

THE ORIENTAL FRUIT FLY

JOHN V. NEWMAN and H. M. ARMITAGE

John V. Newman is a citrus and avocado grower, and is a member of the California Board of Agriculture.

H. M. Armitage is Chief of the Bureau of Entomology, California Department of Agriculture.



ORIENTAL FRUIT FLY (*Dacus dorsalis*)



Actual
Size

(Mr. Newman spoke concerning the Oriental Fruit Fly at the 1949 annual meeting of the California Avocado Society. Unfortunately, his excellent presentation could not satisfactorily be reduced to a form suitable for publication, as his remarks were in the nature of a commentary on a series of illustrative slides.)

To record in these pages the sense of Mr. Newman's annual meeting address, and to give the subject reasonably comprehensive treatment, two other papers are offered to readers of this Yearbook. The first, by Mr. Armitage, is a general discussion of the Oriental Fruit Fly; the second, by Mr. Newman, augments the general statement with specific conclusions and recommendations included in his report to the California Board of Agriculture. Both papers originally appeared in the California Citrograph. His report is based on his observations while in Hawaii with the Legislative sub-committee to investigate the Oriental Fruit Fly problem.)

Armitage:

The Mediterranean fruit fly has been present in the Hawaiian Islands for nearly four years and the Melon fly for an even longer period. They have presented a constant threat to California, and there is every reason to believe they would be established in California today had it not been for the strict quarantine which has been maintained against them by the U. S. Department of Agriculture and enforced by personnel of the California Department of Agriculture acting as federal collaborators.

Recently a third species of trypetid, known as the Oriental fruit fly, *Dacus dorsalis*, also called the Malayan, Formosan or Mango fruit fly, has become established in the Hawaiian Islands and is believed to present an even greater menace to California and mainland agriculture than either the Med-fly or the melon fly.

Apparently the Oriental fruit fly was brought to the Island of Hawaii by Marines returning to the rest camp on that Island from Saipan as early as June 1945. By May 1946 it had increased at an alarming rate and was present on both Hawaii and Oahu. Within a year it was reported to have spread to the five main islands in the Hawaiian group.

This new species has proved to be much more destructive than either the Med-fly or the melon fly. Bananas and pineapples, immune to attack of these other species, as harvested for commercial movement, have been restricted to movement to the mainland as a result of the introduction of the Oriental fruit fly. One hundred per cent infestation of avocados has been reported as well as heavy damage to papaya and mango. This fly has been observed ovipositing in grapefruit in the markets in Honolulu and is said to be replacing the Med-fly as a pest in oranges. It has been observed flying about airplanes at airports. Corsages of gardenias and orchids worn by departing plane and ship passengers are peculiarly attractive to the adult flies, increasing the hazards of their being carried abroad and to the mainland, necessitating safeguard measures to remove this possibility. The Oriental fruit fly has frequently been intercepted in ship stores by quarantine officials, and in the absence of the quarantine screen maintained at maritime ports against the other species over the past 36 years, it seems almost certain this third species would already have been introduced into California.

The introduction and subsequent increase of the Oriental fruit fly in Hawaii is an outstanding example of a species newly introduced into a favorable location without its natural enemies. Not only has it become the dominant species in the Islands in hosts attacked by the Med-fly and melon fly, but it has also been found to infest them to a greater degree, including many new hosts. In fact, there is reason to believe that almost

any above-ground, fleshy fruit, vegetable or seed might be an acceptable host.

The fruit of more than one hundred different plants is now listed among the hosts of the Oriental fruit fly in the Islands. Of plants not observed as hosts in Hawaii, apricots, pears, cherries, and possibly grapes might serve as hosts in California.

It is impossible to predict whether or not the Oriental fruit fly, if it became established in California, would multiply to the same extent as it has in Hawaii. Conditions in Hawaii are extremely favorable for the increase of all the species mentioned as there is a continuous abundance of wild and cultivated fruits throughout the year. Guava, particularly acceptable as a wild host, abounds in ravines and uncultivated areas, along roadsides and ditches, and fruits over a long period. The same is true of the prickly pear, *Opuntia* sp. Oranges, avocados, mangos and papayas grown in yards and gardens offer another source of host sequence. Control measures, such as poison sprays or host-free periods, are hard to enforce under these conditions.

Temperatures at sea level throughout the year in Hawaii vary from about 70 to 90 degrees and approximate those required for greatest activity of the flies and for development of the inactive stages. Professor H. S. Smith, California member of the Commission on Pest Control appointed by the Pacific Science Board of the Council of Agricultural Research, reported fruit flies active at the Parker Ranch in Hawaii at 4,000 feet, very close to the frost line. The flies would unquestionably develop in California, in the summertime and probably could survive the winter in most localities, though experiments carried on in Formosa show definite temperature limitations under experimental conditions.

Commercial plantings of oranges, avocados, papayas and even bananas in Hawaii are trivial when compared with the plantings of sugar cane and pineapple, which is an important factor when considering support in Hawaii in developing research in control measures. Control of insect pests by the introduction of insect parasites has been a tremendous success under the conditions in Hawaii. Almost a complete control of the major sugar cane pests and a 100 per cent control of several minor pests has been accomplished.

Several insect parasites were introduced from Africa against the Mediterranean fruit fly in the early days of the infestation. Some benefit was accomplished and a 50 per cent reduction of infestation in coffee in the Kona district of Hawaii was reported, but further search is certainly needed. It is obviously desirable that a search for parasites of the Oriental fruit fly be undertaken at the earliest possible moment. Such a project, as well as additional search for parasites of the Mediterranean fruit is highly desirable—not only for the benefits that would accrue to Hawaii but also because of the added safety factor for California.

Such a project has already been initiated by both the Hawaiian and Federal authorities. One species of parasite of the Oriental fruit fly has already been introduced and established, and one previously established against Med-fly has been recovered from the Oriental fruit fly.

Parasite expeditions from Hawaii in the past have been financed in large part by private interests, mainly by the Hawaiian Sugar Planters Association. Extensive introductions,

including those for Med-fly, have been financed by the Territorial Board of Forestry and Agriculture and some by the Pineapple Growers Association. Very little has previously been done in parasite introduction to Hawaii by the U.S. Department of Agriculture, although it has supported research projects on the fruit flies and their parasites after they were established.

The Hawaiian growers, supported by the Territorial Board of Forestry and Agriculture, as well as by mainland agricultural agencies, have been successful in securing an appropriation of \$50,000 for the current year to be made available to the Bureau of Entomology and Plant Quarantine of the U.S. Department of Agriculture for use in searching for parasites of the Oriental fruit fly and for their introduction into and distribution in Hawaii.

The following notes have been compiled by Dr. H. T. Osborn, Survey Entomologist in the California Department of Agriculture, who has had considerable first-hand experience with insect problems, including the fruit flies, in the Hawaiian Islands. They have reference to the species in those regions where the Oriental fruit fly has previously been known, and may be of help in understanding the present problem presented by its introduction into Hawaii.

The Oriental fruit fly was originally described as a variety of *Chaetodacus ferrugineus* Feb. by Hendel in 1912 or 1927. Clausen, in 1933, lists *Chaetodacus ferrugineus* as present in Malaya, Dutch East Indies, Burma and India: and *Chaetodacus ferrugineus dorsalis* Hendel as present in Formosa, Philippine Islands, Burma, India and Ceylon. Japanese writers refer to it in Saipan around 1930. In 1937 it is stated that the fly had been causing severe damage for several years in the Bonin Islands to orange, banana, papaya and other fruits. In another article, it is stated that the fly arrived in the Bonin Islands from Saipan in 1932 attacking peach, mango and guava. Clausen, in 1933, stated that "in general the fruit flies of the dipterous family trypetidae are only minor pests of citrus in the tropical section of Asia. The most common of the species here listed are *Chaetodacus ferrugineus*, its variety *dorsalis* and *C. caudatus* which are of very wide distribution. *It appears that these flies attain a destructive status only in subtropical habitat.* This is illustrated in the case of *C. ferrugineus dorsalis*. To citrus fruit, however, it causes serious and widespread loss only in Formosa. In that island it is most abundant in the fruits of grapefruit and citron, although all varieties and species are found to be attacked." Munro, in 1939, decided the variety *dorsalis* did not occur in India and later in 1940 that it occurred only in Formosa. It is known now as a distinct species *Dacus dorsalis* and presumably is the species in Saipan, the Bonin Islands and Hawaii—though further study may change that opinion. It is said to be in Okinawa but not on the main Japanese Islands.

The Mediterranean fruit fly has adapted itself to several regions and become a pest in climates as temperate as California, and my understanding is that the mango fly has infested fruits over a wider climatic range in Hawaii than the Mediterranean fruit fly. It is of course possible that the lower humidity and lack of summer rainfall experienced in California might prove a deterrent to the species reaching seriously damaging numbers here.

Trapping is considered an excellent method of detecting light or incipient infestations of

fruit flies in areas where they have not been previously recorded. A certain amount of such trapping has been conducted in the past in southern California by the counties for both Mexican and Mediterranean fruit flies and more recently for the Oriental fruit fly. Under the permanent survey program as added to the California Bureau of Entomology's activities, an effort will be made to extend similar trapping to selected areas of hazard in the State.

Attrahents differ for the different species of fruit flies so that it is not possible to put out a single type trap to detect all the different species. For the Mexican fruit fly a fermenting solution of brown sugar is used; for the Oriental fruit fly males natural Ceylon oil of citronella is used. Recently D. T. Fullaway of Hawaii states that they have been using straight kerosene for many years in Hawaii for the Med-fly.

A full list of hosts of the Oriental fruit fly recorded to date in Hawaii and furnished by C. G. Lemon, president of the Territorial Board of Agriculture and Forestry, totals 108 names. Of these 31 are grown in California. Estimated acreage and value of the more important crops in California, which might be attacked by the Oriental fruit fly if introduced, is placed at 889,222 acres and nearly \$312 million, covering 13 crops. This is based upon hosts actually found infested in the Hawaiian Islands, which are grown and shipped commercially from California. It might be assumed that all deciduous fruits are potential hosts. Cotton is recorded as a host but there is no way of determining at this time to what extent the crop might be affected. Grapes, not included above, might also be acceptable as a host to the Oriental fruit fly.

Our concern in the presence of this fruit fly in the Islands is our desire to be fully prepared to meet the issue should it find its way here.

Newman:

General Conclusions:

1. The problem involves not only the Oriental Fruit Fly, but the Mediterranean Fly and Melon Fly as well.
2. These flies do pose a great threat to the agricultural economy of the Mainland and are now seriously affecting the economy of the Territory of Hawaii.
3. Territory of Hawaii has contributed and is contributing more than their fair share to the fruit fly problem. Their Governor has signed a bill appropriating \$370,000 for the fight.
4. California should contribute its share of funds and manpower to the problem.
5. Oriental, Mediterranean, and Melon Flies, once established, apparently will thrive in many sections of California, Arizona, Texas, Florida and Gulf States.
6. The fruit fly problem is of national concern, and as such, the greatest contribution should be from the Federal government.
7. Since the introduction of *Dacus dorsalis* into the Islands by the U.S. Armed Forces, the U.S. government has evaded its responsibilities to its citizens to a serious extent.
8. Fruit flies probably cannot be eradicated in the Islands.

9. Quarantine is the most direct way in which movement of flies to the Mainland can be prevented, and is the Mainland's final line of defense.
10. Ecological studies on the Oriental fruit fly are very necessary to approach the problem intelligently.
11. Commodity treatment is the only way in which agricultural products may be moved after establishment of the flies.
12. Use of chemicals is probably the only practical means that can be used to eradicate incipient infestations of fruit flies if and when found on the Mainland.
13. Possibilities of chemical control of flies in the Islands are remote, except under certain limitations, such as area control, etc.
14. Biological control appears to be the only economical way to reduce and control fruit fly population in the Islands, and thus parasite exploration work becomes one of the most important phases of the problem.
15. All agencies in the Islands interested in fruit fly work, including Federal, Territorial and private are, with very few exceptions, staffed by personnel with very high ability, integrity, and interest in their work.

Observations on the effect of the Oriental fruit fly, as well as the Mediterranean fly and Melon fly, on the agricultural economy of the Islands:

1. Citrus—All varieties are attacked by Oriental and Mediterranean flies.
2. Avocados—With the exception of a few very hard shelled types, this is probably the most seriously affected crop. Damage is done by the Oriental fly.
3. Deciduous fruits—All are very susceptible to damage by Oriental and Mediterranean flies.
4. Vegetables and Melons—Economical production almost impossible due primarily to the Melon fly, but Oriental fly is serious.
5. Other Fruits—Practically all fresh fruits, both cultivated and wild, are heavily infested, mostly by Oriental fly.
6. Cotton—Little cotton in Islands, but found pink boll worm and Oriental fly larvae in same boll. USDA Extension Service man reported in 1948 ten acres of cotton on Maui almost 100% destroyed by Oriental fly.
7. Pineapple—Oriental fly larvae have been found in pineapple, but some damage is now being caused by sting marks making the pineapple crack, which causes souring of the fruit. This industry is contributing thousands of dollars to the fruit fly problem.
8. Sugar—While the flies do not attack sugar cane, they are so definitely threatening the entire Territory's economy that the sugar industry is very much concerned and is also contributing funds. The fact that employees depend a great deal on their own home grown fruits and vegetables which are now being destroyed by fruit flies is forcing additional wage raises which are already very high.

Suggested hazards to Mainland economy involved in the presence of these fruit flies in the Islands:

1. If established on the Mainland will affect citrus, deciduous, grapes, avocados, and other fresh fruits, most vegetables, melons, and cotton; in other words a large section of the agricultural economy of the United States is threatened by these flies.
2. It will affect the consumers on the Mainland very materially by so greatly increasing costs of production that the price of products will have to be raised in proportion. For example, due to the extremely large amount of pest control work and hand covering of each individual melon, watermelons raised in the Islands and sold locally cost as much as 43 cents per lb., and yet the farmer is not able to make a reasonable profit.
3. Large fly population increases chance of transportation of flies to the Mainland, in other words, puts too much dependence on quarantine.

What the fly problem requires as an over-all approach:

1. Quarantine is very efficient, but needs more men, definitely more facilities for transportation of personnel, and adequate space in which to carry on their work.
2. Parasite exploration for biological control is not being carried on to a great enough extent. Although there are now three teams of parasite explorers in the field, there are areas in which these fruit flies are known to occur which are not being searched. Greater effort on parasite exploration very likely will give the most results toward the solving of the fly problem.
3. Ecology research is very inadequate and a great deal of additional work is necessary without delay.
4. While some excellent commodity treatment work has been done, this work is still inadequate, particularly so from the point of view of California's needs. No effort should be spared to make available sufficient additional funds to accomplish what is needed in this Division.
5. A great deal of research in the field of chemical control for eradication work on the Mainland is necessary. This work should be done in the Islands.
6. Suspected Mainland hosts should be sent to the Islands for test.
7. Further work in the study of lures and traps for flies is necessary in order that early detection of the flies on the Mainland can be accomplished.
8. Immediate assignment of a qualified B.E.P.Q., Division of Fruit Fly Investigation resident man to conduct research-control studies in Territory of Hawaii with full authority to act.

What contribution can California properly make to the work in the Islands with respect to control or research in control?

1. Ecology—Funds, and men if necessary, should be made available to the University of Hawaii for cooperative work in this study.

2. Parasite Exploration—The University of California through their branch in Lignan University, should hire a Chinese entomologist to search southeast China and Formosa. Very possibly funds should be made available to the Territorial Board of Agriculture and Forestry as a cooperative project for additional parasite exploration as this Board is already doing such work.
3. Mass-rearing of present-known parasites, as well as others that may be introduced, should be instituted at once. This can be done by cooperation of the University of Hawaii and Board of Agriculture and Forestry. California can very properly make available funds for this work.
4. Protective control measures in the vicinity of embarkation points should be done through the cooperation of the University of Hawaii and Board of Agriculture and Forestry. California can very properly make available funds for this work.
5. Test eradication work should be instituted and funds furnished in cooperation with the University of Hawaii, B.E.P.Q., Fruit Fly Investigation Division, and Pineapple Research Institute.
6. All of the above should be done by Federal agencies, but if Federal funds are not immediately available, California should institute the work at once.

What should be done by California in anticipation of the introduction or detection of introduction of these flies on the Mainland?

1. Improve and expand our detection program. Additional knowledge on lures and traps as a result of studies will be of great value in this effort. Grower assistance very properly could be requested in the maintenance of traps throughout the state which would give wider and more general distribution at very little additional cost to the state.
2. Host tests of suspected fruits and vegetables should be instituted immediately with products being shipped to the Territory of Hawaii where the Fruit Fly Investigation Laboratory will cooperate with the State agencies.
3. Determination of host tolerances to sterilization treatments should be instituted immediately in the State. This work will be of prime importance in case fly infestation is discovered here. It seems probable that the B.E.P.Q., Division of Fruit Fly Investigation will not accomplish this work rapidly enough for California's needs regardless of amount of funds made available to the Division.
4. Intelligent publicity on the fruit fly problem should be accomplished in order to gain general citizen support for the work being done and contemplated. An experienced photographer should take pictures in color, both still and movie, showing the fly damage as well as the fly at work. These pictures would be most valuable to show to all groups that may be affected by the introduction of these fruit flies.

This report does not cover technical details, specific areas covered, or detailed observations made, as all of this information will be included in the official report of the Legislative Committee which may be referred to for further information.