

## ANNUAL ADDRESS

Notes on the Role of the Self-Introduced Insects in the  
Economic Entomology of HawaiiBY F. A. BIANCHI  
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(Presented at the meeting of December 7, 1939)

With this meeting we bring to end the 35th year in the life of the Hawaiian Entomological Society. Not outstanding in a long history of achievement, it has been, nevertheless, a good year. Though begun under the clouds of a nation-wide financial regression and ending now unhappily in the glare of a world war, 1939 has brought to our Society its share of growth and opportunity for service. We may look back upon it with the satisfied consciousness that our opportunities have not been wasted and our growth has continued to be deserved. Only one sad thought will mar its memory: the thought of our loss through the death of two of the Society's most valued members, Dr. Royal N. Chapman and Mr. Harold F. Willard. Though the absence of Dr. Chapman from the Territory and the prolonged illness of Mr. Willard had for some time prevented their attendance at our meetings, both retained always a keen interest in our Society and kept close contact with its affairs. Both had made valuable contributions to the study of entomology in Hawaii, both were past-presidents of this Society, and both were men whose professional attainments were matched by their high personal qualities. Those of us who knew them will remember them with affection and admiration.

In the field of finance the Society was faced early in the year with the unpleasant prospect of not being able to publish the proceedings for 1938. Out of early uncertainty, however, has now arisen renewed assurance of the esteem in which our work is held. In spite of the serious difficulties which the sugar industry has been facing for some time, our generous sponsors of other years, the Trustees of the H.S.P.A., have once again undertaken to bear the major share of our publishing costs. The second fascicle of volume X of our Proceedings is now in press and will soon be at hand for distribution. Though somewhat delayed, this number does not fall below standard in contents or size and, as always, it will evoke the Society's appreciation of the unremitting efforts of the editorial staff who have prepared it for publication.

As you know, this number of the Proceedings departs from precedent in two respects: in that it is to be printed in the mainland and in that it is to sell for a somewhat higher figure than the previous

numbers. Though neither departure can be viewed entirely without regret we may derive consolation from the fact that both measures should aid in the future to guarantee the continued publication of our Society's literary output, without which our corporate usefulness and influence would be greatly curtailed.

Leaving now the affairs of the Society, handing them over, as it were, to my successor, with my best wishes for as happy a tenure of office as mine has been, I proceed with the technical part of my address.

Not engaged in economic work of general interest and having only lately undertaken research in the field of taxonomy, I have been forced to seek a subject among those that could be explored entirely by means of the literature at hand. I have finally chosen to deal with the role of the self-introduced parasites in our economic entomology, and although I limit my consideration to the self-immigrant enemies of the orders Diptera, Coleoptera, and Lepidoptera, and the family Coccidae of the Homoptera, I believe that I cover not only the more important phases of the subject but also most of it that can be adequately approached through the available records.

As my primary purpose is the recapitulation and evaluation of knowledge rather than the recompilation of extant records, I have omitted in many cases the citation of specific references. However, as all the records that I use have had their origin in the observations and researches of the members of this Society and as all are already known, if probably not clearly remembered by all of us, the citation of any but the most important references seems unnecessary.

Beginning now with the Diptera and treating each order which I have already mentioned under its respective heading, I incorporate with the discussion of the facts the conclusions which they seem to justify.

#### THE DIPTERA

Without doubt the most effective enemy of the Diptera in Hawaii is the immigrant ant *Pheidole megacephala* (Fab.). That it occasionally destroys desirable Diptera as well as desirable insects of other orders is a matter of common observation, but its influence upon the Diptera in general is probably of benefit to man. Though we have but one recorded observation to the effect (Illingworth, Proc. Haw. Ent. Soc., vol. III, p. 24), its most important role is doubtlessly in the reduction of manure- and refuse-inhabiting species, among which are found some of our most noxious flies.

Probably a similarly beneficial role is played by other predators, including members of the Staphylinidae, Histeridae, and possibly some common Elateridae; but the importance of this role is entirely a matter of surmise. In fact, we have only one record to show its existence. This is a record by Pemberton (Proc. Haw. Ent. Soc., vol. VIII, p. 24) of the feeding of an unidentified Staphylinidae on

the larvae of fruit flies found within fallen guavas. Williams ("The Insects and Other Invertebrates of Hawaiian Sugar Cane Fields," p. 167), without giving specific instances of their activity in Hawaii, mentions two adventitious histerids, *Saprinus lugens* Erich, and *S. fimbriatus* Lec., which frequent carcasses and dung to prey on maggots.

Among the true parasites of the Diptera in the Territory the species of proven or presumed adventitious origin are few, and their value to man, in contrast to that of the predators, is small. Though records are meager, they tend to indicate, in fact, that the benefit derived from the work of some of these parasites must be at least balanced by the harm due to others which destroy beneficial species of Diptera. To make this indication clearer I have separated the recorded instances of parasitism into three groups: first, listing cases of parasitism of undesirable species of Diptera; second, listing cases which may be safely assumed to be of no importance either way; and third, listing cases of parasitism on positively beneficial Diptera.

In the first group we have only the bare records that establish the presence of the parasites concerned, without any indication of their abundance or efficiency. Seven species of parasites are included, parasitizing a total of 11 species of flies, as follows:

1. *Spalangia cameroni* Perk. ex *Stomoxys* sp., *Lyperosia irritans*, *Sarcophaga* sp., *Limnophora* sp., and *Dacus* sp. (Timberlake, "Record of Introduced and Immigrant Chalcid Flies of the Hawaiian Islands," Proc. Haw. Ent. Soc., vol. V, p. 418).

2. *Mormoniella brevicornis* Ashmead ex *Chrysomya megacephala* (Fab.), *Lucilia sericata*, *Sarcophaga dux*, and *S. barbata* (Timberlake, loc. cit.).

3. *Achrysocaris fullawayi* Cwfd. ex *Liriomyza pusilla* (Timberlake, loc. cit.).

4. *Chrysocaris parksii* Cwfd. ex *Liriomyza pusilla* (Timberlake, loc. cit.).

5. *Diaulinus* sp. ex *Liriomyza pusilla* (Timberlake, loc. cit.).

6. *Eucoilidea micromorpha* Perk. ex *Liriomyza pusilla* (Timberlake, Proc. Haw. Ent. Soc., vol. III, p. 399).

7. *Aphaereta muscae* Ashmead ex *Sarcophaga pallinervis* (Bridwell, Proc. Haw. Ent. Soc., vol. IV, p. 178).

In this first group might also be included two more pteromalids, *Muscidifurax raptor* Gir. and Sand. and *Pachycrepoides dubius* Ashm., if it were not that both of these insects have a double status in regard to the manner of their introduction to the Territory and the latter has a double status in regard to desirability as well. The first, *Muscidifurax raptor*, was bred by Swezey and Terry from *Sarcophaga* pupae as early as 1907 and is therefore sometimes called a chance immigrant; but since the same species was later re-introduced by Silvestri from Africa it also has the status of a purposeful introduction. The second, *Pachycrepoides dubius*, having been

reared in 1911 from pupae of *Ceromasia sphenophori*, might be called an undesirable self-immigrant; but it was re-introduced from the Philippine Islands in 1914 as a parasite of fruit flies and melon flies and it also has title to the status of a desirable and purposeful introduction. Fortunately it is better known in this latter role.

The second group of parasites on the Diptera, comprising those recorded only from dipterous species which because of their habits or their scarcity cannot be called of economic importance, is smaller than the preceding and comprises only two enemies of a trypetid fly and one enemy of a syrphid. The origin of both the trypetid, *Tephritis crassipes* (Thomson), and of its two parasites, *Microbracon terryi* Bridwell and a species of *Eurytoma*, is in doubt, but according to Bridwell's opinion (Proc. Haw. Ent. Soc., vol. IV, p. 166) they are probably all adventitious. The syrphid, *Lathryophthalmus arvorum* (Scop.), is of cosmopolitan distribution and is parasitized in Hawaii by an ichneumonid wasp of the genus *Phygadeuon* which has been reared from the puparium of the fly (Williams, Proc. Haw. Ent. Soc., vol. X, p. 288).

The third group into which the enemies of our Diptera are separated comprises five parasites, known to attack, either specifically or otherwise, four useful flies, as follows:

1. *Opius lantanae* Bridwell ex *Ophiomyia lantanae*, the "Lantana Agromyza" which was introduced from Mexico to combat that weed. According to Bridwell (Proc. Haw. Ent. Soc., vol. IV, p. 166), this parasite very probably entered Hawaii accidentally associated with its purposely introduced host and was first noticed by Swezey in 1913. On its effectiveness as a check on the population of the Lantana Agromyza we have no recent record, but in 1918 Bridwell wrote that several breedings had given at that time more parasites than flies and he predicted that thereafter the Lantana fly would play a very restricted part.

2. *Zatropis tortricidis* Cwfd., though first reared in Honolulu from *Gracilaria marginestrigata* Wlsm., a small moth unrelated to Lantana, appears to be another parasite which entered the Territory fortuitously with Lantana material from Mexico. The date of its first appearance (1902) and the fact that it has been reared from *Cremastobombycia lantanella*, the Lantana leafminer, and from the Lantana Agromyza point to that conclusion. Apart from a note by Timberlake (Proc. Haw. Ent. Soc., vol. IV, p. 422) that this parasite is commonly reared from Lantana berries, I find no indication of its importance.

3. *Pachyneuron allograptae* Ashmead has been reared from the pupae of *Ischiodon scutellaris* (Fab.) and from another syrphid which was judged from the circumstances of the find to be a predator on *Aphis maidis* (Timberlake, Proc. Haw. Ent. Soc., vol. V, p. 424).

4. *Pachyneuron eros* Gir. has been reared from pupae of *Leucopis nigricornis* Egger, another predatorial enemy of Aphids (Timberlake, Proc. Haw. Ent. Soc., vol. VI, p. 309).

5. *Diplazon laetatorius* (Fab.) parasitizes *Ischiodon scutellaris* and *Allograpta obliqua* (Say), whose larva is a common predator on *Aphis maidis*.

#### THE COLEOPTERA

In respect to no other order, excepting the Diptera, is our debt to the self-introduced insects so small as it is in respect to the Coleoptera. On one hand the proportion of pre-eminently important pests which belong to this order is large, and on the other hand the proportion of all the undesirable members of the order which is attacked by self-immigrant enemies is small and does not include any of our major pests. Against this formidable debit lies only the credit of a few instances of partial or complete control of minor coleopterous pests and the probable effectiveness of certain Coleoptera themselves, particularly among the Elateridae, Carabidae, Staphylinidae, and the Histeridae, as predatorial enemies of other noxious insects. The Coccinellidae might also be included. Their title however, is not secure, for of the large number of lady-beetles found in the Territory only four, one *Cycloneda* and three *Scymus*, are thought to be self-immigrants, and these, confined mostly to the high mountain regions, are of no economic significance.

More generally attacked by self-immigrant parasites than any other group of Coleoptera are the Bruchids. We have of them 12 species, 9 in the genus *Bruchus* (*B. amicus* Horn, *B. chinensis* Linn., *B. limbatus* Horn, *B. obtectus* Say, *B. phaseoli* Gyll., *B. pruininus* Horn, *B. sallaei* Sharp, *B. quadrimaculatus* Fab., and *B. prosopis* Lec.) and three others, *Megacerus alternatus* Bridwell, *Pachymerus gonagra* (Fab.), *Spermophagus pectoralis* Sharp. All are adventitious and all of probably rather recent arrival in Hawaii. For four of them (*B. amicus*, *B. obtectus*, *M. alternatus*, and *S. pectoralis*) there is no record of parasitism; and the other eight are attacked by 13 species of parasites, of which 7 (*Uscana semifumipennis* Gir., *Aplastomorpha calandrae* (Howard), *Sclerodermus immigrans* (Bridwell), *Charitopodinus swezeyi* (Crawford), *Chaetospila elegans* Westwood, *Pteromalus* sp., and *Bruchobius* sp.) are either known or presumed to be self-immigrants and 6 are purposeful introductions. Among the six introductions one (*Heterospilus prosopidis* Viereck) was brought in 1910, four (*Urosigalphus bruchi* Cwfd., *Lariophagus texanus* Cwfd., *Glyptocolastes bruchivorus* Cwfd., and a sp. of *Horismenus*) were brought in 1921, and the last (*Cerambycobius cushmani* Cwfd.) was brought in 1934.

Most interesting and probably of the greatest importance among all these parasites is the trichogrammatid *Uscana semifumipennis* Gir. Though thought to have entered Hawaii accidentally in material shipped from Texas in 1910 while the Board of Agriculture and Forestry was trying to introduce *Heterospilus prosopidis*, it is believed by Bridwell to be a self-immigrant insect (Proc. Haw. Ent.

Soc., vol. III, p. 478). It has been actually recorded from six Bruchids (*B. chinensis*, *B. pruininus*, *B. phaseoli*, *B. sallaei*, *B. limbatus*, and *Pachymerus gonagra*) and is surmised by Bridwell to attack all the species in the Territory which lay their eggs on the surface of leguminous pods (*loc. cit.*). The same author states that *Uscana* is particularly effective as a check on *P. gonagra*, parasitizing as high as 90% of the eggs of this species laid on Algaroba.

Next in importance to *Uscana* is probably the braconid, *Heterospilus prosopidis*, which became established soon after its introduction and has now been reared from *Bruchus sallaei*, *B. chinensis*, *B. phaseoli*, *B. pruininus*, and *B. prosopis*. Closely following and perhaps equal to the importance of *Heterospilus* is that of the self-immigrant *Aplastomorpha calandrae*, which has been reared from *Bruchus chinensis*, *B. phaseoli*, and *B. quadrimaculatus*. Of interest, if not of proven importance, is *Cerambycobius cushmani*, which seems to prefer *Bruchus sallaei* as a host rather than the well-known pepper weevil it was found on in Guatemala and which it was hoped it would check in Hawaii. Of the importance of the other parasites we may only surmise, possibly mistakenly, that the paucity of records indicates its smallness. None of them have been reared from more than one species of Bruchid and few are recorded more than once.

Apart from the enemies of the Bruchidae, which are more common in the field than in stored grains, we have a number of parasites on the pests of stored products in particular. Their economic importance is with us a matter entirely of surmisal, but it seems reasonable to assume that it is not negligible and deserves more attention than the paucity of available records indicates it has received.

Best known in this group of parasites is probably the same *Aplastomorpha calandrae* which has already been mentioned as a parasite of the Bruchidae. This chalcid is a good parasite of the rice weevil (*Calendra oryzae* (L.)) and has also been associated with the anobiid pest *Catorama herbarium* (Timberlake, Proc. Haw. Ent. Soc., vol. V, p. 422). On *Catorama*, however, another parasite appears to be of greater importance. This is the bethylid wasp *Cephalonomia peregrina* Westw., a parasite which is entitled to the double status of an accidental immigrant and a purposeful introduction. Intercepted originally as a parasite of a ptinid beetle infesting a piece of cardboard mailed from India, *Cephalonomia* was subsequently reared by Mr. Swezey for several generations on various anobiids and was eventually liberated in the grounds of the H.S.P.A. Experiment Station, being recovered from Manoa Valley in May of 1932, just two years after liberation. A long series of the insect in the aforementioned collection indicates that it is still active.

Less important than *peregrina* are three other *Cephalonomias*, *C. hyalinipennis* Ashmead, *C. gallicola* Ashmead, and *C. tarsalis* (Ashmead). The first two were circumstantially associated with the

moth, *Sitodrepa panicea*, in 1916 and have not been recorded again; and the third has been reared from *Oryzaephilus surinamensis* (L.) in raisins according to Swezey (Proc. Haw. Ent. Soc., vol. VIII, p. 31), and from an unknown host in barley according to the data on a specimen in the H.S.P.A. collection.

Short as the list of the foregoing insects is, only one other instance of parasitism by a self-immigrant is known among our Coleoptera. This is the case of the tenebrionid, *Gonocephalum seriatum* (Boisd.), and the bethylid wasp, *Epyris extraneus* Bridwell; but since the wasp is quite rare and *Gonocephalum* is not a pest of any cultivated crop, the case is merely of scientific interest.

#### THE LEPIDOPTERA

With 764 species listed in the "Fauna Hawaiiensis" alone, and probably several dozen species added since the publication of that work, the Lepidoptera constitute a group too large and poorly known to be discussed here in its entirety. Fortunately for our purpose it is only necessary to deal with the species which are of economic importance. These are only 21 in number and our limited knowledge of their interrelations makes it not only advisable but, in fact, imperative that we treat them not individually but in certain groups into which their affinities and habits naturally divide them.

The first of these groups and probably at present the one of greatest economic importance is that of the armyworms and cutworms. It consists of nine species, of which three are endemic and six, by far the most abundant and harmful, are immigrant, and it provides the Hawaiian fauna's most important example of control by accidentally introduced parasites. Its nine members are attacked by 13 enemies, of which five, possibly 6, are intentional introductions and 8, possibly 7, are accidental immigrants, and there is no doubt that the very satisfactory degree of control which normally prevails is due far more to the latter species than to the former. In the former, the intentional introductions, are included two tachinids, *Archytas cirphis* and *Frontina archippivora*, two ichneumonids, *Amblyteles koebelei* and *A. purpuripennis*, and one chalcid, *Euplectrus platyhypenae*. The accidental immigrants include *Chaetogaedia monticola*, a tachinid, *Hyposoter exiguae*, an ichneumonid, *Trichogramma minutum*, a chalcid, *Telenomus narwai*, a scelionid, and three species of vespid wasps of the genus *Polistes*. Though our knowledge is not enough to make possible the unquestionable arrangement of all these parasites in their order of effectiveness it is enough to justify the belief that *Telenomus narwai* is by far the most important factor in the whole complex. This scelionid is certainly most important in the control of *Laphygma exempta*; and from the fact that in the laboratory, at least, it attacks the eggs of other armyworms and cutworms with equal readiness, we may judge that it is also of paramount importance in their control. Field observations, which almost

invariably show coincident fluctuations in the populations of all the species of armyworms and cutworms, tend to justify the same conclusion.

For the second rank in effectiveness among the parasites of armyworms my own observations suggest the three *Polistes* wasps at lower elevations and *Hyposoter exiguae* in the uplands. For the third rank, I believe, *Archytas cirphis* would be a strong candidate. Thus, even if the remaining parasites of armyworms and cutworms cannot be ranked in even approximately accurate order of importance, and even if their aggregate importance be great, which does not seem probable, the accidentally immigrated enemies of a group appear, for once, to be of greater economic importance than those deliberately introduced by man.

This is certainly not the case with the enemies of our next group of Lepidopterous pests, which comprises our two leafrollers of economic importance. These two pests, the palm leafroller, *Omiodes blackburni*, and the sugar-cane leafroller, *O. accepta*, are both native insects and they are both attacked, probably with closely parallel degrees of efficiency, by an even greater number of enemies than attack the armyworms and cutworms. Three of these enemies are native and at least 12 are accidental introductions, but even though among the latter are found the three *Polistes* wasps which hold high rank as enemies of the armyworms and cutworms, the control of the leafrollers is known to depend to a much greater extent on the work of three intentionally introduced enemies than on the efficiency of any, perhaps all, the others. These three important introduced parasites are the chalcid *Brachymeria obscurata*, the braconid *Microbracon omiodivorum*, and the tachinid *Frontina archippivora*. They were all introduced by Koebele between 1895 and 1898 and their establishment is said to have been followed by very pronounced improvement in the leafroller situation.

Having dealt in the two preceding groups with 11 out of our 21 Lepidopterous pests, we have only ten left to discuss. With seven of these, the lima bean pod borer, *Maruca testulalis* Geyer, the corn earworm, *Heliothis armigera* Hb. (*obsoleta* F.), the tortricid leafroller, *Amorbia emigratella* Busck, the koa seed worm, *Argyroploce illepida* (Butl.), the cabbage webworm, *Hellula undalis* (Fabr.), the bean butterfly, *Cosmolyce boetica* (L.), and the cabbage butterfly, *Pieris rapae* (Linn.), our concern can well be brief. Altogether these pests are attacked by 14 parasites and predators, of which 3 are endemic, 8 accidental immigrants, and 3 intentional introductions; but since all seven are still listed as being under unsatisfactory control (Pemberton and Williams, "Some Insect and Other Animal Pests in Hawaii Not under Satisfactory Biological Control," The Hawaiian Planters' Record, vol. XLII, No. 3, 1938), the importance of their enemies, whatever the source or manner of arrival, cannot be considered great.

The three remaining pests deserve somewhat greater attention. They are *Ereunetis flavistriata* Walsm., the sugar cane budworm, *Plusia chalcites* Esp., the garden looper, and *Chilo simplex* (Butl.), the rice borer.

Three parasites have been recorded from *Ereunetis flavistriata*. These have been *Melittobiopsis ereunetiphila* Timb., *Sierola molo-kaiensis* Ashm., and *Microdus hawaiiicola* Ashm. But in addition the budworm is known to be a common prey of one or more predatorial wasps of the genus *Odynerus*, and is probably even more often a victim of *Pheidole megacephala*. It is possible therefore that the relative scarcity of the budworm should be placed to the credit of accidentally immigrated insects; but since neither the origin nor the relative importance of the internal parasites is known, the point is not certain.

*Plusia chalcites* is attacked according to available record by five different species of parasites, among which only the purposely introduced *Litomastix floridana* (Ashm.) seems to be of importance. This tiny encyrtid was brought in by Koebele in 1898 under another name (*Copidosoma truncatellum*) and though it very curiously disappeared for several years after its introduction it is now quite common, its abundance having first come to the attention of Swezey in 1929. Many records of the presence of this enemy of *Plusia* are available; in contrast to the unique records indicating the occasional attack of its other parasites, which are the native *Echthromorpha fuscator* (Fabr.), the adventitious *Chaetogaedia monticola* Bigot, and *Hyposoter exiguae* (Viereck), and the purposely introduced *Brachymeria obscurata* (Walker).

In *Chilo simplex* (Butler), which entered Hawaii from Japan some time previous to 1927, we have another glaring example of the general failure of our accidentally immigrated parasites to deal adequately with a major pest. Established on our shores long before the appearance of *Chilo*, at least three parasitic wasps were found attacking the rice borer from the very first months of its discovery. Neither the work of these three, however (the egg parasite, *Trichogramma minutum*, and the larval parasites, *Nesopimpla naranyae* Ashm. and *Cremastus hymeniae* Viereck.), nor the aiding predatorial activity of ants, caterpillar-hunting wasps, and birds succeeded appreciably in either checking the spread or reducing the ravages of the pest. To the extent that this control has taken place, it appears to be due entirely to the introduction of specific parasites from the Orient, mainly in 1928.

#### THE COCCIDAE

Partly because they are economically important and partly because they are meagerly represented in the Territory, the Coccidae have received a relatively large share of attention. Two divisions of the family in particular provide readily available data from which to

draw a picture of their status. These are the *Dactylopiinae* and the *Diaspinae*. In the former, as early as 1916, Ehrhorn (Proc. Haw. Ent. Soc., vol. III, p. 231) listed 25 species, of which 9 were described from Hawaii and are presumably endemic. Since then considerable juggling of the nomenclature has failed either to increase the original list or to cast new light on the origin of the presumed endemic species. The establishment of three new foreign species has been recorded, however, and brings the total list to date up to 28 *Dactylopiinae* species. Of this total only 16 species are considered of economic significance (Fullaway, Proc. Haw. Ent. Soc., vol. V, p. 305, 1922), and of the 16 only 3 are among the presumably endemic ones. Considering the relatively minor importance of these 3 (*Trionymus insularis*, *Tylococcus giffardi*, and *Ripersia palmarum*), there is a very close correlation between the origin of our *Dactylopiinae* and their economic significance.

Looking into the status of their biological control, it appears that of the 9 endemic species all but one, *Trionymus insularis*, which is parasitized by *Anagyrus swezeyi*, *Anagyrus nigricornis*, and *Xanthoencyrtus apterus*, are entirely free of parasites either adventitious or intentionally introduced; and it appears that of the 19 foreign species 7 are attacked with various degrees of efficiency by self-immigrant parasites of absolute or nearly absolute specificity, as is shown in the following table:

1. *Asterolecanium pustulans* (Ckll.) is attacked by *Tomocera californica* How.
2. *Eriococcus araucariae* Mask. is attacked by *Aphycomorpha araucariae* Timb.
3. *Antonina indica* Green is attacked by *Anagyrus antoninae* Timb.
4. *Pseudococcus longispinus* (Targ.) is attacked by *Anagyrus nigricornis* Timb.
5. *Pseudococcus kraunhiae* (Kuwana) is attacked by *Pauridia peregrina* Timb.
6. *Pseudococcus boninsis* (Kuwana) is attacked by *Xanthoencyrtus fullawayi* Timb. and *Aphycus terryi* Ful.
7. *Ferrisiana virgata* (Ckll.) is attacked by *Blepyrus insularis* (Cam.).

Altogether then 8, or nearly one third of all the Hawaiian *Dactylopiinae* are attacked by self-introduced parasites. But it must not be judged solely from the high proportion of this type of parasitism that its economic importance is very great, for in fact this does not appear to be the case. Further analysis shows that of the eight species parasitized by self-introduced enemies four species (*Trionymus insularis*, *Asterolecanium pustulans*, *Eriococcus araucariae*, and *Ferrisiana virgata*) are not found on crops of economic importance; and one species, *Antonina indica*, has been found on the roots of sugar cane only in a few instances. Only three species are

thus left whose check or control by self-immigrant parasites might be of great economic significance. But here again man's debt to the self-immigrants has failed to attain impressive proportions, for none of the three species (*Pseudococcus boninsis*, *P. kraunhiae*, and *P. longispinus*) have ever been kept within permissible bounds by their self-introduced enemies alone and their status has only become acceptable since the deliberate introduction of foreign parasites and predators. Nor can these three species which are known, at least, to be attacked by self-immigrant enemies be called the pre-eminently important Dactylopiines of the Territory; for the two most harmful species are two others upon which no self-immigrant parasites are known. One of these, *Trionymus sacchari* (Ckll.), has lost much of its previous importance since the introduction in 1930 of *Anagyrus saccharicola* Timb., an efficient parasite from the Philippine Islands; but the other, *Pseudococcus brevipes* (Ckll.), continues to be the principal pest of pineapples, our second most important crop.

So much for the Dactylopiinae; the role of its self-immigrant parasites does not appear to be of great economic importance. Turning now to the Diaspinae, we find conditions which differ considerably in detail but lead to a similar conclusion.

In this sub-family, according to Fullaway's synopsis of 1931 (Proc. Haw. Ent. Soc., vol. VIII, p. 93), we have 36 species, among which only two varieties (var. *sandwicensis* of *Phenacaspis eugeniae* and var. *hawaiiensis* of *Andaspis flava*) might possibly be endemic. It may be surmised, therefore, that no endemic parasites attack any member of the group. Six species of parasites, however, have been reared from Diaspines in Hawaii and five described which have not been recorded elsewhere. These, added to ten species which are known from other countries as well as Hawaii, give us a total of 16 parasites, which, singly and in various combinations, attack 17 species of the host group.

If all 16 of these parasites were known with certainty to have entered the Territory by accident the high proportion of parasitized Diaspinae would constitute an important item to the credit of our self-introduced parasitic fauna. But such is not the case. Though the manner of arrival of most of the 16 species is hidden in doubt due to taxonomic difficulties and neglected records, it is definitely established that at least two of the sixteen parasites were intentionally introduced, and it is reasonably surmised that others, the majority of them perhaps, were brought in at the same time.

Of the two authenticated introductions, one, that of *Comperiella bifasciata* How., took place in 1908 and actually constituted a re-introduction because *Comperiella* had already been recorded from Hawaii by Kotinsky in 1905. The other occurred in 1894 and consisted of a species of *Aspidiotiphagus* brought from China or Japan by Koebele. It is not known which of two species of *Aspidiotiphagus* now found in the Territory this was, and it is not improbable that

both species may have been brought in together. In either case the introduction adds much to the relative importance of the intentionally introduced fauna, for one of the species, *A. agillior* Berl., parasitizes no less than three species of the host family and the other, *A. citrinus* (Craw), no less than ten (Fullaway, Proc. Haw. Ent. Soc., vol. VIII, pp. 112-113).

In addition to being attacked by the foregoing more or less specific parasites, the Diaspinae and the Dactylopiinae are no doubt also subject jointly to the attack of predators which were not intentionally brought to the Territory. These are probably more effective against the Dactylopiinae, and as a matter of fact are actually connected only with that sub-family by available records, but there is no doubt that they must also attack the Diaspinae as well as other Coccidae, at least occasionally. A list of them includes principally, first: a syrphid, *Allograpta obliqua* (Say), which has been recorded feeding on *Pseudococcus virgatus*; second a drosophilid, *Gitonides perspicax* Knab, which is common on various species of mealybugs and seems particularly abundant in cane fields; and third: a midge which is also judged, circumstantially, to prey on the mealybugs of sugar cane (Williams, "The Insects and Other Invertebrates of Hawaiian Sugar Cane Fields," p. 274).