Pacific Insects 6 (3): 525-531 November 10, 1964

DISPERSAL STUDIES ON APHIDIDAE, AGROMYZIDAE AND CYNIPOIDEA[1]

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Abstract: Many specimens of Aphididae were trapped at sea, and lesser numbers of Agromyzidae and Cynipoidea. These families were selected for comparative dispersal studies because of differing flight ability, different ratios trapped at sea, and because they could be identified. An attempt is made to correlate trapping results with normal abundance of individuals. More information is needed before precise conclusions can be drawn.

This report presents partial summarization of results of the air-borne insect trapping activities conducted aboard ships in the Pacific and Antarctic-Subantarctic areas. The object of this dispersal study is to document the theory of natural air dispersal of insects, particularly to isolated islands. The trapping program is connected with the studies of "Zoogeography and evolution of Pacific Insects" and was started during the summer of 1957. In trapping operations, use was made of ships of the Military Sea Transport Service (MSTS), U. S. Navy, U. S. Coast Guard, Scripps Institution of Oceanography, Bureau of Commercial Fisheries (Department of Interior) and the National Science Foundation.

We are deeply indebted to V. F. Eastop, British Museum (Nat. Hist.), London, for the Aphididae determinations and to M. Sasakawa, Kyoto Prefectural University, Kyoto, Japan for identifying the Agromyzidae. We are grateful to A. D. Lowe, Graeme White, and R. A. Cumber, DSIR, New Zealand, and K. A. J. Wise, for helpful information.

In the initial phase of the trapping program, cubical aluminum frame traps with removable screens on five sides painted with resin-castor oil and "deadline" (sticky petroleum base material for trapping insects) were used (Gressitt & Nakata 1958; Yoshimoto & Gressitt 1959). These were followed by nylon wind sock nets (elongate cone-shaped net) on steel rings of 1 m and 75 cm diameter strung in series on steel cables or lines from mast arms to deck railing of ship (Yoshimoto & Gressitt 1960, 1961, 1963; Gressitt, Leech & O'Brien 1960; Gressitt, Coatsworth & Yoshimoto 1962; Yoshimoto, Gressitt & Mitchell 1962) and recently suction traps (Yoshimoto, Gressitt & Mitchell 1962) were also operated.

Gressitt & Yoshimoto (1963) listed 6 families of Hemiptera, 27 families of Diptera, 20 families of Hymenoptera, and also 13 other orders and families of insects trapped. Data indicated that insects were more abundant in warmer months.

For the purpose of this paper, we arbitrarily selected 3 families, Aphididae (Homoptera),

1. Presented at the 11th International Congress of Entomology in London. Partial results of research supported by the Office of Naval Research (through Pacific Science Board) and the National Science Foundation (Office of Antarctic Programs).

Agromyzidae (Diptera) and Cynipoidea (Hymenoptera) from the list of trapped insects. For comparative evaluation, arbitrary categories are suggested here to group these families into types of fliers. The first type is represented by weak fliers, as the winged Aphididae (Johnson 1955). The second type is represented by weak-moderate fliers like the Cynipoidea. The third type includes moderate fliers, as represented by Agromyzidae. Beyond these types would be moderate-strong and strong fliers, not treated in this paper.

In order to make adequate comparisons to explain the differential trapping results for these 3 families, consideration is given not only to different abilities to fly, but the attempt is made to explain the relative ease of becoming airborne, and relative population ratios in nature in areas likely to have been the sources of wind-dispersed individuals taken in the trapping programs. For this purpose, special attention has been paid to New Zealand and the Ryukyu Islands as potential source areas.

The problem of aphid movements has been studied by many investigators including the lateral distribution by Elton (1925), Wadley (1931), Hardy & Milne (1937) and vertical distribution by Berland (1935), Hardy & Milne (1938), Glick (1939), Freeman (1945), Johnson (1957a–1960a-b). Taylor (1958) pointed out that the "majority of aphid migration takes place in windy weather." In further elucidation of dispersal and migration regarding the total number of insects in the air, Johnson (1960a) mentioned that "... the relative abundance at different heights, irrespective of absolute numbers, depends on the species, flight behavior, periodicity, flight duration and the rate of take-off as compared with the rate of landing, and particularly, on the degree of atmospheric stability."

The aerial density of insects depends primarily on terrestrial ecology (Johnson 1960a-b). To correlate with our trapping data, preliminary surveys of the 3 families, Aphididae, Agromyzidae, and Cynipoidea (Eucoilinae) were undertaken on the islands of Iriomote, Ishigaki and Okinawa of the Ryukyu Archipelago. Also, in the Southern Hemisphere, A. D. Lowe, K. A. J. Wise, R. A. Cumber, and other workers have made population surveys on the 3 families of insects in New Zealand. The survey methods include sweeping over vegetation with insect nets, use of Malaise trap, light trap, sticky traps, wind nets, and other means.

Ryukyu Is: Aphid populations on Iriomote, Ishigaki and Okinawa Islands during the month of March 1964 were represented by scattered clusters on branchlets and stems, largely on herbs and shrubs. The aphids were very seldom seen concentrated on one plant or in a particular area, except in lowlands. On an average, the clusters of aphids were dispersed approximately 50–100 meters apart and frequently the distances from one colony to another exceeded 100 meters.

In the lowlands, there seemed to be more aphids on herbs (weeds, grasses, etc.) and staple crops than on shrubs. High populations of aphids where seen along stream banks and edges of rice paddies. At about 200 meters elevation, aphids seemed to be less in numbers; this is probably due to fewer host plants spread thinly in upper zones. Above 300 m elevation, aphids in general were scarce.

Larger collections of agromyzids were made on Iriomote I. than on Ishigaki or Okinawa. Populations of these flies were noticed in the lowlands where lush vegetation occurred. Larval mines were not noted to be abundant.

In general, cynipids were rarely collected in sweeping, but 3 or 4 times as many cynipids were trapped in the Malaise trap (when it was placed in a suitable place) than were taken in a day's sweeping.

Table 1. Preliminary survey of Aphididae, Agromyzidae and Cynipoidea (Eucoilinae) in Ryukyu Is., March 1964.

Locality	Meters elev.	Aphididae	Agromyzidae	Cynipoidea
Ishigaki I.	0–500	50–100/day	5–10/day	2–3/day
Iriomote I.	0–500	50–100/day	10–20/day	2–3/day
Okinawa I.	0–500	25–50/day	5–10/day	1/day

New Zealand: Aphids are commonly found on roadside weeds and staple crops. In a population study, Close & Lamb (1961) used sticky substances in trapping aphids at 1, 19 and 33 meters and found 18 economic species. The population of these species greatly increase in number in summer and most of the species are attached to crops. Cottier (1953) added 8 additional trapped species. A. D. Lowe (pers. comm.) writes that recent trapping work done with aphids adds 4 more species of economic importance. He mentioned that high altitude records were made of *Brevicoryne brassicae* L. at 182 m, Mt Cheeseman, Canterbury by Palmer on 28. III. 1961 and *Rhopalosiphum padi* L. 40 m, Timms Creek, Canterbury, by Hair on 10. III. 1962. G. White informed us that 20 species of aphids were collected largely by wind nets and less frequently by grease cylinders at altitudes of 63 to 100 meters. Also, he trapped a total of three species of cynipids, of which the common species were *Kleidotoma* sp. and *Aulax hypochaeridis* Kieff (Cynipinae). Cumber (1959a, b), Cumber & Harrison (1959) reported sweep-sampling survey of insects on sown pastures in North Island; these included 13 species of aphids, 3 species of agromyzids and 3 species of cynipids.

Agromyzid flies are little known from New Zealand. It appears that *Cerodontha denticornis* is commonly found on wheat, barley and clover and is widely distributed.

Cynipid wasps are hardly known from New Zealand. They are difficult to collect in nature with sweeping nets alone.

The list of 28 genera and 32 species of Aphididae in Table 2 indicates that a large number of species were caught in trap nets in the western Pacific (block with 4 left to right diagonal lines) and fewer numbers (9 genera, 10 species) caught in Subantarctic-Antarctic areas (opposite diagonal markings). Each block represents a single collection of insects at sea. Five genera and 6 species of agromyzids collected at different dates at sea are indicated by the squares after each species. Only 2 genera and 2 species of cynipids were caught in the western Pacific and none were caught in subantarctic areas.

Table 3 shows possible correlation of wind intensity and types of fliers against distance the insects travelled. The weak fliers (Aphididae) were generally collected a greater distance away from land than those of moderate fliers (agromyzids) and weak-moderate fliers (cynipids). A total of 530 living aphids (possibly 17 genera and over 25 species) collected on 12 May 1962, 25 km off Oshima, near Tokyo Bay, Japan represent an unusual trapping record. Also, 25 aphids (7 genera and 8 species) were trapped 12.4 kilometers off Okinawa Island.

Among the Agromyzidae, on 13 May 1962, 88 individuals (30 ♂♂, 5 ♀♀) were trapped near Cheju Do, South Korea; the prevailing wind was 10 knots from NW.

In the Cynipoidea (Eucoilinae), the maximum number taken at one time was 2 specimens.

Table 2. List of species caught at sea in the western Pacific and Subantarctic-Antarctic areas

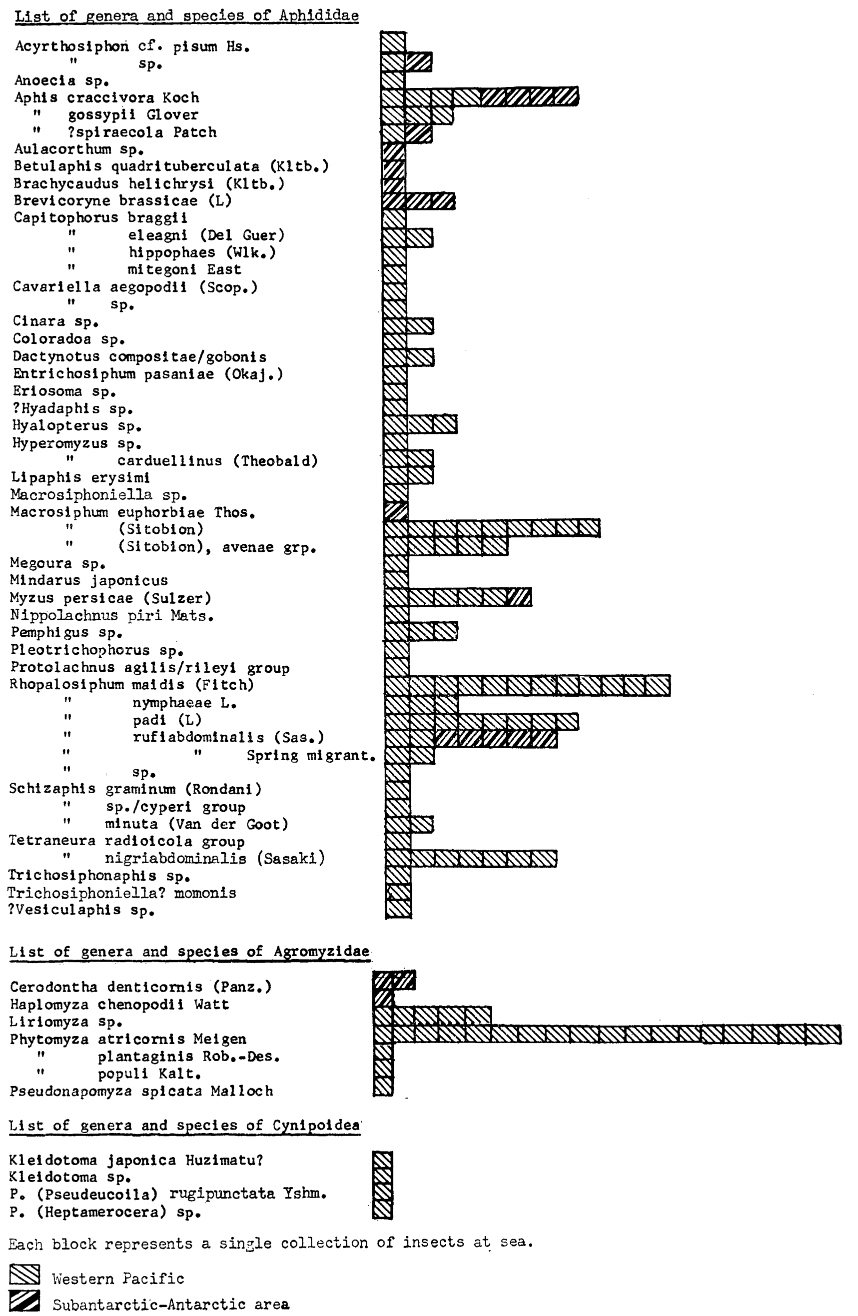
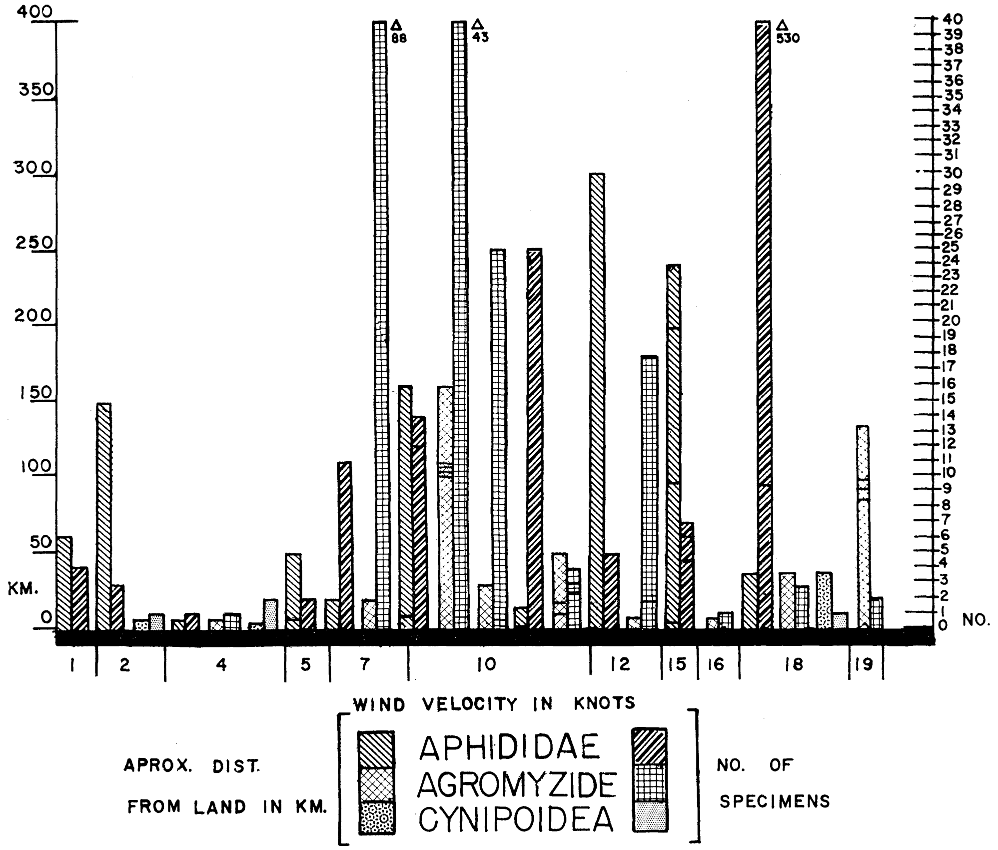


Table 3. Possible correlation of wind intensity vs distance travelled and number of insect specimens trapped at sea.



A reason for fewer cynipid catches in trap nets is probably related to wasp behavior. Cynipid wasps are erractic in their movements; hence they have a tendency to go through rapid changes in flight locomotion and are likely to avoid the upward draft or other air currents. Another reason may be hinged to the life cycle, particularly timing of adult life in nature in relation to trapping activity. It is interesting to note that not a single gall wasp (subfamily Cynipinae) was caught in our trapping program, even though populations of these gall wasps are known to be large in many temperate areas.

Some short-comings of this paper are attributed to the following circumstances: The trapping data form an inadequate sample for detailed statistical analysis; the season to season insect catches in trap nets suggest different interpretations of results; the specimens collected at great distances from land on days of low wind velocity may be the result of one of many factors, such as high wind or storm starting a day or more before the specimens were collected at considerable distances from point of origin, and fluctuation of air movements in the stratosphere. The ecology of the terrestrial insects and the means whereby they become air-borne are also to be considered.

In the discussion of this paper at the Entomological Congress in London, Dr Southwood raised the question of whether many of such trapped insects might not have come from ecologically disturbed areas. This would certainly be true of the aphids, many of which are cosmopolitan, and which were most abundant in the trappings.

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Pacific Insects 6 (3): 531–540 **November 10, 1964**

ANTARCTIC MITE POPULATIONS AND NEGATIVE ARTHROPOD SURVEYS[1]

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Abstract: Notes are given on relative populations of the prostigmatic mites *Stereotydeus mollis* Wom. & Str. and *Nanorchestes antarcticus* Str., and on eggs of the former. The latter mite, only 0.25 mm long when mature, is much more numerous than the former, and appears to have a wide distribution. In addition, notes are given on previously uninvestigated areas which proved negative for arthropods, and on negative searches for spiders and water mites.

This report, from Bishop Museum's project on the U. S. Antarctic Research Program, includes data from the 1962–63 and 1963–64 summer seasons. The data is the result of field work carried out by us (Gressitt both seasons; Fearon 1962–63; Rennell 1963–64), and by O. R. Wilkes and J. C. L. M. Mather in 1962–63 and Alister Spain (partial report) in 1963–64. Some of the Berlese funneling and field supervision was carried out by K. A. J. Wise. Field and laboratory work done by Wise and Spain will be reported later. Gressitt and Rennell were largely occupied with surveys in previously uninvestigated far southern

1. Partial results of grants G-23720 and GA-58 from the National Science Foundation (Office of Antarctic Programs) to Bishop Museum.