

## Introduction of Arthropod Pests into the Hawaiian Islands

JOHN W. BEARDSLEY

*Department of Entomology  
College of Tropical Agriculture and Human Resources  
University of Hawaii, Honolulu, Hawaii 96822*

**Abstract**—Nearly all pest arthropods now present in Hawaii are non-native species that have been introduced to the island since their discovery by man ca. 1,000 years ago. A few introduced pests, such as houseflies, head and pubic lice, and cockroaches, were present at the time of European discovery (mid to late 18th century), presumably as a result of Polynesian exploration and trade. Accidental introductions of pest arthropods became more common during the 19th century as a result of commerce with the outside world, and this trend has accelerated during the 20th century, despite the application of quarantine regulations during the 1890s. The advent of regular trans-Pacific air travel during the 1940s and of jet aircraft during the 1960s have provided new opportunities for rapid dispersal of pest arthropods, to Hawaii and throughout the Pacific Basin. These are exemplified by recent epidemic outbreaks of such new pests as the spiraling whitefly, the leucaena psyllid and the melon thrips. Due to the constantly increasing volume of trans-Pacific air traffic to Hawaii, and to the existence there of many under-utilized ecological niches, it appears likely that new pests will continue to become established there at a relatively high rate, despite improvements in quarantine enforcement and pest detection techniques.

Hawaii is a group of islands isolated near the center of the Pacific Ocean with a land area of about 6,450 square miles. There are about 10,000 species of insects and other terrestrial arthropods present in Hawaii today. Of these, somewhat more than 2,000 species have been introduced into the islands from overseas since man first settled there, around 1,000 years ago.

Hawaii has some 500 species of terrestrial arthropods and mollusks which can be classed as pests. Of these, only a very few are native to the islands: 98% of the pest species have been introduced. Therefore, in Hawaii at least, exotic pest problems are almost our only pest problems.

The Polynesian voyagers who first populated the Hawaiian islands probably carried relatively few foreign arthropods with them. The first Europeans to visit the islands, in the middle to late 18th century, found the Hawaiians bothered by flies (probably *Musca domestica* L.), head and pubic lice, and not much else. Their crops (taro, coconut, sweet potato, yams, sugarcane and a few fruits) apparently were largely pestfree. There were no mosquitoes (Illingworth 1923).

However, following the European discovery of the islands, commerce with the outside world began, and introductions of foreign arthropods became more frequent. In the era of sailing ships many weeks or months at sea were passed before landfall was made in Hawaii. At first, long-lived, hardy arthropods which could live aboard ship in man's shadow (e.g., cockroaches) were among the few which could make it alive to the islands. Other species which became established during this period could live in building materials or ballast (e.g., centipedes, millipedes, tenebrionid beetles) or were able to reproduce during the voyage (e.g., stored product pests, mosquitos in water casks, fleas on domestic animals).

With European settlement and the initiation of European agriculture, the importation of living plant materials for propagation brought with it a multitude of foreign plant parasites, like scale insects, mealybugs, and aphids. Uncontrolled importations of soil, lumber and furniture brought such pests as ants, boring beetles and termites.

The implementation of plant quarantine regulations by the Hawaiian government, near the end of the nineteenth century slowed, but did not halt the influx of new pests. Regular steamship traffic between Hawaii and the continents of North America, Asia, and the South Pacific Islands, beginning in the late nineteenth century, reduced transit time for both humans and arthropod stowaways, increasing chances for new pests to survive. The volume of overseas traffic to Hawaii increased as the nonindigenous human population of the islands grew, and as plantation agriculture, based largely on imported labor, became the economic mainstay of the island economy. More and more new exotic arthropods arrived and became established, as may be seen from records published since 1905 in the Proceedings of the Hawaiian Entomological Society. Published records of accidental introductions of arthropods into the islands prior to that year are generally sketchy and incomplete. Much of the available information was summarized by Illingworth (1923).

The rate of arthropod introduction into Hawaii took a quantum leap with the arrival of the airplane. Regular transpacific air transport was initiated during the late 1930s, and has been increasing exponentially ever since.

In the 1960s, jet aircraft, each capable of transporting several hundred people as well as innumerable hitch-hiking arthropods, were introduced in the Pacific Basin. These aircraft now reach Hawaii hourly from North America, Asia and the South Pacific.

For the past 25 years or so, new, accidentally introduced, foreign arthropods have been found established in Hawaii at the rate of about 20 species per year (Beardsley 1979). That is, since 1965, about 500 new terrestrial arthropod species have been accidentally introduced into and become established in the Hawaiian Islands. Many of these immigrants have been of little or no economic consequence. However, hardly a year has gone by during this period that we were not faced with one or more new arthropod pest problems of serious economic significance.

In 1984, I put together a list of new arthropod pests of minor to major importance that were found for the first time in Hawaii since 1950. That year

marked the midpoint of the 20th century, as well as the beginning of major increases in transPacific air traffic related to military activities and tourism. The list contained the names of 105 species (including three mollusks). It included such major pests as: spiraling whitefly (*Aluerocticus dispersus* Russell), sweetpotato whitefly [*Bemisia tabaci* (Gennadius)], taro root aphid [*Patchiella reaumuri* (Kaltenbach)], Eurasian pine adelgid [*Pineus pini* (Macquart)], coconut scale (*Aspidiotus destructor* Signoret), Egyptian hibiscus mealybug [*Maconellicoccus hirsutus* (Green)], leucaena psyllid (*Heteropsylla cubana* Crawford), southern green stink bug [*Nezara viridula* (L.)], melon thrips (*Thrips palmi* Karny), Western flower thrips [*Frankliniella occidentalis* (Pergande)], banana root borer [*Cosmopolites sordidus* (Germar)], black twig borer (*Xlosandrus compactus* Eichhoff), banana skipper [*Erionota thrax* (L.)], lawn armyworm [*Spodoptera mauritia* (Boisduval)], litchi fruit moth [*Cryptophlebia ombrodelta* (Lower)], celery leafminer [*Liriomyza trifolii* (Burgess)], Malaysian fruit fly [*Dacus latifrons* (Hendel)], long-legged ant [*Anaplolepis longipes* (Jerdon)], and brown garden snail [*Helix aspersa* (Muller)].

In preparing this paper I updated my 1984 list to the end of 1989, and added 36 additional pest species new to Hawaii, including the following important ones: fruit-piercing moth [*Othreis fullonica* (Clerck)], sugarcane tingid [*Leptodictya tabida* (Herrick-Schaeffer)], annona seed wasp [*Bephratelloides cubensis* (Ashmead)], lesser cornstalk borer [*Elasmopalpus lignoscellus* (Zeller)], blue alfalfa aphid (*Acyrtosiphon kondoi* Shinji), yellow sugarcane aphid [*Sipha flava* (Forbes)], and tropical nut borer [*Hypothenemus obscurus* (Fabricius)].

Thus, by my reckoning, 140 new pests have become established in Hawaii during the past 40 years, or, on average 3.5 new pests per year. Comparable data for other parts of the world are not readily available, but it would be instructive to determine if other Pacific island areas have experienced similar rates of new pest introduction.

The advent of regular jet flights between widely separated localities throughout the Pacific Basin by aircraft which are rarely subject to inspection or disinsectization, has resulted in the extremely rapid spread of some pest species.

The leucaena psyllid is a case in point. This pest was unknown outside of the Caribbean region and adjacent Central America until it turned up in Florida in 1983. It made the big jump to Honolulu the following year where it soon devastated leucaena (tangantangan) throughout the Hawaiian Islands. Some people thought that this was a good thing, but others, mostly ranchers who relied upon leucaena for forage, felt otherwise.

In the six years since its arrival in Hawaii, the leucaena psyllid spread completely throughout the Pacific Basin and into southeast Asia, as far west as India and Sri Lanka. It is certain to spread circumglobally wherever leucaena grows, within a few more years at most. I think it is likely that the leucaena psyllid has been spread primarily as hitch-hiking adults on aircraft. Adults of this psyllid are strongly attracted to lights, which are used for night loading aircraft. Its host, *Leucaena leucocephala*, is one of the most common elements of the disturbed area vegetation that is usually found growing around airports in the tropics. The spiraling whitefly, the melon thrips, and the celery leafminer, although they spread

with less spectacular rapidity, are also pests of recent arrival in Hawaii which have become widely distributed in the Pacific Basin via aircraft during the past decade or so.

Some kinds of pests, for example scales, mealybugs and whiteflies, can only be transported long distances on living plants. In Hawaii, 12 new whitefly species have been found established during the past 25 years. Many of these species, like the spiraling whitefly, come from Florida and the Caribbean region. How can such pests get into Hawaii when all living plants imported there are subject to inspection? The answer, I believe, is largely via the U.S. Mail. Air mail packages are first class mail, and within the U.S. they can not be opened for inspection unless the recipient agrees. If an insect-infested plant is air-mailed from Florida or another U.S. state to a recipient in Hawaii there is no way to prevent the importation and possible establishment of any pests which it harbors.

Many important Neotropical arthropod pests are now established in Florida, and others probably are being imported there, frequently on smuggled plant material. This source, which might be called the "Florida Connection", may be responsible for the increased number of Neotropical pests which have become established in the Pacific Basin during recent years. Such new pests in the Pacific as the spiraling whitefly, the annona seed wasp, the sugarcane tingid, the yellow sugarcane aphid and the tropical nut borer may have reached Hawaii by this means.

Two measures which could be implemented to reduce the spread of new arthropod pests into and within the Pacific Basin are: 1) the regular disinsection of all aircraft arriving at, and flying between, Pacific destinations, and 2) the inspection of all packages shipped by mail, first class or otherwise. Unless such measures can be initiated and effectively carried out, it seems reasonable to assume that new pests will continue to become established in Hawaii and in other Pacific areas at the relatively high rates which presently prevail.

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#### References

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