of each voyage were from the the Antarctic continent or from offshore areas near the continent. Only in later stages of the voyages were directions of surface winds from areas supporting a more diversified flora and fauna. General observations made in areas near Heard I. showed that a considerable amount of debris was transported from the island during periods of high winds and storms.

*Discussion*: Although the number of organisms trapped was small, observations did show that passive dispersal by winds does occur in areas near land masses. Negative results for observations made in mid-ocean must be reviewed with respect to both the minute volume of air sampled and the probability of trapping air-borne insects at such low elevations. Just how far organisms could be transported by winds in expansive ocean areas remains to be determined. Certainly, conclusions cannot be drawn from data collected during two single voyages, but these areas are frequented by polar ships each year and the opportunity to continue such studies should be exploited.

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# AIR-BORNE PSOCOPTERA TRAPPED ON SHIPS AND AIRCRAFT

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*Abstract*: Psocoptera captured in air traps carried on the Galathea during its world cruise and on ships in the Pacific are reported upon, and their possible origins discussed. The predominant families in these trappings, Ectoposidae and Lachesillidae, are represented by small-sized, often cosmopolitan species. A live male elipsocid captured in an aircraft trap above New Zealand is referred to *Propsocus pulchripennis*; it is, however, aberrant in several venational respects. The significance of this capture is discussed in relation to the known distribution of the species and its possible relationship to the endemic Hawaiian elipsocid genera.

## Previous records of psocids in the upper air

The first reported capture of psocids in the upper air was that of Hardy & Milne (1938) who, using nets carried by kites over the North Sea, captured a specimen of *Lachesilla pedicularia* (L.) at from 150 to 365 m. Glick (1939) reported overland night-time captures of 7 psocids at 150 m, and 1 at 600 m, and day-time captures of 3 at 6 m, 31 at 60 m, 15 at 300 m, 4 at 600 m, 8 at 900 m, 6 at 1500 m, 2 at 2400 m, and 1 at 3000 m. These included *L. pedicularia* (L.): 2 at 6 m, 14 at 60 m, 1 at 150 m (night), 5 at 300 m, 2 at 600 m (1 at night), 3 at 900 m, 4 at 1500 m, 1 at 2400 m, and 1 at 3000 m; *Lachesilla* sp.: 1 at 60 m, 1 at 150 m (night); *Ectopsocopsis cryptomeriae* (End.): 2 at 150 m (night), 1 at 900 m; *Peripsocus* sp.: 1 at 300 m, 1 at 600 m; *Elipsocus* sp.: 1 at 60 m, 2 at 300 m; *Trogium pulsatorium* (L.): 1 at 1500 m; *Liposcelis divinatorius* (Mueller): 1 at 300 m; *Liposcelis* sp.: 1 at 150 m (night); and *Psocus inornatus* Aaron: 1 at 900 m. Freeman (1945) studying the insect population of the air from ground level to 90 m, found that psocids make up about 10% of the aerial insect fauna, 98.5% of them being *L. pedicularia* L. More recently, Glick (1957) reported the following overland aeroplane captures: *Liposcelis bostrychophilus* complex: 1♀ 150 m; *Ectopsocopsis cryptomeriae* End.: 1♀ 30 m, 1♀ 60 m; *Ectopsocus* sp.: 3 spp. 30 m; *Lachesilla rena* Somm.: 5♂♂ 30 m, 4♂♂, 5♀♀ 60 m.

The most consistent aspect of these records is the appearance of *Lachesilla* species in the captures, particularly *L. pedicularia*, which, common at lower levels over England and N. America, was found as high as 3000 m over America and at 150–360 m over the North Sea. The Ectopsocidae and Liposcelidae are also well represented in the captures; these families consist of species characterized by relatively small size. The Peripsocidae and Elipsocidae (larger insects) were, however, captured at heights up to 600 m, and the capture of *Psocus inornatus*, a relatively large psocid, at 900 m is noteworthy.

Material trapped in recent years on ships and aircraft by Bishop Museum, Honolulu, is reported upon below. Preliminary reports on most of these trappings have been published by Gressitt & Nakata (1958), Yoshimoto & Gressitt (1960 & 1963), Yoshimoto, Gressitt & Mitchell (1962), and Yoshimoto, Gressitt & Wolff (1962).

## Trappings on ships

*The Galathea Expedition* (Yoshimoto, Gressitt & Wolff, 1962): Trapping was carried out in conical metal nets situated on the deck and upper bridge throughout this global cruise when not in port or extremely close to land. Yoshimoto, Gressitt & Wolff state that a high percentage of catch consisted of insects likely to have gained access to the ship whilst in port; less than 40% of the total catch is attributed to natural wind dispersal.

**Ectopsocus maindroni** Badonnel

F 260. 9.III.1951. 07°23′S 48°23′E to 07°30′S 48°21′E. 640 km from Aldebra I., Madagascar to Mombasa leg. Wind WNW, strength 1 (Beaufort Scale) and E×N, strength 1. 1♀.

F 268. 12.III.1951. 04°23′S 46°23′E to 03°25′S 46°00E. 640 km from Mombasa, Madagascar to Mombasa leg. Wind NNE, strength 1; NE, strength 3. 1♀.

F 410. 6.VI.1951. 03°48′N 103°39′E to 04°30′N 103°28′E. 2 km from coast of Malaya, on Singapore to Bangkok leg. Wind NNW, strength 1, and SE.

F 416. 8.VI.1951. 06°45′N 103°00′E to 06°44′N 103°00′E. 80 km from Malaya, in Bay of Siam. 1♀.

**Psocathropos microps** End.

F 14B. 8.XII.1950. 05°41′S 11°26′E to 05°36′S 11°01′E. 30 km from Congo, Port Victoria to Luanda leg. Wind 0. 1♂.

**Lachesilla tectorum** Bad.

F 209. 21.II.1951. 26°24′S 35°44′E to 25°42′S 35°17′E. 95 km from Mozambique, Durban to Beira leg. Wind E×S, strength 3; E×N, strength 1. 1♀.

*On ships in the Pacific.* (Gressitt & Nakata, 1958): Sticky screen traps, installed on U. S. military transport ships sailing from Honolulu to San Francisco and to Guam and Manila, were designed to catch insects traveling passively in air currents. There is little doubt that the insects reported upon in this section were subjected to natural air dispersal.

**Ectopsocus briggsi** McL.

A 5. 29.VII.1957. 18°18′N 128°42′W to 37°48′N 122°32′W. Near the port of San Francisco. 1♀.

**Ectopsocus maindroni** Bad.

E 9. 26.IX.1957. 18°18′N 164°00′E to 20°15′N 179°50′E. Near the port of Honolulu. 1♂.

**Kilauella** spp.

A 10. 11.VIII.1957. 23°54′N 153°54′W (c. 300 km ENE of Oahu) to Honolulu. 1♀. E 4. 13.IX.1957. 15°21′N 150°37′E to 13°34′N 139°44′E, including trappings whilst in the port of Guam. 1♂.

Yoshimoto & Gressitt, 1960: Trapping was done on several ships between North America and Asia. The psocids reported upon in this section were captured in metal funnel traps and wind sock nets. Again, it is more likely that they were passively blown on to the ship, than that they gained access in ports and were later blown up to the traps.

**Liposcelis** sp.

7.III.1959, P. O. F. I. Smith. 23°58′N 153°45′W to 23°58′N 151°58′W 225–700 km from Maui. Wind sock trap. 1 specimen.

**Psoquilla marginepunctata** Rib.

8.IX.1959. U. S. N. S. Shanks. San Bernardino Sts. to Manila. Metal funnel trap. 4 specimens.

**Hemipsocus roseus** (Hagen)

8.IX.1959, U. S. N. S. Shanks. San Bernardino Sts. to Manila. Metal funnel trap. 1♂. 11–12.XII.1959. U. S. N. S. Barrett. Subic Bay, Luzon, to San Bernardino Sts. Wind sock trap? 1♂, 1♀.

Yoshimoto & Gressitt, 1963:

**Ectopsocus briggsi** McL.

14 A. 26–27.XI.1962. Approx. 7 km from Golden Gate, San Francisco, to 35°22′N 128°00′

W. Wind 360°, 25 knots. Nets. 1♂, 1♀.

**Lachesilla** sp.

19 B. 28–29.XI.1962. 30°04′N 139°54′W to 28°00′N 143°50′W. Approx. 1775 km from Oahu, Hawaii. Wind 070°, 15 knots. Suction trap. Part of wing and thorax only.

**Lachesilla pacifica** Chapman

17 A. 28.IX.1962. 34°28′N 130°20′W to 33°50′N 132°20′W. 835 km from San Francisco. Wind 075°, 8 knots. 1♀.

**Ectopsocus** sp.

11 B. 19–20.XI.1962. 33°37′N 134°43′W to 35°18′N. 130°30′W. Approx. 830 km from San Francisco. Wind 345°, 11 knots. Suction trap. Head and thorax only.

Not previously reported upon:

**Ectopsocopsis cryptomeriae** (End.)

6. 25.IX.1963. U. S. N. S. Gaffey. 26°23′N 177°50′W. Approx. 120 km SSE of Midway. Wind 115°, 7 knots. J. C. Harrell. 1♂. 18. 3.X.1963. U. S. N. S. Gaffey. 30°–50′N 130°50′ E. Approx. 30 km S of island of Kyushu, Japan. Wind 060°, 12 knots. J. C. Harrell. 1♂.

**Lachesilla** sp.

1. 23.IX.1963. 21°30′N 160°21′W. Approx. 30 km S of Niihau, Hawaii. Wind 090°, 5 knots. J. C. Harrell. 4♀♀.

## Air trappings

Yoshimoto, Gressitt & Mitchell, 1962: In a 30-day ship's cruise of the Western Pacific, no psocids were caught. Only a single psocid was captured in the air-trapping program.

**Propsocus pulchripennis** (Perkins)

2.II.1962. 43°55′S 172°11′E. Aircraft 2286–4267 m, speed 165–195 knots. Wind 080°, 10 knots. Temperature 17°C. 2206–2214 hours. High speed trap. 1♂, alive.

## Remarks

*Ectopsocus maindroni*, originally described from Arabia, has since been reported from the Congo, Malaya, Hong Kong, Taiwan, and I have recently discovered it in Hawaii. It has been taken on vegetation, in drawers and cup-boards, in stored breakfast cereals, in the cavity of a wild fig, from the nest of a fish owl, from inside deep caves, and recently was found infesting the walls of a new house on Oahu, Hawaii. In 1962 it was intercepted by a plant quarantine officer in Honolulu on material originating in Hong Kong. Captures of this species off the coast of E. Africa and Malaya on the *Galathea* may be the result of port infestations, though this is less likely in the case of the specimen captured near Honolulu.

*Ectopsocus briggsi*, captured on two occasions off the Californian coast, is known to occur in California.

*Ectopsocopsis cryptomeriae*, captured near the Hawaiian chain and near Japan, has been

recorded from Japan, Hong Kong, Taiwan and the United States east of the Rocky Mountains. The specimen captured near Japan could have originated there, but that taken off the Hawaiian Chain is of more dubious origin. The species has not been reported from Hawaii, and is not represented in any of the collections at Honolulu. Although the ship was at the time on the San Franciso to Japan leg, the species' range in the USA would seem to preclude the possibility of access at San Francisco. The possibility remains that access was gained in Japan on the previous visit to that country some four weeks earlier. The specimen was in very good condition and was probably alive when caught. If this is regarded as a 'genuine' air trapping, then it is of considerable interest in view of the discontinuous species distribution.

*Psocathropos microps* is known from the Atlantic Islands, Mozambique, Congo, Angola, Tanganyika (on rats), and Java. Captured off the coast of West Africa, it is possible that it entered the ship in port and was trapped several days later.

The captures of *Hemipsocus roseus* near the Philippines, are consistent with its known distribution which includes Ceylon, the Philippines and Hawaii.

The specimen of *Kilauella*, an endemic Hawaiian genus, captured near Honolulu, is readily explicable, but that captured near Guam, which is of an undescribed species only known to occur on Oahu, is interesting. This small endemic species is found at relatively low elevations on Oahu, and it is thus possible, though not very probable, that it gained access to the ship whilst in port.

*Lachesilla pacifica* has been recorded from the Pacific coast of North America. Its capture some 800 km from San Francisco is probably a 'genuine' air capture. The species of *Lachesilla* captured near Niihau is known to occur in the Hawaiian Islands. *Lachesilla tectorum*, a Mozambique species, was captured 95 km from the Mozambique coast.

The most interesting capture recorded here is the single live ♂ of *Propsocus pulchripennis* (Perkins) (=*Myopsocus nitens* Hickman). This species has a distribution which, it has recently become known, includes Tasmania, Australia, New Zealand, Kenya, South Africa, Chile, and Hawaii (Badonnel, 1963). The closely related *Propsocus pallipes* (=*froggatti* End.) has been recorded only from Australia and Tasmania. Species of *Propsocus* are evidently the closest relatives of the prolific Hawaiian endemic genera *Kilauella* and *Palistreptus*, and *Propsocus pulchripennis* was originally described from the high mountains of the Hawaiian Islands, where it has a restricted distribution. The capture of a live specimen at such an altitude above the mouth of the Rakaia River, New Zealand, is of great interest in view of the species' distribution and its possible relationship with the endemic elipsocid genera of Hawaii. The wind in this instance, if constant, would have carried the insect over the bulk of the South Island, where it would possibly have had a landfall on the Southern Alps or the Haast Mountains.

The specimen differs from *P. pulchripennis* as described by Hickman (1933) and Edwards (1950) from Tasmania, in that the fore wing has *m* only 2-branched with quite a long fusion with *rs* (both wings), and the pigmentation is more restricted (fig. 1c & d); pigmentation is faint in the hind wing (fig. 1e). Moreover, the connection of areola postica to media is in one wing tenuous and long (fig. 1c), and the frons markings apparently differ (there is a lateral buff area mesial to the antennal socket, and a dark brown medial patch). The phallosome appears to be identical (fig. 1b), but the posterior margin of the hypandrium is slightly pointed in the middle, with a single median longer seta a short

distance from the margin (fig. 1 a).

Smithers (1963) has recently provided a further description of *P. pulchripennis*, in which the hypandrium is shown to have the posterior margin slightly pointed medially. The pigmentation of the ♂ fore wing is also consistent with that figured by Smithers. It seems,

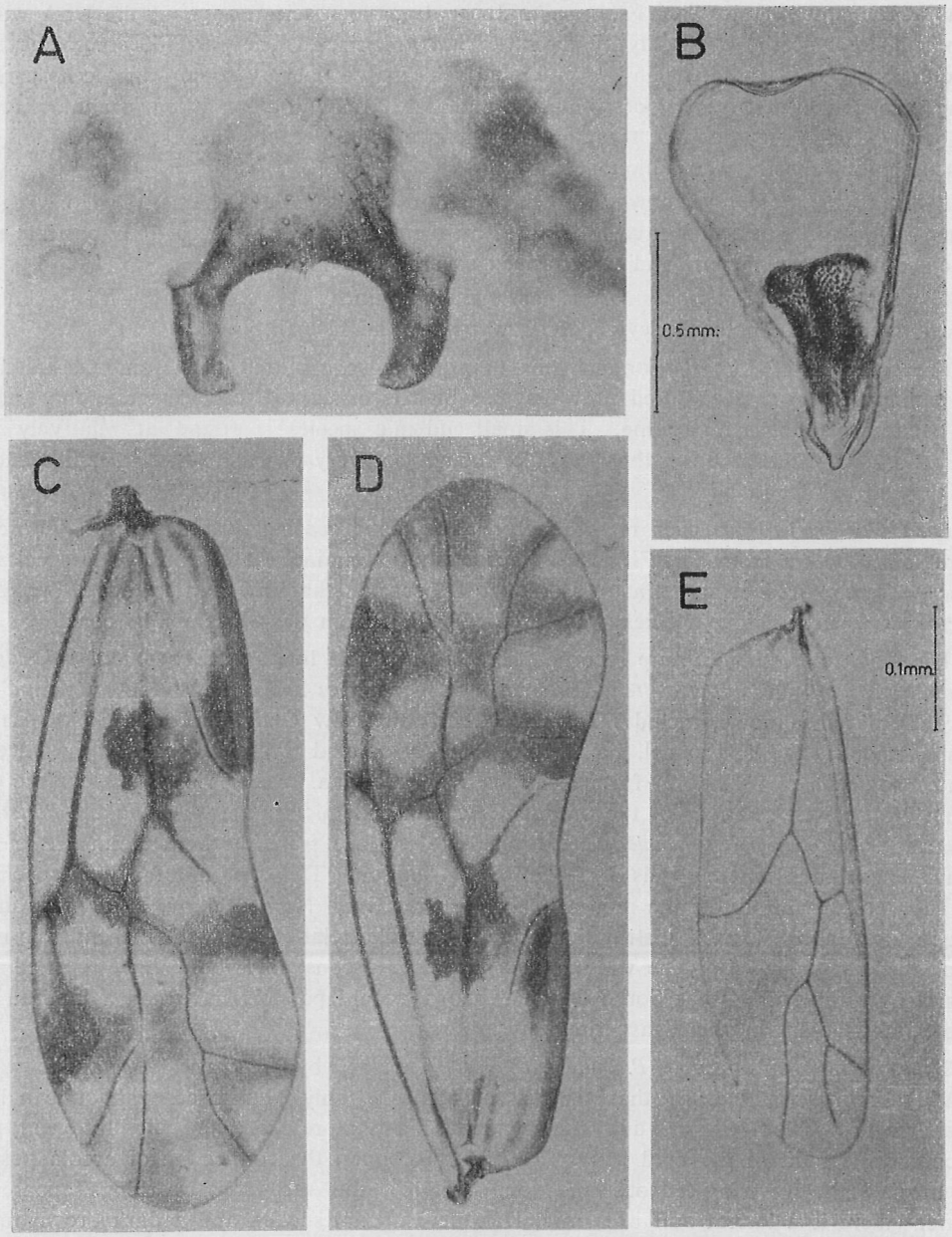


Fig. 1. *Propsocus pulchripennis*, ♂ : a, hypandrium; b, phallosome; c, left fore wing; d, right fore wing; e, right hind wing. Scale for genitalia as in b, for wings as in e.

therefore, that the air-borne specimen is an individual of *P. pulchripennis* which is aberrant in several venational respects (areola postica, *rs* and *m* junction, *m* two-branched).

*General Remarks*: The trappings at sea confirm the results of previous air trappings by showing the predominance of the widespread families Lachesillidae and Ectopsocidae, which are often represented in the catches by cosmopolitan species. *Ectopsocus* is one of the smallest-sized winged genera, and it is not surprising that species of this genus are so well represented in the catches. Many species are capable of living in stored products, habitations, etc., and therefore the high proportion of ectopsocid species in the trappings at sea may be regarded with some suspicion. However, the previous recorded catches of *Ectopsocopsis cryptomeriae* and species of *Ectopsocus* would suggest that species of this family do indeed make up a considerable part of the psocid aerial fauna. Species of the Lachesillidae, mainly of quite small size, are so consistently predominant in air trappings, that it seems likely that *Lachesilla* species possess some ecological attribute (? swarming) conducive to an unusually high representation in the aerial fauna.

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