Pacific Insects 16 (1): 61-65 20 February 1974

NEW GUINEA APHIDS AND THEIR BIOGEOGRAPHICAL AFFINITIES

By **K. P. Lamb**[1]

Abstract: Fifty-seven species of aphids belonging to eight subfamilies have now been recorded from Papua New Guinea. From numerical analysis and studies of coefficients of dissimilarity, it appears that the present day New Guinea aphid fauna has strong affinities with that of the Philippines rather than with Australia and it is suggested that aphids moved into SE Asia mainly from China through the Philippines, into Borneo, Celebes and New Guinea. Another route was probably through Malaya to Borneo and another through Java, Sumatra and South Indonesia. Some Australian aphids may have entered from New Guinea in the north.

A recent check list of Papua New Guinea aphids (Lamb 1972), recorded 57 species of aphids belonging to eight subfamilies. Some 6,800 specimens of alate aphids were trapped from four sites ranging from sea level to 1600 m. Trapping extended from two to four years at each site. Details of the sites are given in Table 1 and Table 2.

Table 1. Aphid trapping sites

Site Location	Altitude (m)	Latitude	Number of species trapped
Port Moresby	sea level	9°29′S	24
Bulolo	731 m	7°12′S	22
Goroka	1615 m	6°4′S	18
Keravat	sea level	4°21 S	22

Table 2. Distances between trapping sites (km)

	Bulolo	Goroka	Keravat
Port Moresby	251	420	785
Bulolo		193	724
Goroka			690

Only four or five species were found frequently at each site while the other species tended to be uncommon. The most common species trapped were:

1. **Aphis gossypii** Glover. This was frequently found in Port Moresby and Bulolo. It occurred throughout the year but populations were maximum between June and September.
2. **Tetraneura nigriabdominalis** (Sasaki) occurred frequently at all sites with peak populations in May — July in Port Moresby and Goroka. They were frequent throughout the year at Keravat and peaks occurred irregularly at Bulolo. This aphid known from rice, sugar cane roots and sweet potatoes in Papua New Guinea has been recorded elsewhere from 18 genera of Gramineae.
3. **Aphis craccivora** Koch has a wide host range but is found especially on legumes. Peak populations were found between May and August (except at Keravat).
4. **Hysteroneura setariae** (Thomas) which occurs on grasses was common at Keravat and Bulolo.
5. **Brachycaudus helichrysi** (Kaltenbach) has a wide host range and is especially found on the flower heads of Compositae, Leguminosae and other families. It was abundant only in Goroka and Bulolo. Population peaks which occurred in May or July in Goroka, tended to be narrow and steep.

1. Biology Department, University of Papua New Guinea.

Comparison with other faunas

When the New Guinea aphid fauna is compared with that of neighboring SE Asian countries it is apparent that there are elements in common with Australia, New Zealand, Malaya, Indonesia, the Philippines and Borneo. Information on neighboring faunas was obtained from British Museum material and from the following published sources:

Australia	Eastop (1966)
Borneo	Heathcote & Eastop (1962)
Indonesia	Van der Goot (1917)
Korea	Paik & Choi (1969)
Malaya	Takahashi (1950)
New Zealand	Cottier (1948); Lamb (1958); Lamb & Close (1961).
Philippines	Calilung (1967, 1968).

In order to obtain some quantitive estimate of affinity between faunas the canonical distribution of commonness and rarity developed by Preston (1962) was applied and the coefficients of dissimilarity (Z) were calculated between the various faunas. This was calculated from the fraction of the joint fauna occurring in each pair of countries thus:

$$\left[\frac{F_1}{F_{1+2}}\right]^{1/Z}+\left[\frac{F_2}{F_{1+2}}\right]^{1/Z}=1$$

The values of Z range from 0 for two identical faunas to 1 for totally dissimilar faunas. Coefficients of dissimilarity are summarised in Table 3.

Table 3. Coefficients of dissimilarity (Z) between countries

	Philippines	Aust.	N.Z.	Indonesia	Malaya	Sabah/Borneo	Korea
Papua New Guinea	.521	.623	.795	.540	.680	.512	.512
Philippines		.655	.760	.520	.650	.483	.385
Aust.			.316	.715	.814	.665	.665
N.Z.				.810	.860	.740	.788
Indonesia					.650	.665	.540
Malaya						.571	.690
Sabah Borneo							.599

Application of Sneath's single linkage cluster analysis to these coefficients gives a diagrammatic representation of interrelationships (Fig. 1). This leads to some interesting results. It appears that the New Guinea aphids have closer affinities with the aphids of Korea and the Philippines than with those of Australia.

If the areas with faunal dissimilarity coefficients less than 0.55 are grouped together, three major regions appear (Fig. 2) with a Papuan region distinct from the Australian and having distinct Oriental affinities. This is in general agreement with the findings of Holloway & Jardine (1968) for butterflies and birds. Gressitt (1960, 1961) considered the Melanesian Coleoptera to be of Oriental origin rather than Australian.

Figure 3 shows a speculative view of possible routes of aphid movement. Shaposchnikov (1971) pointed out that aphids originated before the Angiospermae appeared and suggested that the centre of origin of most of the recent aphid groups was in East Asian mountain regions. I now suggest that aphids probably moved into SE Asia along two routes, the main one being from China down through the Philippines into Borneo, the Celebes and New Guinea. Another route was from Malaya to Borneo and yet another through Java, Sumatra and southern Indonesia. Probably some Australian

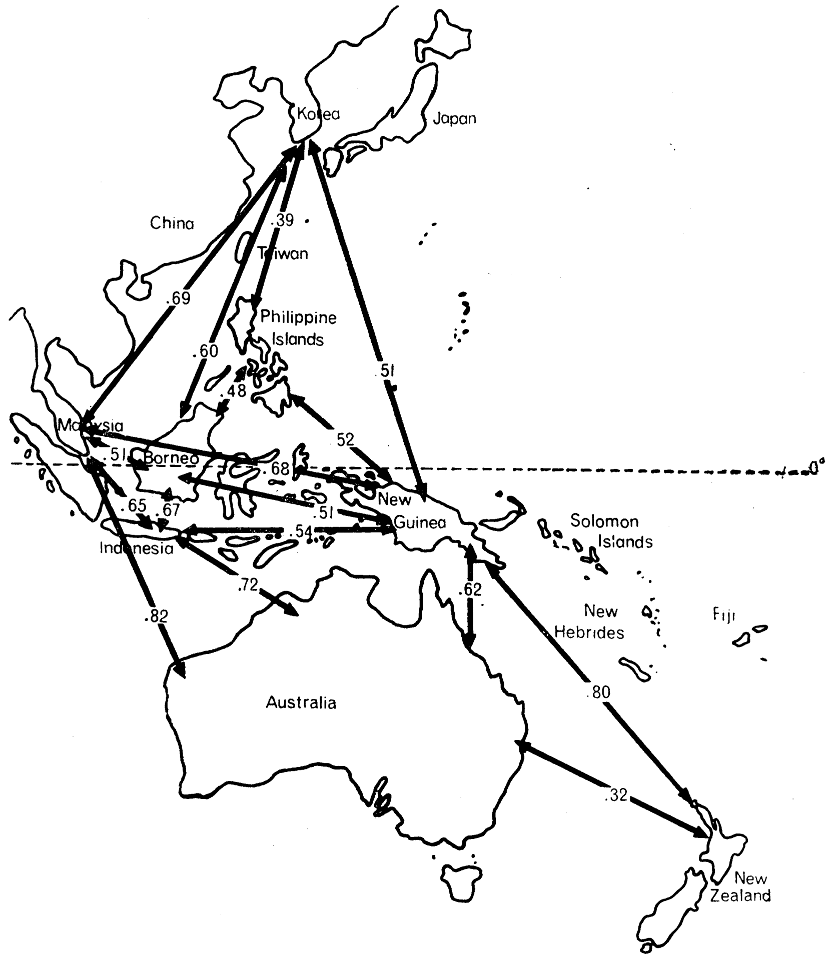

Fig. 1. Coefficients of dissimilarity of some SE Asian aphid faunas.

aphids came from New Guinea in the north while others entered from Indonesia or New Zealand. The Australian aphids have much closer affinities with those of New Zealand than with those of New Guinea. This scheme of dispersal is of course highly speculative.

From another angle we might look at the host plants. Aphids are obligate parasites of higher plants and with varying degrees of host specificity. The distribution of aphids may throw some light on the migration of their hosts or vice versa.

Holloway (1970) reviewed current knowledge of the phytogeography of the Indo-Australian area. Van Steenis (1934) suggested that the spread of plants to the tropical mountains was by three tracks which he termed —

a. Sumatra track from the East Himalayas to Burma to Sumatra to Java.
b. Luzon track from China to Taiwan to Luzon and the South Philippines to Celebes.
c. Papuan track from New Guinea to the Moluccas to Celebes to Borneo and then slight movement to Malaya, Sumatra and the Philippines.

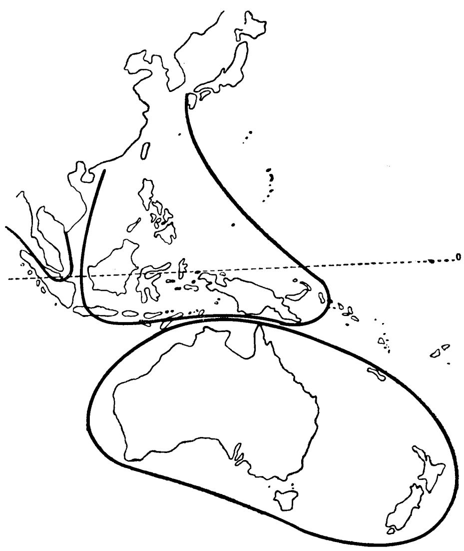

Fig. 2. Countries with dissimilarity coefficients <0.55 grouped together.

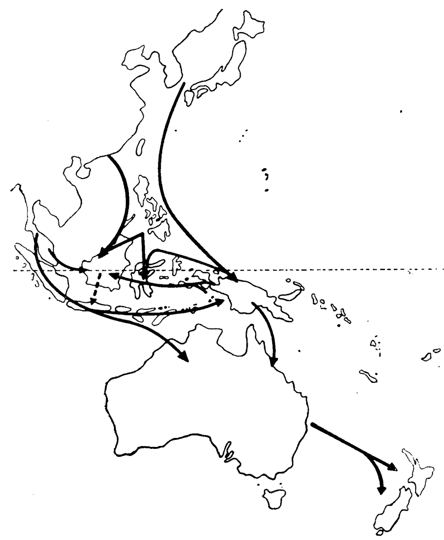

Fig. 3. Possible major routes of aphid movement through SE Asia.

This overall picture seems to fit well with the distribution of New Guinea aphids and cluster analysis of their relationship with faunas of nearby countries. This technique of numerical analysis has been used by Holloway & Jardine (1968) for zoogeographical studies of butterflies, birds and bats of the Indo-Australian area. From this work it is apparent that when a zoogeographical region or its faunal elements are discussed the results are comparative and refer only to the particular area and taxonomic groups studied.

One assumption of this method is that there is relative faunal homogeneity in the primary areas studied. This is almost certainly not true for Papua New Guinea or Australia. Indeed these preliminary results indicate a substantial difference between the aphids of Goroka and other parts of the New Guinea mainland (Table 4).

Table 4. Coefficients of dissimilarity (Z) between trap sites within New Guinea

	Bulolo	Goroka	Kerevat
Port Moresby	.38	.68	.32
Bulolo		.62	.40
Goroka			.41

While Table 4 may represent in part an altitudinal effect, it is more likely related to the history of the ancient and unique mountain flora of this area.

These calculations refer to faunas as they exist today. Since the distribution of aphids is closely related to the distribution of their host plants it is to be expected that the composition of the aphid fauna will be modified as changes occur in the flora: either through the long term processes of natural dispersal of plants or through the influence of man.

Winged aphids are readily moved long distances by the wind. They may also be transported on living plants. It is often assumed that the majority of aphid species have been introduced by man through his agricultural activities in recent times. No doubt some species have been. However, the patterns of aphid distribution shown here may well indicate that aphid migrations were much more ancient than modern agriculture. Somewhat similar distributions have been found for some birds, butterflies and bats in South East Asia.

More information is needed on the evolution and dispersal of higher plants in this region — and the ethnobotanical aspects of plant distribution.

This indicates the need for further studies. It would be of value to have information on the distribution of aphid species within the Australian continent and also on islands to the east of New Britain. However, it does appear that quantitative numerical methods are a useful tool for the comparison of related faunas.

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