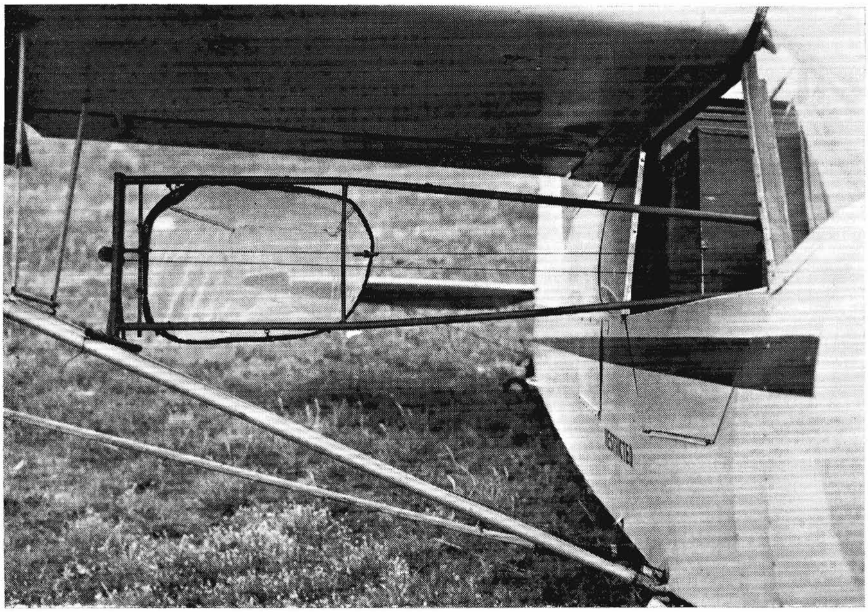

Fig. 3. Insect trap using nets in position on plane; steel tracks extend from rear of cabin to struts of plane, with net in collecting position at end of tracks (Glick, 1960).

Flights were made when weather conditions permitted both night and day collecting. The insects taken were correlated with weather and meteorological data embracing surface and upper-air recordings. The flights in northeast Louisiana from 1926 to 1931 were made throughout every month of the years involved. The other series of flights were made either in the spring, summer, or late fall.

## DISCUSSION

Lepidoptera, the only order considered in this paper, comprised probably the more important species taken, although it represented only one percent of the total insects collected in the upper air. The Lepidoptera included five families of Rhopalocera and 25 families of Heterocera, the greater portion of which were Microlepidoptera. The two families of moths in which we were most interested and for which our flights were primarily made were the Noctuidae and Gelechiidae. The family Noctuidae included several important economic species including adults of the bollworm, *Heliothis zea* (Boddie); cabbage looper, *Trichoplusia ni* (Hübner); cotton leafworm, *Alabama argillacea* (Hübner); fall armyworm, *Laphygma frugiperda* (J. E. Smith); and the armyworm, *Pseudaletia unipuncta* (Haworth). Specimens of the garden webworm,

TABLE I. LEPIDOPTERA COLLECTED BY AIRPLANE IN A SERIES OF FLIGHTS MADE IN ILLINOIS, LOUISIANA, MISSISSIPPI, AND TEXAS AT INTERVALS FROM 1926 to 1957

| Family, genera, and species | State | Altitude (feet) | Number |
|---|---|---|---|
| PIERIDAE: | | | |
| *Colias eurytheme* Boisduval | La. | 50 | 1 |
| NYMPHALIDAE: | | | |
| *Phyciodes tharos* (Drury) | La. | 50 | 1 |
| *Junonia coenia* (Hübner) | La. | 200 | 1 |
| HESPERIIDAE: | | | |
| *Celotes nessus* | La. | 20 | 1 |
| *Epargyreus clarus* (Cramer) | La. | 600 | 1 |
| *Hesperia leonardus* Harris | La. | 20 | 1 |
| *Lerema accius* (Smith) | La. | 200 | 1 |
| *Lerodea eufala* (Edwards) | La. | 200 | 1 |
| AMATIDAE (Syntomidae): | | | |
| *Scepsis fulvicollis* (Hübner) | La. | 200 | 1 |
| | | 1,000 | 1 |
| | | 2,000 | 2 |
| " | Texas | 100 | 1 |
| NOCTUIDAE: | | | |
| *Trichoplusia ni* (Hübner) (= *Autographa brassicae* (Riley)) | La. | 500 | 1 |
| " | Texas | 200 | 1 |
| *Alabama argillacea* (Hübner) | La. | 200 | 2 |
| | | 500 | 14 |
| | | 1,000 | 6 |
| | | 3,000 | 1 |
| *Bomolocha* sp. | La. | 500 | 1 |
| *Eublemma obliqualis* (F.) | La. | 500 | 1 |
| *Heliothis zea* (Boddie) | La. | 500 | 1 |
| *Laphygma frugiperda* (Smith) | La. | 500 | 4 |
| | | 1,000 | 1 |
| NOCTUIDAE (cont'd) | | | |
| | | 2,000 | 1 |
| *Laphygma frugiperda* (Smith) (alive) | La. | 500 | 1 |
| *Ommatochila mundula* Zeller | La. | 500 | 1 |
| *Pseudaletia unipuncta* (Haworth) | Ill. | 200 | 1 |
| *Plathypena scabra* (F.) | La. | 500 | 1 |
| *Tetanolita mynesalis* (Walker) | La. | 500 | 1 |
| Undet. spp. | La. | 500 | 3 |
| | | 1,000 | 1 |
| GEOMETRIDAE: | | | |
| Undet. spp. | La. | 1,000 | 2 |
| PTEROPHORIDAE: | | | |
| *Oidaematophorus* sp. | Texas | 3,000 | 1 |
| *Pterophorus tenuidactylus* Fitch | La. | 200 | 1 |
| *Pterophorus* sp. | La. | 200 | 1 |
| Undet. sp. | La. | 1,000 | 1 |
| PYRALIDAE: | | | |
| Pyralinae; | | | |
| *Pyralis farinalis* L. | La. | 5,000 | 1 |
| Undet. sp. | La. | 600 | 1 |
| Pyraustinae; | | | |
| *Nomophila noctuella* (Schiff.) | La. | 3,000 | 1 |
| *Geshna primordialis* Dyar | La. | 500 | 2 |
| | | 600 | 1 |
| | | 1,000 | 4 |
| *Loxostege similalis* (Guenée) | Texas | 200 | 2 |
| | | 500 | 1 |
| | La. | 500 | 1 |
| | | 3,000 | 1 |
| *Microtheoris* sp. | Texas | 1,000 | 1 |

TABLE I (continued)

| Family, genera, and species | State | Altitude (feet) | Number |
|---|---|---|---|
| PYRALIDAE (cont'd) | | | |
| Undet. spp. | La. | 5,000 | 1 |
| | Texas | 200 | 2 |
| | | 600 | 1 |
| | | 1,000 | 1 |
| | | 2,000 | 1 |
| Crambinae; | | | |
| *Euchromius ocelleus* (Haworth) | Texas | 200 | 1 |
| Phycitinae; | | | |
| *Elasmopalpus lignosellus* (Zeller) | La. | 500 | 3 |
| | Texas | 1,000 | 1 |
| Undet. spp. | La. | 500 | 1 |
| | Texas | 3,000 | 1 |
| TORTRICIDAE: | | | |
| Olethreutinae; | | | |
| *Epiblema strenuana* (Walker) | La. | 500 | 1 |
| *Celyphoides cespitana* (Hübner) | La. | 1,000 | 1 |
| Undet. spp. | Ill. | 200 | 1 |
| | Texas | 200 | 1 |
| | | 2,000 | 2 |
| Tortricinae; | | | |
| Undet. sp. | Texas | 200 | 1 |
| Phaloniidae: | | | |
| *Phalonia* sp. | Texas | 1,000 | 1 |
| COSMOPTERYGIDAE: | | | |
| *Cosmopteryx* spp. | Texas | 200 | 1 |
| | La. | 1,000 | 1 |
| | | 5,000 | 1 |
| Undet. spp. | La. | 500 | 1 |
| | Texas | 500 | 3 |
| | | 2,000 | 2 |
| Walshiidae: | | | |
| *Periploca concolorella* (Cham.) | Texas | 200 | 1 |
| Epermeniidae: | | | |
| *Epermenia* sp. | La. | 5,000 | 1 |
| GELECHIIDAE: | | | |
| *Anacampsis* sp. | Texas | 200 | 1 |
| *Aristotelia* sp. | | | |
| *roseosuffusella* (Clemens)? | La. | 500 | 1 |
| | | 1,000 | 1 |

| Family, genera, and species | State | Altitude (feet) | Number |
|---|---|---|---|
| GELECHIIDAE (cont'd) | | | |
| *Aristotelia quinquepunctella* Busck | La. | 2,000 | 1 |
| *Battaristis concinusella* (Chambers) | Texas | 200 | 5 |
| | | 500 | 1 |
| | | 2,000 | 1 |
| *Chionodes*? sp. | Texas | 200 | 1 |
| *Dichomeris ligulella* (Hübner) | La. | 2,000 | 1 |
| *Eucordylea* sp. | La. | 200 | 1 |
| *Gelechia* spp. | La. | 200 | 1 |
| | | 1,000 | 1 |
| *Gelechia* spp. (larvae) | La. | 500 | 1 |
| | | 1,000 | 2 |
| *Glyphidocera* sp. | Texas | 200 | 1 |
| *Gnorimoschema* spp. | Texas | 100 | 1 |
| | | 500 | 1 |
| | | 2,000 | 1 |
| *Keiferia* sp. | Texas | 100 | 1 |
| *Stegasta bosqueella* (Chambers) | Texas | 200 | 1 |
| | La. | 1,000 | 1 |
| *Pectinophora gossypiella* (Saunders) | La. | 100 | 4 |
| | | 200 | 6 |
| | | 500 | 11 |
| | | 1,000 | 5 |
| | | 2,000 | 3 |
| | Texas | 1,000 | 1 |
| BLASTOBASIDAE: | | | |
| *Holcocera* spp. | La. | 200 | 2 |
| | | 1,000 | 2 |
| GLYPHIPTERYGIDAE: | | | |
| *Glyphipteryx impigritella* Clemens | La. | 3,000 | 1 |
| Scythrididae: | | | |
| *Scythris* spp. | Texas | 200 | 1 |
| | | 1,000 | 1 |
| Undet. spp. | Texas | 200 | 3 |
| COLEOPHORIDAE: | | | |
| *Coleophora* spp. | Texas | 200 | 2 |
| | | 500 | 3 |

TABLE I (continued)

| Family, genera, and species | State | Altitude (feet) | Number |
|---|---|---|---|
| COLEOPHORIDAE (cont'd) | | | |
| | | 2,000 | 4 |
| | | 3,000 | 1 |
| GRACILARIIDAE: | | | |
| *Neurobatha strigifinitella* (Clemens) | La. | 500 | 1 |
| LYONETIIDAE: | | | |
| *Bedellia sommulentella* Zeller | La. | 2,000 | 1 |
| *Bucculatrix* spp. | La. | 200 | 1 |
| | | 500 | 2 |
| Undet. sp. | Texas | 5,000 | 1 |
| TISCHERIIDAE: | | | |
| Prob. *Tischeria* sp. | Ill. | 1,000 | 1 |
| TINEIDAE: | | | |
| *Tinea* spp. | La. | 1,000 | 1 |
| | | 2,000 | 1 |
| NEPTICULIDAE: | | | |
| *Nepticula* spp. | La. | 200 | 2 |
| Microlepidoptera undet. spp. | La. | 200 | 4 |
| | | 500 | 32 |
| | | 1,000 | 12 |
| | | 2,000 | 6 |
| | | 3,000 | 2 |
| | | 5,000 | 2 |
| Lepidoptera undet. spp. | La. | 20 | 2 |
| | | 200 | 18 |
| | | 500 | 28 |
| | | 1,000 | 8 |
| | | 2,000 | 3 |
| | | 3,000 | 1 |
| | | 5,000 | 2 |
| Lepidopterous larvae | La. | 200 | 2 |
| Total Lepidoptera taken | | | 319 |

Total flying time (hours) in Louisiana—852.9
Texas — 40.2
Illinois — 45.0

*Loxostege similalis* (Guenée) (Pyralidae; Pyraustinae), and the meal moth, *Pyralis farinalis* (L.) (Pyralidae), were also represented in the collections.

Several hundred flights were made to determine the height at which pink bollworm moths (*Pectinophora gossypiella* (Saunders)) could be recovered. Thirty-seven specimens were collected in Texas and Mexico at altitudes from 20 to 3,000 feet. Accordingly, since these airplane collections of pink bollworm moths have established the occurrence of the insect in the upper air, it is concluded that this destructive pest has a high power of dispersal, moving about freely in areas with suitable host material. Three larvae of the genus *Gelechia* were taken in the upper air—one at 500 feet at night, and two at 1,000 feet in the daytime. The two specimens at 1,000 feet were collected when the air was slightly rough.

It has been possible to trace the annual advance of the cotton leafworm moth from the time of its first appearance on cotton in the United States at Brownsville, Texas, to its first recorded appearance hundreds of miles

TABLE II. LEPIDOPTERA COLLECTED BY AIRPLANE IN A SERIES OF FLIGHTS MADE AT TLAHUALILO, DURANGO, MEXICO, SEPTEMBER, 1928[1]

| Family, genera, and species | Altitude (feet) | Number |
|---|---|---|
| SATYRIDAE: | | |
| Undet. sp. | 20 | 1 |
| LYCAENIDAE: | | |
| *Hemiargus isola* (Reakirt) (*H. isola isola* (Reakirt)) | 1,000 | 1 |
| PTEROPHORIDAE: | | |
| Undet. sp. | 20 | 1 |
| TORTRICIDAE. | | |
| Oleuthreutidae; | | |
| *Epiblema sosana* (Kearfott) | 100 | 1 |
| GELECHIIDAE: | | |
| *Gnorimoschema* sp. | 2,000 | 1 |
| *Pectinophora gossypiella* (Saunders) | 20 | 4 |
| | 100 | 1 |
| | 1,000 | 1 |
| | 3,000 | 1 |
| HELIODINIDAE: | | |
| Undet. spp. | 500 | 1 |
| | 1,000 | 1 |
| SCYTHRIDIDAE: | | |
| *Scythris* sp. | 100 | 1 |
| GRACILLARIIDAE: | | |
| Undet. sp. | 2,000 | 1 |
| Lepidoptera undet. sp. | 20 | 1 |
| Macrolepidoptera undet. sp. | 20 | 1 |
| Total Lepidoptera collected | | 18 |
| Total flying time (hours)—35.3 | | |

[1] Tlahualilo is situated in the Laguna District of Durango and Coahuila, some 43 miles north of Torreon.

northward. Comparisons of the records for seven years showed that it took 40 to 58 days, or an average of 56 days, for the moth to appear on cotton in northern Louisiana after its initial appearance in southern Texas near Brownsville. From the first record of the moth in fields near Brownsville to the first report of the moth from Wisconsin there was an average of 107 days, with 121 days for Minnesota and 113 days for Michigan. The airplane collections furnished additional information on the flight and migration activity of this moth. There were 23 specimens taken at altitudes from 500 to 3,000 feet. In 1929 the first moth found at Tallulah was taken in the airplane trap on August 5 at the altitude of 3,000 feet. This moth probably was a migrant, since neither eggs nor larvae had been reported in Louisiana previously (Glick, 1939).

The five families of butterflies represented in the airplane collections were Lycaenidae, Nymphalidae, Pieridae, Satyridae, and Hesperiidae.

The known species represented included the pierid, *Colias urytheme* Boisduval, and the nymphalids, *Phyciodes tharos* (Drury), and *Junonia coenia* (Hübner). The specimens were taken from near ground surface to altitudes up to 500 feet in northeast Louisiana. Five determined species of Hesperiidae, taken in the airplane collections up to 600 feet, included *Epargyreaus clarus* (Cramer), *Celotes nessus* (W. H. Edwards), *Hesperia leonardus* Harris, *Lerema accius* (J. E. Smith), and *Lerodea eufala* (W. H. Edwards). A small lycaenid, *Hemiargus isola* (Reakirt), was taken in Mexico near Torreon at 1,000 feet. An interesting incident occurred during a flight in northern Texas when numbers of monarch butterflies (*Danaus plexippus* (L.)) were encountered at 2,000 feet, but were able to evade the plane and continue on their course.

The list of species, genera, and families represented in the airplane collections of insects is shown in Table 1.[2]

## Summary

Collections of Lepidoptera and other orders of insects were taken in the upper air with the use of airplanes equipped with specially designed insect-collecting traps. Over 1,500 flights were made over Texas, Louisiana, Arkansas, Mississippi, Illinois, Indiana, and in Mexico to study the flight and seasonal activity of certain species of economic insect pests. Other insects encountered were also recorded. Lepidoptera composed only one percent of the total insects collected, but 25 families of Heterocera and five families of Rhopalocera were represented in the overall collections.

## Literature Cited

Glick, P. A., 1939. The distribution of insects, spiders, and mites in the air. U. S. Dept. Agr. Tech. Bull., 673, 150 pp.

1941. Insect population and migration in the air. Committee on Apparatus (National Research Council). Techniques for appraising air-borne populations of microorganisms, pollen, and insects. Phytopathology, 31(3): 216–220.

1942. Insect population and migration in the air. Aerobiology (Edited by Forest Ray Moulton). Amer. Assoc. Adv. Sci., 17: 88–98.

1955. Pink bollworm moth collections in airplane traps. Jour. Econ. Ent., 48(6): 767.

1957. Collecting insects by airplane in southern Texas. U. S. Dept. Agr. Tech. Bull., 1158, 28 pp.

1960. Collecting insects by airplane with special reference to dispersal of the potato leafhopper. U. S. Dept. Agr. Tech. Bull., 1222, 16 pp.

Glick, P. A., J. P. Hollingsworth, & W. J. Eitel, 1956. Further studies of the attraction of pink bollworm moths to ultraviolet and visible radiation. Jour. Econ. Ent., 40(2): 158–161.

Glick, P. A., & L. W. Noble, 1961. Airborne movement of the pink bollworm and other arthropods. U. S. Dept. Agr. Tech. Bull., 1225, 20 pp.

Tutt, J. W., 1902. The migration and dispersal of insects. London, 132 pp.

[2] Information in Table 1 compiled from several publications by the author, but taxonomic names appear as presently used.