UNITED STATES
DEPARTMENT OF AGRICULTURE
CIRCULAR No. 168

Washington, D. C. August, 1931

INSECTS INJURIOUS TO AGRICULTURE IN JAPAN

By

C. P. CLAUSEN

Senior Entomologist, Division of Deciduous Fruit Insects
Bureau of Entomology

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Circular No. 168. United States Department of Agriculture. "Insects Injurious to Agriculture in Japan," by C. P. Clausen.

CORRECTION SLIP

Page 10. For Scolytus japonicus Chapu. read Scolytus japonicus Chap.

Page 27, line 33. For oil read soil.

Page 58, line 2. For Pestinophora gossypiella read Pectinophora gossypiella.

Page 64. For Curculionidale read Curculionidae.

Page 82. For Dendrolimus spectabiliis read Dendrolimus spectabilis.

Page 92. For Pyralis farnalis read Pyralis farinalis.

Page 107. For Cosmopolites sordidis read Cosmopolites sordidus.

Page 113. For Pulviniara aurantii read Pulvinaria aurantii.

SAKHALIN
ISLAND
KURILE ISLANDS
Sea of Okhotsk
Pacific Ocean
JAPAN
Honshu
Hokkaido
Kyushu
Shikoku
Tokyo
Osaka
Nagoya
Sapporo
Yokohama
Kobe
Kyoto
Hiroshima
Fukuoka
Sendai
Niigata
Kanazawa
Okayama
Kagoshima
Nagasaki
Matsuyama
Kochi
Wakayama
Tottori
Toyama
Fukui
Gifu
Shizuoka
Nara
Shiga
Mie
Aomori
Akita
Yamagata
Iwate
Fukushima
Ibaraki
Tochigi
Gunma
Saitama
Chiba
Kanagawa
Yamanashi
Nagano
Miyazaki
Oita
Saga
Kumamoto
Ehime
Tokushima
Kagawa
Hyogo
Okinawa
Ryukyu Islands
Yellow Sea
Sea of Japan
East China Sea
Philippine Sea
Bonin Islands
Volcano Islands
Marcus Island
Wake Island
Midway Islands
Hawaiian Islands
Honolulu
Guam
Saipan
Palau Islands
Caroline Islands
Marshall Islands
Gilbert Islands
Phoenix Islands
Line Islands
Samoa
Fiji
Tonga
Kermadec Islands
New Zealand
Auckland
Wellington
Christchurch
Dunedin
Hobart
Tasmania
Melbourne
Sydney
Canberra
Adelaide
Perth
Brisbane
Darwin
Alice Springs
Cairns
Townsville
Rockhampton
Mackay
Gladstone
Bundaberg
Toowoomba
Ipswich
Geelong
Ballarat
Bendigo
Albury
Wagga Wagga
Orange
Dubbo
Tamworth
Newcastle
Wollongong
Gosford
Lismore
Coffs Harbour
Port Macquarie
Taree
Grafton
Armidale
Broken Hill
Mildura
Whyalla
Port Augusta
Port Pirie
Mount Gambier
Port Lincoln
Kalgoorlie
Bunbury
Albany
Geraldton
Broome
Port Hedland
Karratha
Kununurra
Tennant Creek
Mount Isa
Charters Towers
Longreach
Roma
Dalby
Warwick
Stanthorpe
Gympie
Maryborough
Hervey Bay
Bundaberg
Gladstone
Rockhampton
Mackay
Townsville
Cairns
Innisfail
Atherton
Mareeba
Kuranda
Port Douglas
Daintree
Cape Tribulation
Cooktown
Weipa
Thursday Island
Horn Island
Normanton
Burketown
Camooweal
Mount Isa
Cloncurry
Julia Creek
Richmond
Hughenden
Winton
Boulia
Birdsville
Windorah
Quilpie
Charleville
Cunnamulla
St George
Dirranbandi
Goondiwindi
Inglewood
Texas
Stanthorpe
Warwick
Toowoomba
Dalby
Roma
Miles
Chinchilla
Kingaroy
Nanango
Gympie
Maryborough
Hervey Bay
Bundaberg
Gladstone
Rockhampton
Yeppoon
Emerald
Clermont
Moranbah
Dysart
Middlemount
Blackwater
Springsure
Rolleston
Injune
Mitchell
Augathella
Tambo
Blackall
Barcaldine
Aramac
Longreach
Winton
Boulia
Birdsville
Windorah
Quilpie
Charleville
Cunnamulla
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Augathella
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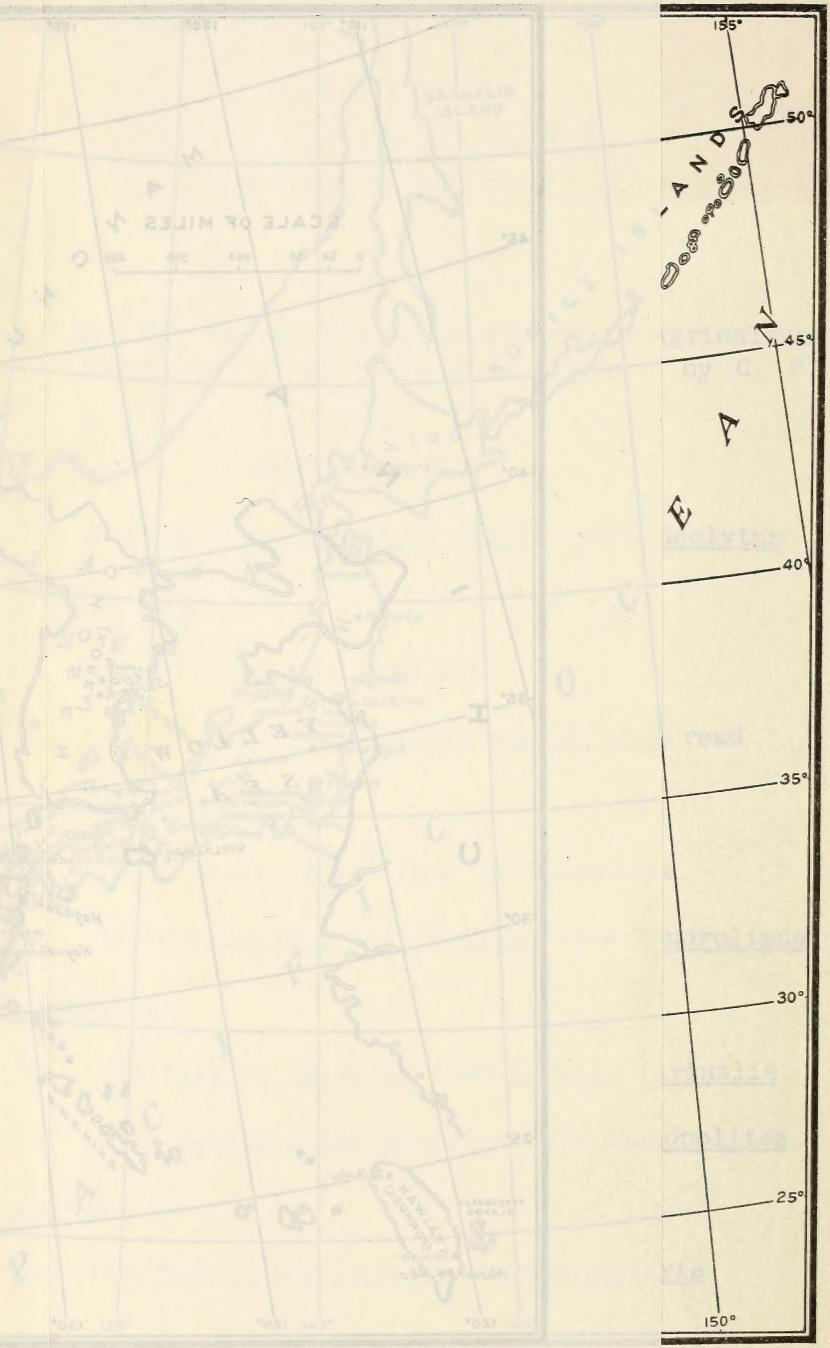
Blackall
Barcaldine
Aramac
Longreach


155°
50°
45°
40°
35°
30°
25°
150°

CIRCULAR NO. 168 AUGUST, 1931

UNITED STATES DEPARTMENT OF AGRICULTURE

WASHINGTON, D. C.

INSECTS INJURIOUS TO AGRICULTURE IN JAPAN

By C. P. CLAUSEN

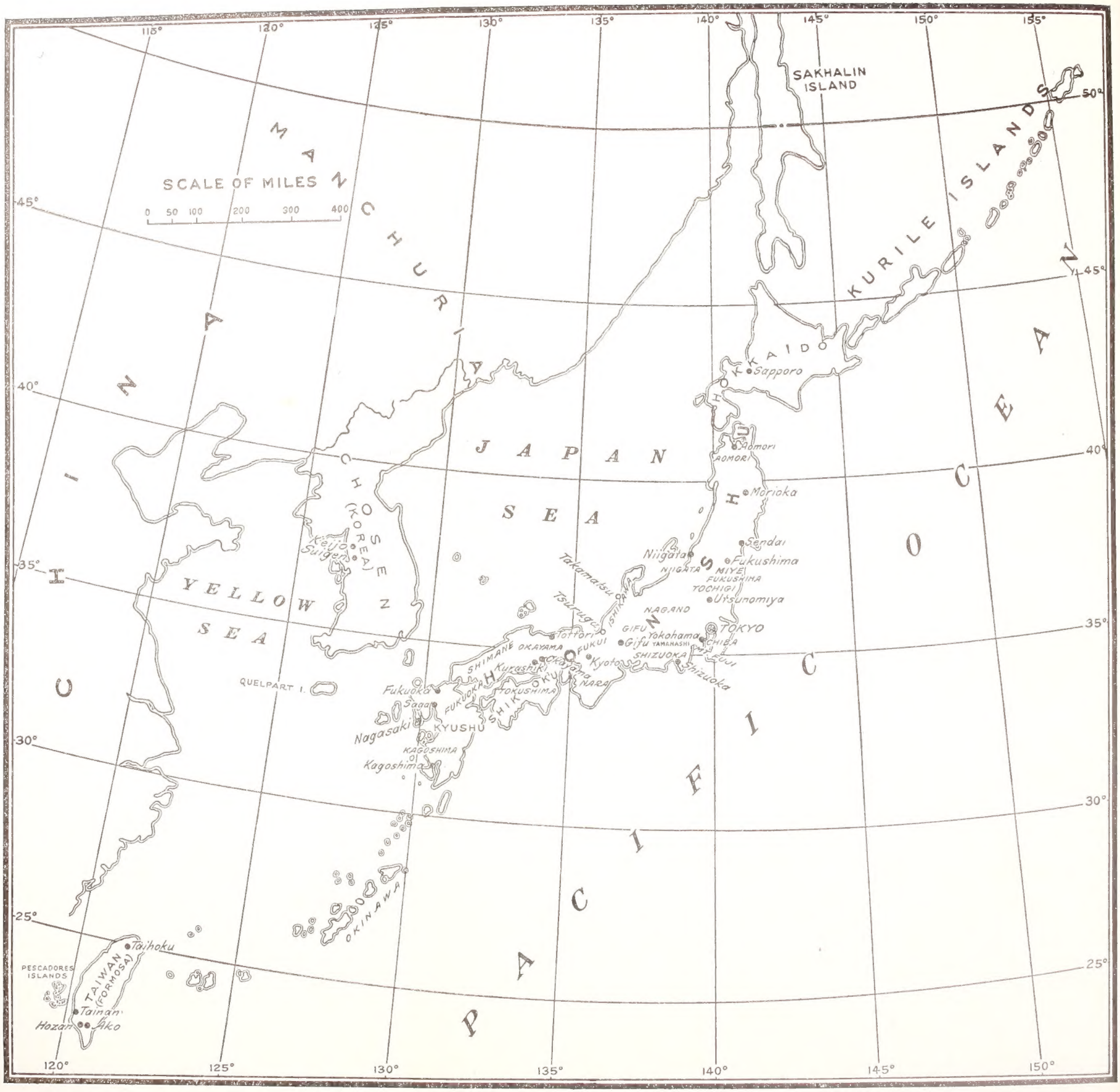
Senior Entomologist, Division of Deciduous Fruit Insects, Bureau of Entomology[1]

CONTENTS

INTRODUCTION

The purpose of this publication is to present a résumé of the published data available to the end of 1926 on the various insects injurious to agricultural crops and their products in Japan. As the trade relations between Japan and the United States are so extensive it is quite essential that the species which occur there should be known in order to guard against their introduction, and to have some information regarding them if such introduction should occur.

[1] The writer is indebted to S. Matsumura, of the Hokkaido Imperial University, I. Kuwana, of the Department of Agriculture and Forestry, and S. Kuwayama, of the Hokkaido Agricultural Experiment Station, for corrections in the manuscript and suggestions as to synonymy, distribution, etc. Acknowledgment is also made of the work of K. Sato and Y. Ouchi, assistants in the investigations of Popillia parasites in Japan, for the preparation of abstracts of a large part of the papers referred to in this circular; and the abstracts furnished of the more important papers by the Review of Applied Entomology since its inception have been of great assistance. After a study by the specialists of the Bureau of Entomology of the scientific names used in this circular it was decided that it would be better to leave these as they were used in the original publications, since it would be in no case possible, in the absence of any specimens, to verify any changes into present-day terminology.


SCALE OF MILES
0 50 100 200 300 400
SAKHALIN ISLAND
KURILE ISLANDS
HOKKAIDO
Sapporo
Aomori
AOMORI
Morioka
Sendai
Niigata
NIIGATA
Fukushima
MIYEI
FUKUSHIMA
TOCHIGI
Utsunomiya
NAGANO
GIFU
Gifu
Yokohama
YAMANASHI
CHIBA
TOKYO
SHIZUOKA
Shizuoka
Tottori
FUKUI
SHIMANE
OKAYAMA
Okayama
Kyoto
NARA
Kurashiki
HIROSHIMA
Fukuoka
FUKUOKA
Saga
Nagasaki
KYUSHU
KAGOSHIMA
Kagoshima
OKINAWA
QUELPART I.
Keijo
Suigen
Taihoku
TAIWAN (FORMOSA)
PESCADORES ISLANDS
Tainan
Hozan
Ako
JAPAN SEA
YELLOW SEA
CHINA SEA
PACIFIC OCEAN
MANCHURIA
KOREA
120°
125°
130°
135°
140°
145°
150°
155°
50°
45°
40°
35°
30°
25°

By far the greater part of the publications, many of which contain information of considerable value to entomologists in other countries, are naturally published in the Japanese language, and consequently are entirely inaccessible to all foreign workers except the very few who have facilities for translation. In recent years an increasing number of Japanese authors have followed the practice of presenting a summary of their more extended papers in English, French, or German; and in some cases the entire text is given in two languages. The writer's own observations (*11*, *12*)[2], made incidental to eight years' investigations on the problem of insect parasites in all parts of the country, have also been incorporated in the present work.

The biological and control notes presented regarding the more important species are of necessity limited. Whenever possible the more important points in the life history, such as the number of broods per year, the placement of the egg, the manner of feeding of the larva, the place of pupation, and the stage in which hibernation occurs, have been noted.

Certain of the control measures mentioned, such as the collection of adults, larvae, or eggs and the bagging of the fruit, are practicable in Japan, though not in the United States, because of the different conditions under which the various crops are grown and the lower cost of farm labor.

INSTITUTIONS IN JAPAN DOING ENTOMOLOGICAL WORK

The higher educational institutions or other units engaged in entomological research or teaching in Japan, with the names of the entomologists in charge of the respective departments, may be listed under their administrative headings as follows:

Department of Education:	
Tokyo Imperial University, Tokyo	
Kyoto Imperial University, Kyoto	H. Yuasa.
Kyushu Imperial University, Fukuoka	T. Esaki.
Sendai Imperial University, Sendai	
Hokkaido Imperial University, Sapporo	S. Matsumura.
Taihoku Imperial University, Taihoku, Taiwan (Formosa)	T. Shiraki.
Kagoshima Agricultural and Forestry College, Kagoshima	G. Okajima.
Morioka Agricultural and Forestry College, Morioka	K. Monzen.
Tottori Agricultural College, Tottori	S. Inomata.
Utsunomiya Agricultural College, Utsunomiya	B. Shibata.
Department of Agriculture and Forestry:	
Bureau of Agriculture	I. Kuwana.
Imperial Central Agricultural Experiment Station, Nishigahara, Tokyo	S. Kinoshita.
Sericultural Experiment Station, Nakano	Y. Yokoyama.
Bureau of Forestry	M. Yano.
Forestry Experiment Station, Meguro, Tokyo	M. Yano.
Department of Finance:	
Imperial Plant Quarantine Service, Tokyo	I. Kuwana.
Provincial and territorial stations:	
Hokkaido Agricultural Experiment Station, Kotoni, Sapporo	S. Kuwayama.
Fukushima Agricultural Experiment Station, Fukushima	K. Ito.
Okayama Agricultural Experiment Station, Okayama	S. Matsumoto.
Niigata Agricultural Experiment Station, Niigata	S. Takahashi.
Shimane Agricultural Experiment Station, Shimane	R. Nozu.
Shizuoka Agricultural Experiment Station, Shizuoka	K. Yoshida.
Chosen Agricultural Experiment Station, Suigen, Chosen, (Korea)	S. Nakayama.

[2] Numbers in italics in parentheses refer to Literature Cited, p. 92.

Provincial and territorial stations—Continued.
Chosen Forestry Experiment Station, Keijo (Seoul)..... J. Murayama.
Formosan Agricultural Experiment Station, Taihoku, Taiwan (Formosa)..... S. Isshiki.
Formosan Sugar Experiment Station, Taihoku, Taiwan (Formosa)..... H. Takano.
Private laboratories:
Nawa Entomological Laboratory, Gifu..... U. Nawa.
Ohara Instituts für Landwirtschaftliche Forschungen, Kurashiki..... C. Harukawa.

ENTOMOLOGICAL PUBLICATIONS IN JAPAN

Aside from the bulletin series of the various research institutions, the following are the publications now being issued, in which practically all entomological papers appear:

Published in the Japanese language:
Byochu-gai Zasshi (Journal of Plant Protection), Plant Protection Society, Tokyo.
Byokin-gaichu Iho (Journal of Pathology and Entomology), Department of Agriculture and Forestry, Tokyo.
Dai Nippon Nō Kwaihō (Journal of the Agricultural Society of Japan), Tokyo.
Dōbutsugaku Zasshi (Zoological Magazine), Zoological Society of Japan, Tokyo.
Konchu Sekai (Insect World), Nawa Entomological Laboratory, Gifu.
Kontyû (Insecta), Tokyo Entomological Society, Tokyo. (Some papers in foreign languages.)
Sapporo Norin-gaku Kwaihō (Transactions of the Sapporo Society of Agriculture and Forestry), Sapporo.
Transactions of the Natural History Society of Formosa, Taihoku. (Some papers in foreign languages.)
Transactions of the Sapporo Natural History Society, Sapporo. (Some papers in foreign languages.)
Published in foreign languages only:
Berichte des "Ohara Instituts für landwirtschaftliche Forschungen," Kurashiki.
Insecta Matsumurana (privately, by S. Matsumura), Sapporo.
Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo.
Journal of the College of Agriculture, Tokyo Imperial University, Tokyo.

The list of publications cited, which comprises a total of 212 titles, appended at the end of this circular does not include papers of a purely taxonomic nature. An effort has been made to include all of the more important contributions to economic entomology of the present century. Unless otherwise noted in the list, all papers in Japanese publications are in that language. In a number of cases the original papers have not been available, and reference has been made to the abstract appearing in the Review of Applied Entomology.

A number of general reference books upon injurious insects and their control have appeared in relatively recent years, among which may be mentioned those by Sasaki (*159*), Matsumura (*95*, *96*), and Kuwana (*56*) in Japan and by Shiraki (*169*, *171*) in Taiwan (Formosa).

Upon general classes of crops are those upon fruit insects by S. Takahashi (*184*), upon field-crop insects those by Murata (*108*) and S. Takahashi (*186*), upon vegetables insects those by Sasaki (*165*) and S. Takahashi (*185*), and upon forest insects those by Sasaki (*160*) and Niijima (*124*).

The more extensive publications dealing with particular groups of insects, which, though largely taxonomic in nature, yet contain considerable information of value as regards host plants, biology, and distribution, are those upon Lepidoptera by Nagano (*114*, *115*, *117*) and Matsumura (*93*), that upon Buprestidae by Mitsuhashi (*97*), that upon Melolonthidae by Niijima and Kinoshita (*125*), that upon Platypodidae by Murayama (*113*), and those upon Scolytidae by Niijima (*122*, *123*), those upon the Homoptera of Taiwan by Schumacher (*166*) and Esaki (*14*), those upon the Aphiidae by Kudo (*52*) and R. Takahashi (*178*, *179*, *180*, *181*, *182*), that upon the Psyllidae by Kuwayama (*74*), and those upon the Coccidae and Aleyrodidae by Kuwana (*57*, *58*, *61*, *64*, *65*, *66*, *67*, *68*, *69*, *70*, *71*).

The list of insect species attacking agricultural crops in Hokkaido, published by Kuwayama (*77*), gives detailed distribution records of the various pests as well as the known food plants. That for Okinawa (Loo-choo Islands), the group of islands extending between Japan and Taiwan (Formosa), is largely based upon the list published by Hirotaka (*32*).

An interesting publication is that by Miyake (*99*), in which an extended account is given of all of the species of insects known to have been used for food or in medicine either in past times or at present. Quite a number of insects are considered to be very palatable articles of food, and in Nagano Prefecture the collection and canning of the mature larvae and pupae of *Vespa japonica* is a well-established industry.

DISTRIBUTION RECORDS

Accompanying the lists of insect species attacking the various general groups of agricultural crops, as compiled in this circular, is given the known distribution of each species in the central Asiatic region. Though this publication deals primarily with Japan proper, it presents also such data as are available regarding the insects of Chosen (Korea), Taiwan (Formosa), and Okinawa, and their distribution to China has been noted where such records were available. These distribution records have been compiled from a large variety of publications, as the papers referred to following the species often give only the sectional distribution. In various publication in the past much confusion has resulted from the inclusion of Korean and Formosan species in papers dealing with Japanese insects, but in the accounts given herewith the records for Japan must be understood to indicate only the main group of islands representing the country geographically, rather than the political limits of the Empire.

In Japan one is impressed particularly with the great abundance in the number of insect species which may be found and in their relatively high numerical level. This is in contrast to the condition which exists in tropical regions, where the number of species is usually very large yet their numerical level is low. A considerable number of the more important insect pests of the United States are apparently native to Japan, and among these may be mentioned the gipsy moth, the European corn borer, the Japanese beetle, and others of lesser consequence. Many others, some of which are familiar to us in

the United States, have been introduced into Japan, of which the woolly apple aphis and the scale insects *Aspidiotus perniciosus*, *Lepidosaphes ulmi*, *Ceroplastes rubens*, and *Prontaspis yanonensis* may be cited. A considerable number of other species of importance are believed to have become established in Japan at more remote times, and authentic data are not available regarding their early history in the country. These came largely from China and the South Pacific regions. The oriental fruit moth is presumably to be numbered with this group.

CLIMATIC CONDITIONS

The main islands of Japan, with Chosen and Taiwan (see map), present a wide range of climatic conditions, extending from the north-temperate conditions of southern Sakhalin and Hokkaido to the tropical in southern Taiwan. In Hokkaido there is a relatively light rainfall in summer, and heavy snowfall during the winter, the maximum precipitation occurring during this latter period. In Honshu, Shikoku, and Kyushu the maximum precipitation, with a constantly high humidity, occurs during the summer months, from early June to the end of September; and relatively little precipitation occurs during the period from November to April. In the lower elevations of the sections south of Tokyo only occasional light snows occur during the winter, and the temperature drops only slightly below freezing and then for only short periods. On the western coast of Honshu, bordering the Japan Sea, the winter temperatures are much lower than on the eastern coast, which is warmed by the Japan Current. In Taiwan the plains area on the western side of the island receives fairly heavy rains throughout the year, with the maximum during midsummer, whereas on the eastern side the rainfall is considerably less. There is a marked difference in the temperature conditions between the northern and the southern sections of the island, particularly during the winter months, much more than would be expected in a range of less than 200 miles of latitude. In Chosen the summers are very hot, and the rains rather excessive during July and August; the winters are cold, but there is little snow.

In general it may be said that Hokkaido and northern Honshu present climatic conditions similar to those of the North Central States, and southern Japan and Taiwan conditions similar to those of the Gulf States, but that of Chosen has no counterpart in the United States.

DECIDUOUS-FRUIT INSECTS

Practically all the data available at the present time regarding the fruit pests of Japan are embodied in bulletins and reports from the various government and provincial experiment stations. In a considerable number of cases the specific determination as originally given has been found to be erroneous, and distribution records have had to be revised accordingly. In his recent publication Kuwayama (*77*) records 121 species of insects as being injurious to fruit trees in Hokkaido alone, and these are listed according to the host plant attacked. Upon apple and pear 88 species are mentioned, with 48 upon peach and other species of Prunus, 12 upon grape, and 28 upon mulberry.

The sections of Japan in which the various deciduous fruits are grown are in some cases quite restricted, owing to various factors. The distribution of the areas devoted to the various fruits, with a discussion of the reasons for their adaptability to these fruits, is given in detail by Ikeda (*37*). The apple is grown largely in northern Honshu and Hokkaido, and the sand pear, which is much preferred and more generally grown than the European varieties, is produced throughout all of the main islands, but most extensively in central Honshu. The peach is grown throughout Honshu and southern Hokkaido, whereas grape production is largely restricted to western and northwestern Honshu.

The manner of growth of the tree, whether natural in form or artifically trained, has an important bearing upon the possibilities of insect control by the various methods employed. The sand pear, for instance, is grown almost entirely upon either vertical or horizontal trellises. With the vertical trellis the thorough application of sprays is much more easily accomplished than where the natural tree form is retained. A considerable part of the commercial pear orchards, however, are grown on the horizontal trellis. This usually consists of heavy uprights about 10 feet apart supporting a network of bamboo crosspieces at 1 to 2 foot intervals at a height usually of 5½ feet above the ground. This covers the entire orchard, and the shoots of the young trees are tied to these poles and trained to the proper form. This method of growth has many advantages, but renders insect control by the application of sprays more difficult. Grapes are now grown largely after the manner employed in Europe and the United States, though formerly almost entirely on the horizontal trellis.

The inclosure of the individual fruits or clusters in paper bags for protection against insects is a practice which has been followed for a long period of time. While formerly applied to oranges also, it is now restricted to the deciduous fruits. It is claimed that this practice, in addition to providing protection from insect attack, favors growth, accelerates ripening, gives a more delicate skin, and is conducive to a greater uniformity in size. The bags are removed several days before the fruit is picked in order to permit of better coloring. Small holes are always left in the corners for drainage and aeration.

The paper used for the bags is either ordinary newspaper or a special paper know as "mino-gami." In some sections it is treated with the juice of the persimmon, which renders it waterproof. Persimmons are often grown for this purpose alone. The fruit is bagged immediately after thinning, this being said to prevent premature dropping.

This bagging of the fruit is done entirely by women, and each worker is capable of covering from 1,500 to 2,000 fruits per day. Prior to the present century this method was satisfactory, as labor costs were very low, but at the present time farm labor is demanding a rapidly increasing wage, and the cost of bagging, including both labor and materials, is now approximately 75 cents per tree. In addition to this protection of the fruit, spraying is often necessary to kill leaf or sap feeding insects, and the combined costs have had much to do with the maintenance of a retail price for the product often higher than that in the United States.

LIST OF DECIDUOUS-FRUIT INSECTS

	Distribution [1]	Host plants
HYMENOPTERA		
Pamphiliidae:		
Neurotoma iridescens (André)	J.	Cherry.
Cephidae:		
Janus piri O. and M	K.	Pear.
Argidae:		
Hylotoma mali Mats	J. K.	Apple.
Cimbicidae:		
Cimbex carinulata Konow	J. K.	Pear, cherry.
Tenthredinidae:		
Eriocampoides limacina Retz	J.	Apple, pear, peach, plum, cherry, quince, persimmon.
Friocampoides matsumotonis Haruk	J.	Peach, plum, cherry.
Hoplocampa pyricola Rohw	J.	Pear, plum.
DIPTERA		
Cecidomyiidae:		
Diplosis morivorella Naito	J.	Mulberry.
Diplosis quadrifasciata Niwa	J. K.	Do.
Trypetidae:		
Chaetodacus ferrugineus dorsalis Hendel	F. O.	Peach, pear, loquat, guava.
LEPIDOPTERA		
Pieridae:		
Aporia crataegi adherbal Fruhs	J. K. C.	Apple, pear, plum, mountain cherry.
Lycaenidae:		
Thecla w-album Knoch	J.	Apple.
Sphingidae:		
Acosmeryx ancea Gam	J.	Apple, cherry.
Acosmeryx castanea Roths. and Ford	J.	Grape.
Ampelophaga rubiginosa B. et G	J. K. C.	Do.
Langia zeuzeroides nawae Roths	J.	Peach, plum, apricot.
Marumba gaschkewitschi echephron Boisd	J.	Pear, plum, peach, cherry.
Rhagastis mongoliana Butl	J.	Grape.
Sphinx planus Wlk	J.	Apple, plum, cherry.
Theretra japonica Orza	J. K. F. C.	Grape.
Saturniidae:		
Actias artemis Brem	J. K.	Apple, pear, cherry.
Dictyoploca japonica Butl	J. F.	Apple, pear, plum, mulberry.
Arctiidae:		
Amsacta lactinea Cram	J. F. C. O.	Mulberry.
Diacrisia bifasciata Butl	J. K.	Do.
Diacrisia imparilis Butl	J. K.	Apple, peach, plum, cherry, mulberry.
Diacrisia infernalis Butl	J.	Apple, plum, cherry, mulberry, currant, gooseberry.
Diacrisia lubricipeda L	J. K. F. C.	Cherry, mulberry.
Diacrisia subcarnea Wlk	J. K. F. C. O.	Mulberry.
Noctuidae:		
Acronycta incretata Hamps	J. K. C.	Apple, pear, plum, peach, cherry.
Acronycta rumicis L	J. K. C.	Pear, mulberry.
Amphipyra pyrimida L	J.	Apple, pear, peach, cherry.
Asteropetes noctuina Butl	J. K.	Grape.
Calpe capucina Esp	J. K. C.	Pear, peach.
Calpe emarginata Fab	J. K. C.	Apple, pear, grape.
Calpe excavata Butl	J. K. C.	Apple, grape.
Ophideres tyrannus Guen	J. K. F. C. O.	Apple, pear, plum, peach.
Othreis fullonica L	J. K. F. C.	Apple, pear, grape.
Pangrapta obscurata Butl	J.	Apple, pear.
Phytometra chalcytes Esp	J. K. F. C.	Fig.
Prodenia litura Fab	J. F. C. O.	Mulberry.
Seudyra subflava Moore	J. K. C.	Grape.
Taeniocampa incerta Hufn	J. K. F. C.	Apple, cherry.
Notodontidae:		
Phalera flavescens B. et G	J. K. C.	Pear, plum, cherry.
Stauropus fagi L	J.	Apple, pear, cherry.
Lymantriidae:		
Arctornis chrysorrhoea L	J. K. C.	Mulberry.
Dasychira dudgeoni Swinh	F.	Pear, plum, mulberry.
Dasychira mendosa Hübn	F.	Mulberry.
Dasychira pudibunda L	J. K. F. C.	Apple, pear.
Euproctis latifascia postica Wlk	F. C.	Pear, peach, plum, mulberry, fig, grape.
Euproctis montis Leech	F. C.	Pear, peach, mulberry, grape.
Nygmia flava Brem	J. K. C.	Apple, pear, peach, cherry.
Nygmia pulverea Leech	J.	Peach, plum.
Orgyia gonostigma Fab	J. K. C.	Apple, pear, cherry.
Orgyia thyellina Butl	J. K.	Apple, pear, cherry, mulberry.
Porthesia taiwania Shir	F.	Mulberry.

[1] Distribution symbols are as follows: J., Japan; K., Chosen (Korea); F., Taiwan (Formosa); C., China; and O., Okinawa (Loo-choo or Riukiu Islands).

List of deciduous-fruit insects—Continued

	Distribution	Host plants
LEPIDOPTERA—continued		
Lymantriidae—Continued.		
Porthesia xanthocampa Dyar	J. K. C.	Apple, pear, cherry, mulberry.
Porthetria dispar L.	J. K. C.	Apple, pear, plum, cherry.
Porthetria dispar japonica Motsch.	J.	Apple, pear, cherry.
Porthetria mathura Moore	J. K. C.	Apple.
Lasiocampidae:		
Dendrolimus undans excellens Butl.	J. K. F. C.	Do.
Epicnaptera populifolia Esp.	J.	Apple, pear, cherry.
Gastropacha quercifolia L.	J. K. C.	Apple, pear, plum, apricot.
Malacosoma neustria testacea Motsch.	J. K. C.	Apple, pear, peach, plum, cherry.
Odonestis pruni L.	J. K. C.	Apple, pear, cherry.
Geometridae:		
Anisopteryx membranaris Christ.	J.	Cherry, plum.
Boarmia atrilineata Butl.	J. K. F. C. O.	Mulberry.
Cistida couaggaria Guen.	J. K. C.	Apple, pear, peach, cherry.
Ennomos alniaria L.	J. K.	Apple.
Hemithea mali Mats.	J.	Do.
Hemithea sasakii Mats.	J.	Peach.
Himera pennaria L.	J.	Apple.
Phigalia sinuosaria Butl.	J.	Do.
Selenia tetralunaria Hufn.	J.	Apple, pear, plum, cherry.
Zamacra juglansiaria Graeser	J.	Pear, mulberry.
Psychidae:		
Clania minuscula Butl.	J. F. C.	Apple, pear, mulberry, cherry, grape.
Clania variegata Snell.	J. F. C.	Pear, mulberry, grape.
Limacodidae:		
Cnidocampa flavescens Wlk.	J. K. C.	Pear, plum, peach, cherry, persimmon.
Microleon longipalpis Butl.	J.	Persimmon.
Miresa inornata Wlk.	J.	Do.
Parasa consocia Wlk.	J. K. C.	Persimmon, Aleurites.
Parasa sinica Moore	J. K.	Apple, pear, plum, cherry, apricot.
Scopenodes venosa Wlk.	J. C.	Persimmon.
Pyralidae:		
Acrobasis indigenella Zell.	J.	Apple, pear, peach, plum, cherry.
Dichocrocis punctiferalis Guen.	J. K. F. C.	Peach, cherry.
Margaronia brizoalis Moore	J. F. C.	Fig.
Margaronia pyloalis Wlk.	J. F. C. O.	Mulberry.
Melitene bifidella Leech	J. K.	Pear.
Nephopteryx pirivorella Mats.	J. K.	Do.
Zygaenidae:		
Elcysma westwoodi Voll.	J. K. C.	Cherry, plum.
Illiberis pruni Dyar	J. K. C.	Apple, pear, cherry.
Pterophoridae:		
Stenoptilia vitis Sasaki	J.	Grape.
Cosmopterygidae:		
Kakivoria flavofasciata Nagano	J.	Persimmon.
Gelechiidae:		
Metzneria sp.	K.	Pear.
Tachyptilia subsequella Hübn.	J.	Peach, plum, cherry, apricot.
Aegeriidae:		
Conopia hector Butl.	J.	Apple, pear, peach, cherry, apricot.
Parathrene regalis Butl.	J.	Grape.
Sannina uroceriformis Wlk.	J.	Persimmon.
Olethreutidae:		
Exartema mori Mats.	J.	Mulberry.
Exartema morivorella Mats.	J.	Do.
Grapholitha cerasivora Mats.	J.	Cherry.
Grapholitha molesta Busck	J. K. C.	Apple, pear, peach, plum, cherry, apricot, quince, Crataegus.
Hedia dimidiata L.	J.	Apple, pear, cherry.
Spilonota ocellana Schiff.	J. K.	Do.
Spilonota prognothana Snell.	K.	Apple.
Tortricidae:		
Adoxophyes fasciata Wlsm.	F.	Mulberry.
Cacoecia asiatica Wlsm.	J.	Do.
Cacoecia crataegana Hübn.	J.	Do.
Cacoecia ingentana Christ.	J. F.	Apple.
Cacoecia longicellana Wlsm.	J. F.	Do.
Cacoecia xylosteana L.	J. K. C. F.	Apple, pear, cherry.
Pandemis heparana Schiff.	J.	Do.
Pandemis ribeana Hübn.	J. K. C.	Apple, pear, peach, plum, cherry.
Tortrix sinapina Butl.	J.	Apple.
Tortrix 5-fasciana Mats.	J.	Apple, cherry.
Carposinidae:		
Carposina sasakii Mats.	J. K.	Apple, pear, peach, plum.
Glyphipterigidae:		
Simaethis pariana Clerck	J.	Apple.
Plutellidae:		
Cerostoma sasakii Mats.	K.	Apple, pear.

List of deciduous-fruit insects—Continued

	Distribution	Host plants
LEPIDOPTERA—continued		
Hyponomeutidae:		
Argyresthia conjugella Zell	J.	Apple, plum, cherry.
Hyponomeuta malinella Zell	J.	Apple, pear, cherry, apricot, quince.
Coleophoridae:		
Coleophora malivorella Riley	J.	Apple, plum, cherry.
Coleophora nigricella Steph	J.	Do.
Gracilariidae:		
Lithocolletis blanchardella F	J.	Apple, pear, peach, plum, cherry,
Lithocolletis malivorella Mats	J. K.	Apple, pear, peach, plum, cherry, quince.
Lithocolletis triflorella Peyer	J.	Apple, pear, peach, plum, cherry.
Ornix sp	J.	Apple, peach, plum, cherry, apricot.
Lyonetidae:		
Lyonetia sp	J. O.	Apple, pear, peach, cherry.
Cossidae:		
Zeuzera pyrina L	J. F. K. C.	Apple, pear, cherry.
Hepialidae:		
Hepialis signifer Wlk	J.	Peach.
COLEOPTERA		
Buprestidae:		
Agrilus mali Mats	J. K. C.	Apple.
Trachys niedata Saund	J.	Cherry.
Bostrychidae:		
Sinoxylon japonicum Lesne	J.	Mulberry, persimmon.
Scarabaeidae:		
Adoretus sinicus Burm	F.	Mulberry.
Adoretus tenuimaculatus Waterh	J. K. C. O.	Apple, pear.
Anomala daimiana Har	J. K.	Grape.
Anomala geniculata Motsch	J. F. O.	Cherry, grape.
Anomala rufocuprea Motsch	J.	Do.
Holotrichia diomphalia Bates	J. K. C.	Pear, cherry, mulberry.
Maladera orientalis Motsch	J. K. C.	Apple, pear, plum, peach, mulberry.
Oxycetonia jucunda Fald	J. K. C. O.	Apple, pear.
Popillia japonica Newm	J.	Cherry, grape, gooseberry, currant.
Serica salebrosa Brenske	J.	Gooseberry, currant.
Serica similis Lewis	J. K. C.	Apple, pear, mulberry.
Cerambycidae:		
Apriona rugicollis Chevr	J. K. F. O.	Apple, pear, mulberry, fig.
Batocera lineolata Chevr	J.	Loquat.
Callidum maaki Kraatz	J.	grape.
Chreonoma fortunei Thoms	J.	Apple, plum, apricot.
Clytus caproides Bates	J.	Persimmon.
Hammoderus susukii Mats	F.	Mulberry.
Leprotes pulverulentus Jac	J.	Apple.
Melanauster chinensis Först	J. K. F. C. O.	Apple, fig, mulberry.
Mesosa japonica Bates	J.	Apple, cherry.
Oberea japonica Thunb	J. K. F. C.	Apple, pear, cherry.
Phymatodes albofasciatus Motsch	J.	Cherry, grape.
Psacothea hilaris Pasc	F.	Mulberry.
Purpuricenus lituratus ritsemi Voll	J. K.	Apple.
Xylotrechus chinensis Chevr	J. C. O.	Mulberry.
Xylotrechus pyrrhoderus Bates	J.	Grape.
Chrysomelidae:		
Acrothinium gaschkewitchi Motsch	J. F.	Grape.
Agelastica coerulea Baly	J. K.	Apple.
Cryptocephalus approximatus Baly	J.	Apple, pear.
Demotina decorata Baly	J.	Mulberry.
Eumolpus obscurus L	J.	Grape.
Galerucella semifulva Jacoby	J.	Apple.
Metriona thais Boh	J.	Apple, pear, peach, plum.
Nodostoma fulvipes Motsch	J.	Pear, grape.
Phyllobrotica armata Baly	J.	Apple, mulberry.
Phyllotreta funesta Baly	J.	Mulberry.
Curculionidae:		
Amystax fasciatus Roel	J.	Pear.
Anthonomus bifasciatus Mats	J.	Cherry.
Anthonomus pomorum L	J. K.	Apple, pear.
Baris deplanata Roel	J.	Mulberry.
Chlorophanus grandis Roel	J.	Apple.
Hylobius gebleri Bohem	J.	Do.
Hylobius perforatus Roel	J.	Olive.
Hylobius transversoguttatus Goez	J.	Apple.
Hypomeces squamosus Fab	F.	Mulberry.
Phyllobius argentatus L	J.	Apple.
Phyllobius pruni Mats	J.	Apple, peach, cherry.
Rhynchites betuleti motschulskyi Lew	J.	Apple, grape.
Rhynchites heros Roel	J. K.	Apple, pear, peach, cherry, loquat.

List of deciduous-fruit insects—Continued

	Distribution	Host plants
COLEOPTERA—continued		
Curculionidae—Continued.		
Rhynchites lacunipennis Jekel	J. K.	Grape.
Scepticus insularis Roel	J. K.	Peach.
Scolytidae:		
Cryphalus exiguus Blandf	J.	Mulberry.
Cryphalus malus Niis	J.	Apple, plum, cherry.
Scolytus japonicus Chapu	J.	Do.
Xyleborus apicalis Blandf	J.	Apple, grape.
Xyleborus atratus Eichh	J.	Mulberry.
Xyleborus germanus Blandf	J.	Do.
Xyleborus morivorella Niis	J. F.	Do.
HEMIPTERA		
Pentatomidae:		
Chrysocoris grandis Thunb	J.	Aleurites.
Tingitidae:		
Stephanitis ambigua Horv	J.	Pear, cherry.
Miridae:		
Heterocordylus flavipes Mats	J.	Apple, pear, mulberry.
Cercopidae:		
Aphrophora flavomaculata Mats	J.	Apple, pear.
Aphrophora intermedia Uhl	J.	Do.
Aphrophora vitis Mats	J.	Grape.
Cosmoscarta bispecularis White	F.	Mulberry.
Cicadellidae:		
Bythoscopus mali Mats	J.	Apple, pear
Chlorita flavescens Fabr	J. K. F. C. O.	Apple, peach, mulberry.
Erythroneura apicalis Mats	J.	Grape.
Erythroneura mori Mats	J.	Mulberry.
Tartessus ferrugineus Wlk	J. C.	Fig.
Tettigoniella ferruginea apicalis Wlk	J. K. F. C.	Apple, pear, peach, mulberry.
Tettigoniella viridis L	J. F. C. O.	Pear, peach, plum, cherry.
Fulgoridae:		
Geisha distinctissima Wlk	J. F. C. O.	Mulberry.
Oliarus mori Mats	F.	Do.
Ricania japonica Melich	J. F.	Do.
Chermidae:		
Anomoneura mori Schwarz	J. F.	Do.
Aphalara nebulosa Zett	J. K.	Apple.
Psylla hexastigma Horv	J.	Pear.
Psylla mali Schmid	J.	Apple.
Psylla malivorella Mats	J.	Do.
Psylla pyricola Först	J. F.	Pear.
Psylla pyrisuga Först	J.	Apple, pear.
Aphiidae:		
Anuraphis pyri Mats	J.	Pear.
Aphis japonica E. and K	J.	Apple.
Aphis pomi deG	J. F.	Apple, pear, cherry, quince.
Aphis siphonella E. and K	J.	Pear.
Aphis somei E. and K	J.	Apple, pear.
Eriosoma lanigerum Hausm	J. K.	Do.
Hyalopterus arundinis Fab	J. F.	Pear, plum, peach.
Myzus malisuctus Mats	J.	Apple.
Myzus momonis Mats	J.	Peach.
Nippolachnus piri Mats	J. F.	Pear.
Omyzus persicae Sulz	J. K. F.	Peach, plum, cherry.
Omyzus sakurae Mats	J. F.	Plum, cherry.
Prociphilus pyri Fitch	J.	Pear.
Rhopalosiphum avenae Fab	J.	Apple.
Rhopalosiphum nymphaeae L	J.	Pear, peach, plum, apricot.
Toxoptera piricola Mats	J.	Pear.
Phylloxeridae:		
Cinacium iaksuiense Kishida	J. K.	Do.
Phylloxera vastatrix Planch	J. K.	Grape.
Aleyrodidae:		
Aleurodes sp	F.	Mulberry.
Aleurolobus taonabae Kuw	J.	Grape.
Bemisia shinanoensis Kuw	J.	Mulberry.
Coccidae:		
Aspidiotus perniciosus Comst	J. K. C.	Apple, pear, peach, plum, cherry, quince, persimmon.
Aulacaspis pentagona Targ	J. K. F. C.	Peach, plum, cherry, apricot, mulberry, persimmon, grape.
Ceroplastes ceriferus And	J. F. C.	Apple, pear, peach, mulberry, persimmon.
Ceroplastes floridensis Comst	J. F.	Apple, pear, peach, loquat, mul, berry, persimmon.
Ceroplastes rubens Mask	J. F. C.	Apple, pear, plum, loquat, mulberry, persimmon.
Drosicha corpulenta Kuw	J.	Apple, pear, peach, fig, persimmon.
Icerya purchasi Mask	J. F. C. O.	Apple, pear, mulberry.
Lecanium kunoensis Kuw	J.	Cherry, gooseberry, currant.

List of deciduous-fruit insects—Continued

	Distribution	Host plants
HEMIPTERA—continued		
Coccidae—Continued.		
Lecanium prunastri Fonsc	J. K.	Plum, cherry.
Lepidosaphes conchiformis Gmel	J.	Pear.
Lepidosaphes kuwacola Kuw	J.	Persimmon.
Lepidosaphes tubulorum Ferris	J. C.	Pear, plum, grape, currant, gooseberry.
Lepidosaphes ulmi L	J.	Apple, plum, currant, gooseberry.
Lepidosaphes ume Kuw	J.	Plum, cherry, apricot.
Leucaspis japonica Ckll	J.	Apple, pear.
Parlatoria theae Ckll	J.	Pear, grape.
Parlatoria proteus Curt	J. F. C.	Pear.
Phenacoccus pergandei Ckll	J.	Apple, plum, cherry, persimmon.
Pseudococcus citri Risso	J. F. C.	Mulberry.
Pseudococcus comstocki Kuw	J.	Pear.
THYSANOPTERA		
Bethrothrips mori Niwa	J.	Mulberry.
Phloeothrips sp	F.	Do.
Rhaphidothrips sp	F.	Do.
ODONATA		
AGRIONIDAE:		
Lestes temporalis Selys	J.	Apple, pear, mulberry.
ISOPTERA		
Rhinotermitidae:		
Leucotermes speratus Kolbe	J. K. F. O.	Cherry.
Termitidae:		
Termes formosanus Shir	F. C. O.	Peach, mulberry.
ORTHOPTERA		
Gryllidae:		
Brachytrypes portentosus Licht	K. F. C.	Mulberry.
Gryllotalpa africana P. deB	J. K. F. C. O.	Grape.
Locustidae:		
Holochlora brevifissa Brunn	J.	Mulberry.

APPLE AND PEAR INSECTS

The major insect pests of apple in Japan are *Carposina sasakii*, *Argyresthia conjugella*, *Spilonota* (*Eucosma*) *ocellana*, *Simaethis pariana*, *Hyponomeuta malinella*, *Malacosoma neustria testacea*, *Rhynchites heros*, and *Xyleborus apicalis*. Those upon pear are *Grapholitha* (*Laspeyresia*) *molesta*, *Nephopteryx pirivorella*, *Spilonota* (*Eucosma*) *ocellana*, *Apriona rugicollis*, and *Hoplocampa pyricola*. Okomoto lists the apple and pear pests of Chosen in the following order of importance: *Grapholitha molesta*, *Carposina sasakii*, *Spilonota* (*Tmetocera*) *prognothana*, *S. ocellana*, and *Nephopteryx pirivorella*. The production of fruit on a commercial scale in Chosen has been largely restricted on account of the heavy infestation by these species.

FRUIT FEEDERS

For purposes of comparison the four lepidopterous species which feed upon the fruit, *Grapholitha molesta*, *Carposina sasakii*, *Argyresthia conjugella*, and *Nephopteryx pirivorella*, will be discussed together. *G. molesta* (*56*, *60*, *64*, *104*, *119*, *136*, *137*, *204*) in Japan and Chosen, in contrast to the condition existing in the United States, is of more consequence as a pest of sand pear than of peach. In addition, it attacks apple, quince, cherry, plum, apricot, and Japanese apricot (*Prunus ume*). The distribution of the species is general throughout the central and southern parts of Japan

proper (Honshu, Shikoku, and Kyushu), and in Chosen and China. It is relatively rare in northern Honshu, and according to Kuwayama does not as yet occur in Hokkaido. According to Harukawa (*17*, *22*, *25*, *27*), there are five generations, or four with a partial fifth, each year in southern Japan and four in the northern provinces of Honshu, while Matsumura (*95*) records three for Chosen. The length of the life cycle, not considering the overwintering brood, ranges from 20 to 25 days in the case of the fourth generation to from 35 to 45 days for the first spring brood. The greater part of the larvae spin their cocoons in crevices in the bark of the trunk and larger branches rather than in rubbish or in the soil. The habits of the species have been found to be quite variable in different localities. The first two generations attack principally the peach, in some cases from 80 to 90 per cent of the shoots being attacked. It is rather notable that the injury to peach fruit is not nearly so extensive in Japan as it is in the infested localities in the United States. When the pears begin to mature in midsummer this fruit is much preferred, particularly the sand pear, as high as 46 per cent of the fruit having been found infested in some orchards. Oviposition takes place normally during the early evening, but may be quite extensive during the afternoon on cloudy days. The greater part of the eggs of the early generations are placed upon newly expanded leaves, and in pear orchards they are sometimes found upon the green fruit, whereas the later generations generally deposit them in the calyx and stem cavities of the maturing fruit.

Several control measures are recommended by Harukawa, the main ones being the removal of all infested peach twigs in the spring before the larvae have left them for pupation; the removal of loose bark from the trunk and larger branches of the trees as well as rubbish from the ground, thus reducing the preferred places for pupation; and spraying about three times between the middle of July and the end of August with kerosene emulsion and pyrethrum powder. Arsenic sprays and nicotine are also extensively used. According to Yago (*204*), the bagging of the fruit and spraying with nicotine sulphate, together with the removal of infested twigs, are the most effective measures against this pest.

In relatively recent years *Carposina sasakii* (*Cydia persicana* of early literature) has become a more important pest of apple in northern Japan than is *A. conjugella*. It is of equal or greater importance as a pest of peach and attacks pear as well. Its distribution is general, and serious injury is caused throughout all the fruit-growing sections of Japan and Chosen.

The life history of *C. sasakii* for western Honshu has been studied by Matsumoto and Watanabe (*92*), who record three generations per year in that area, though a portion have only two generations and others may have only one. Each brood forms two types of cocoons, some being spindle shaped and others oval or nearly spherical. The pupae in the former transform very quickly and emerge, whereas those in the oval cocoons carry over until the following spring. All overwintering cocoons, of whatever generation, are of this type. A variable proportion of this type is formed by the early generations, and evidently the proportion is dependent upon various environmental influences. The first brood of adults appears in late May

and June, the second from the middle of July to early August, and the third from the middle of August to early in September. The egg stage ranges from 6 to 8 days, the combined larval stages 12 to 18 days, and the pupal stage (in spindle-shaped cocoons) 10 days. The eggs are laid in small groups upon the fruit, these being placed in any position upon the varieties of peach having a very hairy skin, whereas upon the smooth-skinned forms and upon apple and pear the preferred place is in the vicinity of the calyx cup and also near the cavity at the stem end. The newly hatched larvae immediately enter the fruit and feed largely upon the seed. Upon the peach the entrance hole is noticeable because of the presence of a small amount of excrement upon the surface at that point, but upon apple there is only a light, brownish-colored secretion. The larva feeds throughout its life within a single fruit only, and when mature enters the soil for hibernation. The adults are nocturnal in habit and live from 4 to 18 days.

According to Okamoto (*149*), there are but two generations per year in Hokkaido, the adults of the first brood emerging in July and those of the second in late August and September. Here also the two types of cocoons previously mentioned are found.

The egg is ovoid in shape, 0.5 millimeter in length, and greenish-white, with a tinge of red at the posterior end. The surface is covered with tuberculate projections at the anterior end, 10 or more of greater size and distinctive form being found. The mature larva is pink, with the head and dorsal plate of the first thoracic segment dark brown. It is about 12 millimeters in length. The cocoons are grayish, 10 millimeters in length, either spindle shaped or oval in form, and very elastic. A covering of soil usually adheres to the surface.

Control measures recommended by Matsumoto and Watanabe include hand collection of the moths, the bagging of fruit sufficiently early to prevent oviposition upon them, and the removal of all fallen fruit and rubbish from beneath the trees. Inasmuch as the moths are nocturnal in habit, it is doubtful whether the first-mentioned remedy is practicable.

Argyresthia conjugella (*73*, *147*, *148*, *149*, *194*), the well-known apple fruit miner of Europe and North America (British Columbia), is confined in its Japanese distribution to the island of Hokkaido and the northern provinces of Honshu, in which districts it attacks apple, and in Honshu cherry and plum to a slight extent also. According to Okamoto (*148*) and Kuwayama (*73*) there is a single generation each year, and the winter is passed in the mature larval stage in cocoons in the soil. The adult moths appear about the middle of July. These are nocturnal in habit and deposit their eggs in groups of three or four, and occasionally more, upon the young fruit. Each moth lays in all 30 or more eggs. These hatch in about seven days and the young larvae immediately enter the young fruit, the place of entrance being indicated by a light-brown secretion at that point. As many as 20 larvae have been found in a single fruit in commercial orchards. The feeding period covers about 50 days, and when mature the larvae leave the fruit and enter the soil to spin their cocoons. Late-developing individuals may form their cocoons in crevices in the packing cases.

The eggs are ovoid in shape, about 0.4 millimeter in length, and may be distinguished from those of *C. sasakii* by their light-yellowish color and reticulate surface. The mature larvae are 6 millimeters in length and flesh colored, with the head and plate of the first thoracic segment brown. The cocoon is brown, 8 millimeters in length, and of two layers, the outer of which is rough and open, giving the cocoon a netted appearance.

This and the preceding species are the most important pests in Hokkaido, and the control measures used are designed to be effective against both. Spraying for the codling moth in North America is usually effective if done while the calyx cup is still open, as this is the point of entrance of a majority of larvae, but such is not the case with these two species. The best time for spraying has been found to be between July 10 and 25, and stomach poisons are more effective than contact sprays. The mixture known as Sapporo solution, which is both a fungicide and an insecticide, has given the best results in Hokkaido. This is a Bordeaux mixture containing approximately 6½ pounds each of copper sulphate and of lime to 100 gallons of water to which has been added 1 quart of stock solution of sodium arsenite which is made by dissolving 1 pound of arsenious acid and 4 pounds of carbonate of soda in 1 gallon of water.

The use of this spray is more satisfactory than bagging the fruit, giving more complete control at lower cost and permitting better coloring of the mature fruit. Also, less fruit drops prematurely from the tree than when the bags are employed. Some growers are now using lead arsenate in place of the above spray. At the present time the cost of bagging is approximately 75 cents per 1,000 fruits, in comparison with which spraying is much cheaper. The growers, however, have a strong aversion to the use of any chemical sprays, owing to the belief that an injurious amount of the poison is retained upon the fruit when it is marketed, and a very large portion of them still continue the use of bags.

The fourth fruit feeder of importance is *Nephoteryx pirivorella* (*73*, *90*, *96*, *149*), which causes extensive damage to pears throughout Japan and Chosen. This species is frequently listed in literature as *N. rubizonella*, but according to Matsumura this latter name is incorrect. The injury by this species differs from that of those previously discussed in that the larvae do not feed exclusively upon the fruit and that they attack it when it is small or half grown and leave before it matures. According to Matsumoto (*90*) there are two broods per year in the Okayama section of Honshu. The winter is passed in the partly-grown larval stage within the buds, particularly the flower buds. In the spring these larvae emerge and begin feeding at the opening flower buds, which they cover with a web of silk, thus preventing expansion. These larvae also bore into newly developed shoots, causing them to wilt and die, then move to others and repeat the process. Later the young fruits are attacked, a single larva binding a cluster of them together and feeding externally upon all of them, usually where they touch one another. Maturity is reached in the latter half of May, and pupation takes place in a cavity made in the young fruit. After two weeks the adults emerge, and the period of their greatest abundance is the first half of June. Oviposition takes place soon after emergence, and the eggs hatch in

eight or nine days. The larvae of this brood feed upon the shoots and half-grown fruit and reach maturity about the middle of July, the adults emerging at the end of that month and early in August. The eggs of this generation are laid upon the buds or upon the bark of a near-by twig. The young larvae consume a few buds and then spin a whitish cocoon within the last one eaten, and in this pass the winter.

The only control measures suggested are the bagging of the fruit as soon as possible and the removal of infested clusters and twigs.

There are a number of Noctuidae which in the adult stage suck the juice from the ripening fruits of apple and pear after the paper bags inclosing them have been removed. The most important of these are *Calpe* (*Oraesia*) *emarginata*, *C. excavata*, and *Ophideres* (*Adris*) *tyrannus*. They are major pests of these fruits in Chosen (*150*) and China, though not so injurious in Japan. The feeding punctures serve as points of infection for putrefactive organisms. *Othreis* (*Ophideres*) *fullonica* and *Calpe capucina* are also mentioned as attacking these fruits, though to a much lesser extent than the above three species.

Other insects injurious to the fruit itself, though not of so great importance as those already discussed, are the curculionid *Rhynchites heros*, the sawfly *Hoplocampa pyricola*, and the mirid bug *Heterocordylus flavipes*.

Rhynchites heros is very abundant in the southwestern sections of Hokkaido and also occurs in numbers in Honshu and Chosen. Kuwayama (*73*) has recorded the life history in Hokkaido, in which locality the adults appear in the latter part of May. These feed first upon the foliage and young shoots of apple, pear, and peach and later upon the ripening fruit. The eggs are laid largely during July in holes eaten into the surface of the fruit, and the stem of the fruit is partially cut following oviposition so that the fruit will later fall to the ground. When mature, the larvae leave the fruit and enter the soil for hibernation, passing the winter in the larval stage and pupating in the early spring.

Muramatsu (*107*) has studied the life history in Chosen, and there the adults appear about the middle of June. The eggs hatch in one week. After leaving the fallen fruits, the larvae enter the soil and feed upon the roots of various weeds and vegetables. The winter is passed in this stage, and pupation occurs in May.

Control measures employed when necessary are the collection of adults by shaking them from the tree on to cloths, bagging of the young fruit, the destruction of infested and fallen fruit, and spraying with a preparation containing naphtha, insect powder, and soap. Poison sprays are also extensively used in Japan.

The apple blossom weevil of Europe, *Anthonomus pomorum*, is at times a serious pest of Japanese pear (*Pyrus serotina*) both in Japan and Chosen. According to Murata (*109*), a single generation is produced each year, and the winter is passed in the adult stage. These adults come out of hibernation in the spring and in April deposit their eggs in holes eaten into the flower buds. The eggs hatch in from seven to nine days. The contents of the buds are entirely consumed by the larvae, and pupation occurs in the chamber formed therein. The adults from these usually emerge during June.

The recently described sawfly *Hoplocampa pyricola* is a common pest of pear throughout Japan, and at times considerable damage may be done by it. The life history as studied by Harukawa (*23*) corresponds quite closely to that given for *Hoplocampa* sp. by S. Takahashi in 1912 (*183*), and both papers doubtless deal with the same species. Though pear is the principal host, plum is also sligthly attacked. The early varieties of pear are much more susceptible to damage than those which blossom later. There is one brood per year, and the winter is passed in the mature larval stage in the soil. The adults emerge in April, and the eggs are laid shortly thereafter in slits in the tissue on the outside and upper part of the calyx. Only a single egg is laid in each incision. It is covered by a gummy material, probably consisting of plant juices, and this soon becomes black. Upon hatching, the young larvae feed upon the surrounding tissue and then bore about the calyx end of the young fruit. An entire cluster of fruits may be damaged by a single larva. Owing to this injury the young fruits wither and drop from the tree shortly after the petals have fallen. Upon larger fruits the larvae feed in the seed cavity. They are full grown by the end of July and then enter the soil for hibernation.

Control measures advocated are the removal of all wild pear trees from the vicinity of cultivated orchards, the collection of adults by net during April, winter plowing to kill the hibernating larvae in the soil, and spraying with stomach poisons to kill the migrating larvae.

The mirid bug *Heterocordylus flavipes* (*96*, *131*) is common in the northern provinces of Honshu, particularly Aomori Prefecture, and at times causes serious damage. There is one brood per year, and the winter is passed in the egg stage under the bark. The eggs hatch early in the spring, and the young nymphs feed at the buds and later upon the juice of the fruit, causing extensive deformation. The greatest damage is done at the time the fruit is about one-half inch in diameter. The adults appear at the end of May and the first part of June.

FOLIAGE FEEDERS

The most important of the leaf-feeding insects upon apple and pear in Japan are *Spilonota* (*Eucosma*) *ocellana*, *Simaethis pariana*, *Hyponomeuta malinella*, *Malacosoma neustria testacea*, *Rhynchites heros*, *Holotrichia diomphalia*, and *Hylotoma mali*. The different localities in which the species predominate will be discussed along with the various insects.

The apple bud moth, *Spilonota ocellana* (*73*, *96*), well known both in Europe and North America, is found abundantly in Hokkaido, northern Honshu, and Chosen, where apple, pear, and cherry are attacked. There is one generation per year in Hokkaido, with the partly grown larvae passing the winter in light cocoons on the twigs and branches. Feeding takes place in the spring upon the opening buds. Occasionally they may feed also upon the young fruit. The adults emerge at the end of June or early in July, and shortly thereafter the eggs are laid singly or in small clusters upon the leaves. In Hokkaido very extensive damage was formerly done each year, but the species is now easily controlled by the application of a stomach poison such as Sapporo solution or lead arsenate.

The oblique-banded leaf roller, *Cacoecia longicellana* (*73*), is restricted in distribution in the Far East to the island of Hokkaido. In that island it is a common though usually not an injurious pest upon apple. A single generation is produced each year, and the adults appear the middle of July. Hibernation is in the intermediate larval stages in a web of leaves and dirt upon the twigs. In the spring these larvae become active and feed upon the young leaves and buds, inclosing them in a light web, and may at times feed also upon the young fruit. Pupation occurs about the first of July. Control measures employed are the collection of adults at lantern traps and spraying in the early spring with Sapporo solution or lead arsenate, when the larvae are feeding at the buds.

Pandemis (*Tortrix*) *heparana* (*95*), a European species, is recorded from Hokkaido and Honshu as a pest of apple, pear, and cherry, as well as of several forest trees. The adults appear in July and August, and the winter is passed in the immature larval stages upon the branches. These larvae feed upon the young buds in the spring in the same way as do those of the preceding species. In England this species is recorded as feeding at times upon the young fruit. The adults may be collected at lantern traps.

Cacoecia xylosteana (*95*) ranges in distribution from Hokkaido and Honshu in Japan to Chosen, China, and Europe. Its preferred food plants are apple and pear, though feeding occurs also upon cherry and a variety of forest trees. Its life history is similar to that of the other Tortricidae already discussed.

The apple and thorn skeletonizer of Europe, *Simaethis* (*Hemerophila*) *pariana*, which is a recent introduction into the United States, is now well established in Hokkaido and at times causes great damage. The life history in that island has been studied by Kuwayama (*75*), who records three generations per year. The eggs are deposited in the groove of the apple leaf petiole, and at times on the upper sides of the midrib of the leaf. The larvae feed upon the foliage, producing a netted effect. The adults have been observed to assemble in large numbers upon the blossoms of cultivated chrysanthemum. Control is effected by the application of Sapporo solution or lead arsenate at the middle or end of July, and the treatment is repeated two or three times.

The ermine moth, *Hyponomeuta malinella* (*73*, *103*, *147*), a species of world-wide distribution, is at times very abundant and injurious upon apple in Hokkaido and northern Honshu. Other host plants in this section are pear, sand pear, quince, cherry, and apricot. According to Kuwayama there is one brood a year in Hokkaido, and the winter is passed in the first larval stage under cover of the clustered eggshells. In the spring these young larvae emerge and feed upon the buds. After the first molt a web is spun at the crotch between some of the smaller branches, a single web inclosing the entire colony. This is gradually enlarged and eventually incloses a considerable amount of foliage. The greatest damage occurs during May and June, at which time maturity is reached. Pupation occurs early in July, and the adults emerge about three weeks later. The eggs are laid en masse in the crotches of branches or near buds during the latter part of July, and hatch in about 25 days. The control methods suggested are the collection of adults

during July and August and the destruction of the colonies of larvae during the early spring.

Kuwayama (*73*) has recorded two species of Coleophora (*C. nigricella* and *C. malivorella*) as occurring upon apple in Hokkaido. The latter is the well-known eastern pistol casebearer of the United States. The life cycles of the two species are identical in northern Japan, there being one brood a year with the adults emerging the middle of July. Hibernation is in the larval stage in the bag attached to the twig. In the spring the larvae feed upon the opening buds and young foliage. The bag of the apple and plum casebearer, *C. nigricella*, is brown in contrast to the black of *C. malivorella*. Control measures recommended for both species are spraying with Sapporo solution or lead arsenate when the buds open in the spring and again in August after the eggs have hatched.

The leaf miner *Lithocolletis malivorella* (*8*) is a pest of apple, pear, and quince in Chosen, and occurs also in Japan. There are six broods a year in those countries, and hibernation is in the pupal stage in cocoons on the dead foliage. The adults emerge early in the spring, and the eggs are laid singly upon the leaves. Upon hatching, the young larvae enter the leaf tissue and feed therein until mature. Only new foliage is attacked. The mature larva leaves its mine and spins the cocoon upon the underside of the leaf, it being fastened by two strands of silk at each end, these strands causing that portion of the leaf to curl somewhat. The egg, larval, and pupal stages cover from 4 to 7, 13 to 18, and 5 to 7 days, respectively. Another species of the genus with similar habits, but not nearly so abundant as the preceding species, is known, but it has not as yet been determined. Control of both may be effected by the removal and burning of all dead foliage under the tree in the fall or winter. A third species, *L. triflorella*, in Japan has a similar life history.

The geometrid *Phigalia sinuosaria* (*73*) is common upon apple in Hokkaido and northern Honshu, though at the present time it is much less injurious than in previous years. There is one brood per year, and the adults appear early in April. The eggs are laid in crevices in the bark, and the larvae feed upon the newly developed foliage and blossoms. These larvae are mature by the middle of June, enter the soil, transforming to pupae at the end of that month, and hibernate in the soil. The adult females are wingless. The most practicable means of control is the banding of the trunks in the early spring with cotton or sticky tree-banding material to prevent the females from ascending the tree for oviposition. Where necessary, spraying with Sapporo solution may be done shortly after the eggs have hatched.

Ennomos alniaria (*73, 149*) is found upon apple in Hokkaido and Honshu and ranges in distribution westwards to Europe. One brood is produced each year, and the winter is passed in the egg state upon the trunk or larger branches. Hatching occurs about the 1st of June in Hokkaido, and the larvae are mature in approximately five weeks. Pupation takes place in a curled leaf, which is bound by a few strands of silk. This stage covers a period of about two weeks, and the adults emerge at the end of July. Very soon thereafter the eggs, numbering from 250 to 350, are placed upon the bark in a single compact

layer. Control measures employed when necessary are the collection of egg clusters during the winter and spraying with Sapporo solution or naptha emulsion shortly after the hatching of the eggs.

Himera pennaria has the same range of distribution as the above species and feeds upon apple. Okamoto (*149*) records one brood per year, the adult moths appearing early in May and depositing their eggs upon the bark. The larvae feed until late in August, when they enter the soil and pupate, the winter being passed in the pupal stage in Hokkaido. Breeding studies at various experiment stations in Honshu, however, have given rather different life histories, some indicating hibernation in the egg stage and others in the mature larval or pupal stages.

The tent caterpillar *Malacosoma neustria testacea* (*73*, *149*) is found throughout all of the main islands of Japan and in Chosen, China, Manchuria, and Siberia as well. Extensive damage is done to many varieties of fruit trees, chiefly apple, pear, plum, and cherry. This species is particularly injurious in Hokkaido and northern Honshu. One brood a year is produced, and hibernation is in the egg stage. The eggs are laid in masses of from 250 to 300 in rings about the twigs. Hatching occurs at the end of April in Hokkaido, and the colony of young larvae builds itself a tent-shaped web at a crotch of the smaller branches. This web has a single entrance and is gradually enlarged. Feeding is done during the day outside the web, and the larvae return to it for the night or during cool periods. When maturity is reached the web is abandoned.

The combined larval stages cover a period of about 10 weeks, and pupation occurs about July 1, the whitish cocoons being formed within the folded leaf, though an occasional larva may return to the old web for pupation. The duration of the pupal stage is from 30 to 36 days, the adults emerging early in August and the females depositing their eggs the latter part of that month. Control measures employed are the collection of egg clusters during the fall and winter, the destruction of the colonies of young larvae in the web during the early spring, and the collection of adult moths at lantern traps.

Gastropacha quercifolia (*117*) is common, though not particularly injurious, upon apple, pear, plum, and apricot throughout Japan, and is recorded from Chosen and China also. There are two broods a year, and the winter is passed in the larval stage upon the branches or trunk of the host tree. The overwintering larvae become active in April and feed upon the newly developing foliage. The adults of the first brood appear in June and those of the second the middle of August and in September. The eggs are laid in masses of 400 or more upon the leaves and branches.

Odonestis pruni (*117*) occurs upon apple and pear in Japan, Chosen, and China, but is of minor importance. Two broods are produced each year, the adults appearing in June and August, respectively. The life cycle and habits are practically identical with those given for *G. quercifolia*.

Of the minor lepidopterous pests of apple and pear the noctuids *Acronycta incretata*, *Pangrapta obscurata*, and *Taeniocampa incerta* may be mentioned. *A. incretata* (*95*) (often listed in literature as *tridens* Schiff.) is found in Hokkaido, Honshu, Chosen, and China,

and occasionally may become abundant. It attacks practically all deciduous fruits. There are two broods a year, the first brood of adults appearing in June and the second at the end of July. The winter is passed in the pupal stage in the soil. *A. rumicis* is also found upon pear and other fruits. This species is recorded as an occasional pest of cotton in Turkestan.

Pangrapta obscurata is found upon apple and pear in Aomori Prefecture, at the northern extremity of Honshu, and at times causes some injury. The life history has been studied by Nishiya (*129*), who records two broods per year, with the adults of the first brood appearing in early June and those of the second the middle of August. Pupation occurs in crevices in the trunk, and the winter is passed in the pupal stage. When control is necessary it may be effected by the collection and destruction of these pupae during the winter.

Taeniocampa incerta (*128*) has been noted in Aomori Prefecture as attacking apple and cherry. Its distribution is apparently general through the Far East. There is one brood per year, and the winter is passed in the pupal stage in the soil. The adults appear the last half of April and shortly thereafter deposit their eggs upon the foliage. Maturity is reached early in June, and pupation occurs in August. The remedy suggested for the control, where the species becomes abundant, is the shaking of the larvae from the tree on to cloths and destroying them.

The gipsy moth, *Porthetria dispar*, is common and at times abundant in Hokkaido and Chosen as a pest of apple, pear, and cherry in addition to the various forest trees which it attacks. In Hokkaido it is one of the common pests of apple, and control is largely effected by the collection of the egg masses during the winter.

Porthetria mathura, primarily a pest of forest trees, at times becomes an orchard pest. According to Nishiya (*130*) this species appeared upon apple trees in Aomori Prefecture in 1918 in such numbers as to cause complete defoliation in many orchards. The eggs are usually laid upon the trunks of pine trees adjoining the orchards. The larvae in the spring migrate to the apple trees and feed upon the opening buds and later upon the mature foliage.

Orgyia gonostigma (*95*) is another lymantriid found at times attacking apple, pear, and cherry. It is distributed over Hokkaido and Honshu in Japan proper and over Chosen and Manchuria, and westward to Europe. There are two broods a year in Hokkaido, the adults of the first brood appearing in July and those of the second in September. The winter is passed in the partially grown larval stages concealed under bark or in rubbish beneath the tree. These larvae emerge in the spring and feed upon the young foliage. Control, when necessary, is the same as for other members of this family.

Orgyia thyellina, occurring in Japan and Chosen as a minor pest of apple, pear, cherry, and mulberry, has two generations a year. In Hokkaido the adults of the first generation appear in July and August, and those of the second in September and October, whereas in central Honshu they appear about one month earlier. Two female forms are found, the one normal and the other semiapterous. The eggs of *O. gonostigma* bear a felted covering, whereas those of this species have none.

Dasychira pudibunda (*149*) is distributed through all the sections under consideration except Okinawa, and is occasionally abundant upon apple, attacking pear and various forest trees also. There are two broods a year, the adults of the first emerging the middle of May and those of the second early in August. Hibernation is in the pupal stage in a rough cocoon in a folded leaf. The eggs are laid in rows upon twigs, there being about 300 in each cluster. The durations of the egg, larval, and pupal stages (first generation) are approximately 10, 45, and 10 days, respectively.

The limacodid *Parasa sinica* (*8*) is common in Chosen as a minor pest upon practically all deciduous-fruit trees with the exception of peach. There are two generations a year, and the winter is passed in the larval stage within the conspicuous egglike cocoons upon the branches. The first brood of adults appears in early June and the second about the middle of August. The eggs are laid in clusters upon the undersides of the leaves and hatch in from six to nine days.

Another limacodid, common upon pear in Japan, Chosen, and China, is *Cnidocampa* (*Miresa*) *flavescens*, the so-called oriental moth of the eastern part of the United States. In the pear-growing sections in the vicinity of Mount Fuji the species is particularly abundant, and in some years it is quite numerous upon plum in the Tokyo-Yokohama section. There is one brood each year, and the winter is passed in the mature larval stage within the cocoons upon the tree. These cocoons are similar in form to those of *P. sinica*, but have different markings. Control of this and the preceding species is secured by the collection of cocoons during the winter, these being very conspicuous upon the branches when the leaves are absent. In central Japan this pest is at times heavily parasitized by the tachinid *Chatexorista javana* B. & B. This same parasite is recorded as very effective upon *Setora nitens* Wlk. in Java, 87.7 per cent of its host being killed by it. It has not as yet been recorded upon this host in Taiwan.

The pyralid *Melitene bifedella* (*96*, *107*) occurs in Hokkaido and Honshu in Japan proper, and in Chosen as a pest of pear. There is one brood each year, the winter being passed usually in the third larval stage. Pupation occurs in Chosen in June, the adults appearing the latter part of that month. In northern Japan they are not found until early July. The eggs are deposited upon the leaves and hatch in two weeks. The larvae are nocturnal in habit, feeding upon the younger leaves at night and resting during the day in tunnels formed from various materials. The greatest damage is that done to the young foliage by the mature larvae during the early spring. Control measures are the collection of adults at lantern traps and spraying in the early spring with Sapporo solution.

The zygaenid *Illiberis pruni* (*96*, *149*) (occasionally referred to in literature as *I. sinensis* Wlk.) is found in northern Japan, Chosen, China, and Siberia, and attacks pear, apple, and cherry, being particularly serious upon the first-named. There is one brood each year, and the winter is passed in the larval stage in crevices in the bark. The larvae feed in the spring upon the buds and young foliage, and the adults emerge in midsummer. For control, spraying with Sapporo solution in August, shortly after the eggs have hatched, is recommended.

Diacrisia (*Spilarctia*) *infernalis* (*73*) is at times quite abundant in Hokkaido upon apple, mulberry, and various other fruits as well as upon deciduous forest trees. There is one brood a year, and the adults are found from the middle of July onwards. The eggs are laid in masses of several hundred each upon the undersides of the leaves and bear a felted covering. These eggs hatch about the first of August, and the larvae feed upon the foliage until the end of September. They are at first gregarious but later solitary. The winter is passed in the third larval stage in dirt and rubbish under the tree, the larvae emerging in the spring and feeding upon the newly developed foliage. Pupation occurs about the middle of June, the cocoon consisting of a thin layer of silk over a leaf. Control measures employed are the destruction of egg masses and colonies of young larvae, spraying against the latter with stomach poisons, and the collection of adults at lantern traps.

The sphingid *Sphinx planus* (*114*) is found on all of the main islands of Japan upon pear and species of Prunus as well as upon several ornamental plants. There is a single generation each year, the adults being present from June to August and the larvae until September, at which time they enter the soil for pupation.

The notodontid *Phalera flavescens* (*96*) is common and at times injurious upon pear, plum, and cherry, particularly in Hokkaido, and it occurs also in Chosen and China. There is a single brood each year, the winter being passed in the pupal stage in the soil. The adult moths appear in July and August, and the eggs are deposited in clusters on the undersides of the leaves.

The pierid butterfly *Aporia crataegi* var. *adherbal* (*73*, *149*) is of wide distribution, extending from Hokkaido to Chosen, and Siberia, and to Europe, Asia Minor, and northern Africa. In Hokkaido it is known to attack apple, pear, plum, and mountain cherry, particularly apple. There is a single brood annually, and the adults appear in late June and early July. The eggs, which are laid in plate-shaped masses of from 100 to 300 on the undersides of the leaves, hatch in three weeks. The larvae attain the third stage by fall and hibernate among the dead leaves. They emerge in the spring and feed upon the newly developed foliage, transforming to the pupal stage early in June, when a number of pupae are usually massed together under a light web. Control measures advised are the collection of adults by net, of pupae from the twigs in June, and the destruction of rubbish under the trees during the winter.

Thecla w-album (*95*) has one brood each year upon apple, and the winter is passed in the pupal stage in the soil or under rubbish. The eggs are laid upon the foliage.

The chrysomelid beetle *Agelastica coerulea* (*73*) causes some injury to apple trees in Hokkaido during late July and early August. Two generations are produced each year, and the winter is passed in the adult stage in sheltered places. The adults appear in the spring and feed upon the young foliage. The lemon-colored eggs are laid en masse upon the leaves. The larval stage covers about one month, and pupation occurs in a cell in the soil. For control the adults are collected each morning by beating the tree. Spraying shortly after the eggs hatch is effective against the larvae.

Another chrysomelid upon apple, found most commonly in Nagano Prefecture, though of general distribution, is *Galerucella semifulva*. According to Takagi (*176*) there is only one generation a year, the adults emerging in late June and early July and carrying over in that stage until the following spring in rubbish and other places of concealment. Upon emergence from hibernation in the spring these adults oviposit at the margins of newly developed leaves. The larval stage covers about one month, after which the larvae enter the soil for pupation. The method of control used is the collection of adults during the fall and early spring.

Among the Scarabaeidae of Japan and Chosen the only species of importance upon fruit trees is *Holotrichia* (*Phyllophaga*) *diomphalia* (*8*). There is said to be one generation a year, though the writer's investigations in that section have indicated a cycle of two, or probably three years. The pupae transform to adults late in the fall, and these remain in the soil until early in the following summer. They are nocturnal in habit and when abundant strip the trees of their foliage. The only measure of control thus far practiced is the collection of the adults.

The curculionid *Hylobius gebleri* (*50*, *132*) is recorded as attacking apple in the Aomori Prefecture in northern Honshu. There are two broods per year, the first brood of adults appearing in May and the second in September. The eggs are laid upon the underside of the leaf, after which the leaf is rolled and the stalk cut. The affected leaf dies and, after a few days, falls to the ground. The larvae feed upon the dead leaf tissue and when mature leave it and pupate in cells in the soil. Hibernation is in the mature larval stage in the soil. The adults feed upon the buds. For control, the collection of adults and the destruction of rolled leaves containing the eggs and larvae are suggested.

Eriocampoides (*Caliroa*) *limacina* (*202*), the common pear slug of Europe and North America, is very injurious to pear and apple in Fukushima Prefecture. In this section two broods are produced each year, and the winter is passed in the mature larval stage in the cocoons in the soil. The life cycle of the first generation covers about 50 days in central Honshu.

Another sawfly injurious to apple in Hokkaido and Chosen is *Hylotoma mali* (*73*, *193*). There are two broods a year in Hokkaido, the adults appearing in June and the latter part of August. The winter is passed in the mature larval stage in cocoons in the soil. The eggs are laid singly in incisions in the margin of the leaf and hatch in two weeks. The damage due to the feeding of the larvae upon the foliage is at times very extensive. Though the cocoons are usually formed in the soil they may frequently be found in dry grass and rubbish and under buildings. Several means of control are suggested, among which are shaking the larvae from the trees on to cloths and killing them, the burning of rubbish in the orchards during the summer and fall, providing pupation traps at the bases of the trees and killing such larvae as assemble in them, and also tightly closing places usually left open under the floors of houses and other buildings in the orchards. The report of the Chosen station for 1917 states that this species has three generations in Chosen, the adults

of the first appearing in May, those of the second in late June, and those of the third in July and August. The larvae are gregarious in habit. The egg, larval, and pupal stages cover from 10 to 17, 11 to 12, and 6 to 12 days, respectively. Spraying with soap solution containing pyrethrum powder during the early larval stages is recommended for control.

BORERS

Apriona rugicollis (*95*, *188*) at times attacks apple and pear trees quite extensively, causing considerable damage, and occurs also upon mulberry and fig, upon which hosts it is found even more commonly than on apple. The life cycle extends over a period of three years, and the adult beetles appear in the field during August. The eggs are laid in groups of seven or eight in incisions in the bark of the trunk and larger branches. The first-stage larva feeds in the cambium layer, and the later stages in the woody portions of the tree.

Chreonoma fortunei (*95*) has one brood each year upon apple in Japan and hibernates in the mature larval stage in its burrow in the wood. The adults appear in May or June.

Oberea japonica (*150*) is recorded as a serious pest of apple and pear throughout Japan, Chosen, and Siberia. There is one generation a year. The egg is laid in an incision in the twig, and the young larva bores through the pith. Extensive damage is done in some sections. According to Takahashi (*188*), the injury attributed to this species is in reality caused by *Apriona rugicollis*.

The buprestid beetle *Agrilus mali* (*8*, *106*) is known as a pest of apple in the central and northern sections of Chosen and occurs also in Manchuria and China. The species has been studied by Muramatsu, who reports it to be very injurious in some sections, for at times entire orchards of young trees have been killed, the branches of the older trees being also injured. The adults are found in the field from the middle of June until September. The eggs are laid singly upon the surface of the bark of injured or diseased areas or in crevices in buds, etc. The larvae feed upon and tunnel through the bark, but enter the woody portion to pupate. The bark of the infested areas becomes blackened and dry, and a small quantity of sap usually flows from some point of the injured area. The winter is passed in the larval stage in the burrows in the bark. The egg, larval, and pupal stages cover from 2 to 3 weeks, 10½ months, and 12 to 19 days, respectively. Control measures suggested are the shaking of the adults from the tree into pans of oil, the cutting away and burning of infested parts of the branches and trunk, and the killing of the larvae in their burrows by the use of a broad-tipped stick bearing many sharp-pointed nails, these being driven into the bark where the larvae are noted to be present.

Three species of Scolytidae (*95*, *122*, *123*) are recorded as found upon apple in northern Japan; these are *Cryphalus malus*, *Xyleborus apicalis*, and *Scolytus japonicus*. The first also attacks cherry, but in most cases injury is done only to trees which are deficient in sap, and consequently not growing well. There is one generation a year, the winter being passed in the adult stage in crevices in the trunk and other sheltered places. *X. apicalis* hibernates in the mature larval stage in the burrow. These burrows extend into the

center of the branches, often causing their death. Though the trees attacked are usually those in an unhealthy condition, sound ones may also be damaged. This is one of the most injurious insects upon apple in northern Japan, and it is also recorded as attacking grape. Control measures are largely cultural, consisting of sufficient watering and the extensive use of fertilizer; and in addition extensive pruning, with the destruction of all dead wood. It is also suggested that the trunk and larger branches be painted with kerosene emulsion during June and July to prevent oviposition.

Scolytus japonicus is recorded as infesting apple and plum throughout Japan, being particularly injurious in Hokkaido. Healthy and vigorous trees are attacked from the main trunk to the twigs 1 inch in diameter. The trees become much weakened and finally die.

The clear-wing moth *Conopia* (*Aegeria*) *hector* (*96*) is a very serious pest of various deciduous fruits, particularly apple, pear, and cherry, and is most abundant in Hokkaido. One brood is produced each year, and the winter is passed in the intermediate larval stages in the burrow under the bark. Pupation occurs in midsummer, the adults appearing in August and September. The eggs are laid in crevices in the bark.

Okamoto and Muramatsu (*152*) have recently described an additional species of sawfly upon pear in Chosen under the name *Janus piri*, which is now becoming a very serious pest in some sections. It was first noted as causing damage in 1919. The European pear (*P. communis*) is much more severely attacked than the Japanese sand pear (*P. chinensis*). Of the former the Keiffer is relatively lightly attacked and the Bartlett moderately so. When interplanted, the native varieties are very slightly injured and the foreign ones often very badly. The attack is particularly serious upon young trees which it is desired to train to a certain type of growth. A single generation is produced each year, the adults appearing in April. Oviposition takes place in incisions in the young shoots 2 or 3 inches in length. These twigs are then girdled about 1 inch beyond the point where the egg was inserted, causing immediate wilting beyond that point. The larvae, upon hatching, feed in the center of the twig. Late in the season and during the winter the infested twigs may be recognized by the more or less swollen condition at the base. The egg and pupal stages cover 7 or 8 and 8 or 9 days, respectively, and the winter is passed in the larval stage in the twigs. The eggs are laid on warm, sunny days from 10 a. m. to 1 p. m., and usually on the southern side of the tree. Control measures advised are the removal of infested twigs during the winter and early spring and of wilted shoots during April and early May, as these latter contain the eggs and young larvae at that time.

A lepidopterous borer, *Metzneria* sp. (*8*), is recorded as at times causing injury to pear twigs in Chosen. One brood is produced each year, the adults appearing late in April. The eggs are laid at the base of the bud and hatch in 16 or 17 days. The young larvae crawl about the twigs for a time and finally choose a suitable spot at which to enter. About 36 hours is required for penetration. Within two weeks the twigs begin to swell at the point attacked and eventually become much enlarged and distorted. The larval stage covers a period of approximately six months, and the winter

is passed in the pupal stage in the gall. This species is not an important pest, but it occasionally becomes abundant, and in such case may be controlled by the pruning away of all twigs bearing galls, these being easily recognizable during the fall and winter.

SAP FEEDERS

The tingitid bug *Stephanitis ambigua* (*S. pyrioides* Scott) (*95*) is found upon pear throughout the islands of Japan and at times causes serious damage, even the killing of the trees, particularly nursery stock. There are three broods a year, the first brood of nymphs appearing in July, the second in September, and the third in October. These nymphs gather in large numbers on the underside of the foliage, often causing such an extensive withdrawal of sap as to prevent the proper ripening of the fruit. The winter is passed in the egg stage.

The leaf hopper *Chlorita flavescens* (*73*), which is of general distribution throughout all the oriental regions, is a common pest of apple and pear in northern Japan. In Hokkaido there is one and possibly two broods a year, the insect hibernating in the egg stage. The eggs hatch early in June, and maturity is reached about the end of that month. The adults and nymphs assemble on the undersides of the foliage and where abundant may cause some damage. The control measure suggested is spraying with naphtha emulsion during the early part of June, at which time the hoppers are in the early nymphal stages.

The more or less cosmopolitan woolly apple aphis, *Eriosoma lanigerum* (*73*), is at times a serious pest of apple throughout Japan and in southern Chosen. The winter is passed in the nymphal stages in crevices in the bark of the trunk and branches and on the roots, though this latter place is not often used in Japan. Of the various grafting stocks used, *Pyrus prunifolia* is the most valuable as it is immune from attack. In Chosen there are 10 or more broods a year. In a recent extended account of this species in northern Japan, Monzen (*101*) records two wingless viviparous generations per month, with a total of 10 during the season. Sexual reproduction apparently takes place upon the elm (*Ulmus campestris*). The method of control generally practiced is the removal of roughened portions of the bark, the scraping out of cracks and crevices during the winter to destroy the hibernating nymphs, and the painting of the infested portions in the spring with fish oil-lye emulsion, rapeseed oil-sulphur emulsion, or tar emulsion, or concentrated lime-sulphur. Banding the trunk with a sticky material is also practiced, as is spraying with nicotine-sulphate solution, lime-sulphur, and kerosene emulsion.

Nippolachnus piri is one of the most important of the aphids infesting pear in Japan. Its winter host is *Eriobotrya japonica*. Other species of aphids are the mealy plum aphid, *Hyalopterus arundinis* (*pruni*) Fab., the well-known green-apple aphid, *Aphis pomi*, and *Anuraphis pyri*.

A new genus and species of phylloxerine, *Cinacium iaksuiense*, has recently been recorded by Kishida (*48*) upon pear in Nara Prefecture in Honshu, of which he has described the wingless form. It is not sufficiently abundant to produce appreciable injury. This species is said by some Japanese entomologists to be identical with *Phylloxera piri* Mokr.

The San Jose scale, *Aspidiotus perniciosus* (*55*, *63*), was presumably introduced into Japan from the United States some 50 years ago, and has now become thoroughly distributed over all of the main islands. It was not recognized until 1897, following which an extended search revealed its presence in many localities. It develops most extensively at elevations below 400 feet, and is rare at higher elevations. In Japan it readily attacks citrus as well as deciduous trees, though this is not the case in California. The writer has observed several heavy infestations in Honshu upon *Poncirus trifoliata*.

Among the other scale insects of some importance attacking apple and pear in Japan may be mentioned *Lepidosaphes ulmi* (*73*, *147*), *L. conchiformis* (*69*), and *Parlatoria theae* (*68*). Very extensive damage is done to apple in Hokkaido by the first-named species. It was introduced into the country upon stock from Germany in 1871, and from California the following year. Various methods of control have been tried experimentally, but the orchardists still prefer painting with fish oil-lye emulsion, and spraying with lime-sulphur and other contact insecticides. *L. conchiformis* is gradually becoming a serious pest of pear in Honshu, attacking principally the smaller branches and fruit. According to Kuwana this species may possibly be identical with *L. ficus* upon fig in California.

PEACH, PLUM, AND CHERRY INSECTS

Among the major pests of peach two have already been discussed as affecting apple and pear, these being *Carposina sasakii* and *Grapholitha molesta* (pp. 11 and 12). Another fruit feeder which might be mentioned is *Dichocrocis punctiferalis* (*96*), which is found in the central and southern parts of Japan, and in Chosen, Taiwan, China, and India as well. Its food plants are exceedingly diverse, including peach, orange, and chestnut in Japan, whereas in Queensland it is recorded as a cotton pest, and in India it attacks peach fruits and mango blossoms and is particularly injurious to castor-bean pods. In Honshu there are two broods a year, and the winter is passed in the mature larval stage in crevices in the trunk, in rubbish, or in the oil. The eggs are laid upon the peach fruit in irregular clusters of seven or eight, and upon hatching the larvae immediately burrow into the flesh, thus opening the way for entrance of organisms of decay and rendering the fruit valueless. The injury due to the attacks of this species may be avoided by bagging the fruit while small and by collecting adults at lantern traps.

Four species of noctuid moths have, in the adult stage, the habit of sucking the juices of the fruits; the general result being the entrance of putrefactive organisms at the point of puncture and later the dropping of the fruit from the trees. *Calpe* (*Oraesia*) *emarginata* and *C. excavata* are particularly serious in Chosen and China, being numbered among the major pests of stone fruits in some localities, while *Othreis fullonica* and *Ophideres* (*Adris*) *tyrannus* are of general distribution in the Far East, but attack more particularly the citrus fruits.

Two sphingids are recorded as attacking various species of Prunus in Japan. Of these, *Marumba gaschkewitschi* var. *echephron* (*114*) is a minor pest of peach and pear which occurs on all of the main islands of Japan. One generation is produced annually, the adults of which emerge in May and are found in the field until August,

while the larvae are present on the foliage from June to September. *Langia zeuzeroides* var. *nawae* (*114*) occurs in Honshu and Kyushu, and its life cycle is similar to that of the preceding species, though the adults emerge somewhat earlier in the season and the larvae persist for a longer period.

The saturniid *Dictyoploca* (*Caligula*) *japonica* (*198*) feeds upon various species of Prunus and upon chestnut and camphor as well. There is but one brood each year, and the winter is passed in the egg stage on the branches and trunk of the trees. The larvae greatly resemble the excreta of birds. The duration of the larval and pupal stages is from 70 to 80 days each, the adults appearing early in October.

Two species of leaf miners occur in Japan upon peach and other members of the same genus. These are species of Lyonetia and Ornix. The first is discussed by Harukawa and Yagi (*29*) and is stated to be the cause of considerable injury in central and southern Japan. It is recorded also in Okinawa. It was listed as *L. clerckella* by Kuwana and Takachiho (*72*) in 1911, at which time its life history and habits were studied in some detail in Tokyo. The species was first reported as a pest of peach by Doctor Sasaki in 1903. The first-mentioned authors consider the Japanese form to be distinct, and base this conclusion in part on the fact that seven generations are produced each year in Japan, whereas the European form has only two, both in England and on the continent. No description of the species, however, has as yet been published. The adults are nocturnal in habit and oviposit during the night in incisions made in the tissue of the leaf. Each female deposits more than 100 eggs. The larva is said to molt only twice, and when mature it leaves its mine and spins a cocoon on the underside of the leaf. The egg, larval, and pupal stages cover from 2 to 8, 7 to 16, and 3 to 9 days, respectively, depending upon the season. The adults which emerge in the fall are of a darker color than those found in the spring. The winter is passed in the adult stage in crevices in the trunk and branches, in rubbish, and in other sheltered places.

The same authors (*28*) have given an account of the life history and habits of a species of Ornix which is known as a minor pest of peach, plum, and cherry in the Tokyo and Okayama sections, and which is also recorded upon flowering cherry, apple, and apricot. There are four complete generations and a partial fifth each year in southwestern Honshu. The adults are nocturnal, and the eggs are laid singly upon the undersides of the leaves, usually close to the midrib, at dusk or during the night. Upon hatching, the young larvae immediately enter the leaf tissue and feed there until mature. They usually form the pupal chamber by folding over the edge of the leaf and binding it with silk, though the cocoons are often found in curled strips of bark. The egg, larval, and pupal stages cover from 3 to 14, 14 to 40, and 7 to 10 days, respectively, dependent upon the season. The last generation overwinters in the pupal stage in a cocoon in fallen foliage upon the ground. Control measures consist of the destruction of this fallen foliage and rubbish under the trees during the late fall and winter and the scraping of the bark and larger branches at the same time to remove such cocoons as may have been formed there.

Anthonomus bifasciatus has recently been recorded (*200*) as feeding in the larval stage in cherry seeds in northern Japan, the adults emerging at the end of September. It is also common in central Honshu.

An undetermined dipteron (*127*) is recorded as causing severe injury to cherry fruits in Honshu.

The sawfly *Eriocampoides matsumotonis* (*16*, *19*, *21*) is a serious pest of peach and pear in Okayama, Nagano, and Gifu Prefectures and attacks also plum and cherry. According to Harukawa there are three generations a year, the adults of the different broods appearing in June, late July to the middle of August, and September, respectively. The larvae of the first brood are found in the field during July, those of the second during August, and those of the third in late September and early October. The first-generation life cycle averages 41 days and the second 35.6 days, but the third includes those larvae which pass the winter in cocoons in the soil. Some larvae of the second brood may also carry over the winter. The cocoons are usually located less than 1 inch below the surface of the soil. The eggs are laid singly beneath the epidermis of the upper side of the leaf, though inserted from the lower side, and hatch in from 8 to 10 days. The larvae feed upon the upper epidermis only. Very few of the larvae from unfertilized eggs become adults, most of them dying in the cocoons, but such as do emerge are males. The method of attack and form of injury by this species are similar to those of the common pear slug of the same genus in Europe and North America. Clean culture and midwinter tillage to kill the larvae in the soil are recommended as control measures.

Among the scale insects by far the most important species upon peach, plum, and cherry (*121*), particularly the first, is the white peach scale, *Aulacaspis pentagona*, which occurs generally throughout Japan, Chosen, Taiwan, and China. It is particularly injurious in southwestern Honshu and Kyushu, and many orchards have been observed where the trunks and branches of the younger trees were completely covered by the scale, making them conspicuously white. The San Jose scale, *Aspidiotus perniciosus*, is at times a serious pest on these trees in the southwestern sections of Honshu.

PERSIMMON INSECTS

The most serious pest of the persimmon in Japan is the cosmopterygid moth *Kakivoria flavofasciata* (*116*), the damage at times being so extensive as to prevent the ripening of a single fruit upon the trees. According to Fujimoto (*15*) there are two broods a year, the first brood of adults appearing in May and June and the second in July and August. The eggs are deposited on the buds at the base of the leaf petiole, or between them. Upon hatching, the young larvae penetrate into the bud and later make their way to the fruit. Each larva may attack several fruits, thus increasing the amount of injury. Pupation occurs in the calyx cavity or, in the case of the overwintering brood, beneath strips of bark. The winter is passed in the mature larval stage in the cocoon. The sweet varieties of persimmon are particularly susceptible to attack. Satisfactory prevention of attack is secured by bagging the fruit.

An undetermined black limacodid (*190*) is a serious pest of persimmon and Aleurites in central Japan, and the trees are often

entirely defoliated by it. Two broods are produced each year, the adults of the first appearing in May and those of the second in August. The winter is passed in the mature larval stage within cocoons upon the twigs and larger branches. The eggs are laid in masses of 700 or more upon the leaves of the lower branches. In the early stages the larvae are gregarious and feed upon the undersurface of the leaf only, but later they separate. Control may be brought about by the collection of cocoons during the winter, by the collection of the colonies of larvae during their early stages, and by the prevention of migration by banding. It is also recommended that mixed planting of persimmon and Aleurites be avoided, as the latter is also a favored host.

The oriental moth, *Cnidocampa flavescens*, is a common pest of persimmon in central Honshu and Kyushu. It is discussed among the insects attacking pear (p. 21).

The cerambycid *Clytus caproides* (*95*) is at times found boring in the trunk and larger branches. There is one generation each year, and the adults appear in June and July.

In Japan one of the most important pests of persimmon is the coccid *Lepidosaphes tubulorum* (*69*), which occurs also upon pear, various species of Prunus, grape, etc. Among the Coccidae, the mealybugs (*Pseudococcus* spp.) are often found in numbers under the lobes at the stem end, but seldom in sufficient numbers to cause injury, and *Ceroplastes floridensis* and *C. ceriferus* are usually found upon the twigs. *Phenacoccus pergandei* is also a common pest. *L. tubulorum*, however, is the only one among the scale insects against which control measures are necessary.

MULBERRY INSECTS

Though the mulberry is here listed as a matter of convenience among the deciduous fruits, it is grown in all sections of the Far East, almost entirely for the production of leaves for the feeding of silkworms, and practically never for fruit. Owing to this fact, the trees are not permitted to grow to their normal form, but the branches are trimmed back each year to the main trunk, which is usually from 4 to 5 feet in height, or they may be cut back almost to the ground. The new foliage produced is thus greater in quantity, and the leaves are larger and more succulent and are within easy reach for frequent gathering for feeding purposes. The above manner of growth has an important bearing upon the attacks of several insect species, as will be discussed later.

The major pests of mulberry in Japan (*6*, *199*) and Chosen are *Diacrisia imparilis*, *Margaronia pyloalis*, *Boarmia atrilineata*, *Diplosis morivorella*, *D. quadrifasciata*, *Melanauster chinensis*, and *Sinoxylon japonicum*. According to Maki (*81*), the more important ones in Taiwan are *Margaronia pyloalis*, *Prodenia litura*, *Orgyia postica*, *Apriona rugicollis*, *Psacothea hilaris*, *Xyleborus morivorella*, *Psylla* sp., *Aulacaspis pentagona*, *Pseudococcus citri*, *Aleurodes* sp., and *Rhaphidothrips* sp., though a considerable number of others of minor importance are recorded. Yokoyama (*211*) in a recent publication lists 115 species in Taiwan and 97 from Japan as attacking this host.

The pyralid *Margaronia* (*Glyphodes*) *pyloalis* is one of the most serious pests of mulberry in Japan and Taiwan, extending its distribution to China and India. In Japan, according to Yokoyama (*212*) who has studied the life history in some detail, there are 4 broods a year, though Maki (*81*) records 10 in Taiwan. The winter is passed in the mature larval stage in cocoons in the soil or crevices in the bark. The first adults appear in May. The eggs are laid on the lower surface of the leaves and hatch in five or six days, the young larvae feeding at first upon this leaf surface, and later folding the leaf. Control measures recommended are the collection of adults at lantern traps, the trapping of hibernating larvae by wrapping straw about the trunk, and spraying against the early stages with a kerosene-soap emulsion containing pyrethrum powder.

Boarmia (*Hemerophila*) *atrilineata* (*6*, *96*, *211*) is one of the most common of the Lepidoptera attacking mulberry in Japan, and it is found also in Chosen and Taiwan. There are two broods of larvae each year, and hibernation takes place in the third larval stage in crevices in the trunk. The adults from the overwintered individuals appear in early July and those of the following generation in early September. In the early spring the hibernating larvae emerge and begin to feed upon the buds and new leaves. Two additional molts follow, and the cocoon is then formed among dead leaves on the branches and twigs. The eggs are deposited in clusters upon the leaves and young shoots.

Diacrisia imparilis (*5*) feeds upon quite a wide range of plants, but is particularly injurious to mulberry. There is one brood a year, and the third-stage larvae pass the winter concealed in rubbish beneath the tree. These appear early in the spring and feed upon the young foliage. The adults emerge in July and deposit their eggs in masses of several hundred on the undersides of the leaves. The larvae are at first gregarious but later solitary. Control is effected by the destruction of egg masses and young larvae and by the collection of adults at lantern traps.

The lymantriid *Arctornis chrysorrhoea* (listed as *A. phaeorrhoea* Don. and *Porthesia similis* Fuess.) is a very common pest on mulberry, though it is not abundant enough to cause injury to the tree. The importance of this species upon mulberry lies in the fact that the urticating hairs of the caterpillars, some of which adhere to the leaves, cause serious sickness to silkworms when they are fed with such foliage (*3*, *126*).

Prodenia litura (*81*) is common upon mulberry in Taiwan and southern China, and is recorded as attacking citrus and other plants as well. There are said to be eight broods a year, and hibernation is in the pupal stage in the soil. The eggs, which have a felted covering, are laid en masse upon the foliage. The young larvae feed upon the lower leaf surface, whereas the older ones feed at the margin.

The cerambycid borer *Melanauster chinensis* is mentioned as a major pest of citrus occurring throughout Japan, Chosen, Taiwan, and China. It is equally destructive to mulberry, the larvae boring through the trunk and larger branches and at times killing the tree. It is, however, a minor pest in Taiwan. Citrus, mulberry, fig, and apple are the only fruit trees recorded as hosts of this pest.

Xylotrechus chinensis (*95*) at times causes serious injury to mulberry in Japan by the boring of the larvae in the trunk and larger branches. A single brood is produced each year, the adults appearing in midsummer. The eggs are deposited in August and September and hatch in approximately two weeks. The young larva bores into the cambium layer and there passes the winter. In the spring, as growth proceeds, the woody portion of the tree is penetrated.

Another species of this family, *Apriona rugicollis*, is a serious pest of mulberry, and a short account of it is given on page 24 among the insects attacking apple and pear.

The bostrichid beetle *Sinoxylon japonicum* (*49*) was first observed as a pest of mulberry in 1918, when considerable damage was done in Nagano Prefecture. Late in the spring the adult bores beneath a bud and continues its burrow about 1 inch down the stem. The affected buds die, and the twigs often break at the point of injury. Nothing is known regarding the early stages. Persimmon and oak are also chosen as host plants.

The curculionid *Baris deplanata* (*95*) is at times a serious pest owing to its attack upon the new buds and twigs. The female beetle chews a series of holes in a young twig, and the eggs are deposited therein. The larvae bore their way down through the woody portion of the twig, ultimately killing it, and pass the winter in the pupal stage in the burrow. In the spring the emerging adults feed upon the buds and new leaves.

The cecidomyiid *Diplosis morivorella* (*120*, *201*), is very common in all sections of Japan where the mulberry is grown. The adults appear in June and July, and the eggs are laid in the buds, from 2 to 20 being placed in each. The larvae cause the formation of greenish-colored, plum-shaped galls from 5 to 9 millimeters in length at the base of the new buds or on the stalks of the basal leaves of young shoots. Infested buds often fail to develop. The winter is passed in the larval stage in the fall, and pupation takes place in early June in the same position. The injury inflicted by this species is not so severe as might be, owing to the fact that the basal rather than the terminal buds are attacked. The general effect is an increase in the number, but a reduction in the size, of the leaves produced, a disadvantage where the foliage is used for feeding silkworms.

Another species of this group known to attack mulberry in Japan and Chosen is *Diplosis quadrifasciata* (*10*), which was previously known only in the section about Tokyo, but is now a serious pest in Chosen also. Two broods are produced annually, the adults of which appear in May and July, respectively. The winter is passed in the larval stage. Oviposition takes place upon fresh, soft shoots which are in contact with the ground. The larvae bore under the bark and eventually enter the cambium, causing these branches to decay and eventually die. Damp places are very much preferred as places in which to develop, consequently the branches near the ground are much more heavily infested. The attack by these larvae in numbers causes the bark to split, and it is in the crevices thus produced that the eggs of the second brood are usually placed. Protection may be obtained by pruning away all branches to at least 5 inches above the ground.

FIG INSECTS

The pyralid moth *Margaronia* (*Cirrhochrista*) *brizoalis* (*143*) is a pest of fig in Japan. There are two broods a year, the first adults appearing in May and June and those of the second brood in August and September. The winter is passed in the early larval stages in webs on the tree, and in May these larvae become active and bore into the stem of the fruit, and then into the fruit itself, causing it to become deformed and finally to drop from the tree. More than one fruit is attacked by each larva, it being estimated that the larva moves to a fresh fruit at intervals of about five days. Pupation of the summer brood of larvae occurs late in July in crevices in the bark. The method of control recommended is the removal of infested fruits in the early stages, these being easily recognizable by the presence of brown spots on the surface.

Two other fig pests are the noctuid *Phytometra chalcytes*, a cosmopolitan species whose larvae feed upon the foliage, and the cicadellid *Tartessus ferrugineus*. Both, however, are of minor importance.

In some sections the trunk borer *Apriona rugicollis* inflicts very serious damage on fig trees. The life history is discussed on page 24, where the insect is treated as a pest of apple and pear.

GRAPE INSECTS

Of the Lepidoptera attacking grape in Japan, eight species representing the Sphingidae and Noctuidae are foliage feeders, and four of the latter family attack fruit.

Ampelophaga rubiginosa (*96*) is found on the islands of Honshu and Hokkaido in Japan proper, but extends to Chosen, China, and India. The adults are to be found in the field from July to September. The eggs are laid singly upon the foliage, and the larvae feed upon the leaves and occasionally upon the blossom stems. The winter is passed in the pupal stage in rubbish beneath the vine.

Theretra japonica (*114*) ranges in distribution over all the main islands of Japan and to Chosen, Taiwan, and China as well. The larvae feed upon a number of plants, but the cultivated grape and the so-called blind grape (*Cissus japonica*) are much preferred. The food plants of this genus are largely restricted to grape and related plants, as there are four species in India attacking it, and others are recorded in various countries. The adults emerge in May and June.

Acosmeryx castanea (*114*) is limited in distribution to the islands of Honshu and Hokkaido and feeds upon *Cissus japonica* as well as upon the cultivated grape. Adult moths may be found from May to August and the larvae from June to September.

Rhagastis mongoliana (*114*) is found in Honshu, Shikoku, and Kyushu, and feeds upon cultivated grape, *Cissus japonica*, *Impatiens balsamina*, and *Berberis vulgaris*. The adult moths appear from May to August and the larvae may be found upon the foliage until the end of September.

Among the Noctuidae the most important are the fruit feeders *Othreis fullonica*, *Ophideres* (*Adris*) *tyrannus*, *Calpe cmarginata*, and *C. excavata*. Upon grape the latter is most important, particularly in Chosen. The injury is produced by the adult moths, which

puncture the ripening fruit and suck the juices, the puncture holes then serving as points of entrance for putrefying organisms.

Seudyra (*Zallisa*) *subflava* (*118*) is found in Honshu and Kyushu in Japan, and also in Chosen, Manchuria, China, and Siberia. Two generations are produced each year in the Gifu section of Honshu, the adults of the first brood appearing in early spring and those of the second in July. This species is particularly injurious to the young foliage in Manchuria.

According to Sasaki (*164*) the pterophorid *Stenoptilia vitis*, which he described, is restricted in distribution to the Kagawa district in the island of Honshu and is primarily a pest of grape. Only one brood occurs each year, and the winter is passed in the pupal stage in the soil. The injury produced is due to the feeding of the larvae upon the flesh of the fruit. For control, the collection of egg masses during the spring and of the larvae later in the season is recommended. Later Takahashi (*184*) recorded the species as being most common in Kyushu, and as having two generations each year rather than one. The first generation of larvae feed upon the flower buds and opened blossoms, and the second in the fruit itself. The adults of the first brood appear in May and those of the second in August and September.

The aegeriid moth *Parathrene* (*Sciopteron*) *regalis* (*96*) is particularly common in Honshu, and its injury to grape is due to the boring of the larvae in the trunk. Where the insects are abundant the injury produced is extensive. A single generation is produced each year, the adults appearing in May.

Two cerambycid borers are known to attack grapevines, the most important being *Xylotrechus pyrrhoderus* which occurs most commonly in northern Honshu. The life history of this species has recently been studied by Matsumoto and Watanabe (*91*), who record one generation per year, the winter being passed in the larval stage in the burrows in the twigs. During the spring the larvae feed upon the wood immediately beneath the bark, gradually working around the twig and finally girdling it. As a consequence the branch beyond the feeding point withers and dies, and further feeding takes place upon the dead tissue. The adults appear in August and September and live about one week, during which time the eggs are laid in the bark or between the buds and the leaf petiole. The duration of the egg stage is about five days, and penetration by the newly hatched larva is effected through the buds. No excrement is thrown out of the burrow by the larva, and because of this fact it is difficult to detect the presence of the pest until the death of the twig takes place. Infested nodes may at times be recognized by a blackening of the node at the point of entrance. Control measures recommended are the removal of infested shoots and the cutting out of such larvae as can be located.

The second of the cerambycids mentioned is *Phymatodes albofasciatus* (*Callidium albicinctum* Bat.) (*95*), which attacks cherry as well as grape. There is a single brood each year, and the winter is passed in the pupal stage in the stem of the host plant. The adults emerge in late May and early June, and the females oviposit upon the bark of the stem. The young larvae feed externally for some time upon the bark itself and later penetrate into the woody tissues,

following which the vine, or that portion of it attacked, withers and dies. Hand collection of adults soon after emergence is the only remedy suggested.

A curculionid, *Rhynchites lacunipennis* (*8*), is recorded as a pest of grape in Chosen. Though not of major importance, it is very common and at times becomes sufficiently abundant to cause some injury. There is one generation a year, and the winter is passed in the adult stage in rubbish and other places that offer protection. The adults emerge from their hiding places about the middle of May, and oviposition begins a few weeks later. The eggs are laid in groups of from three to seven in rolled leaves and hatch in about one week. The larval stage covers a period of two months, and feeding is completed within the rolled leaf. The larva then leaves it and enters the soil for pupation. The pupal stage extends over a period of 17 or 18 days.

The curled leaves in which the larvae have developed fall to the ground early in August. Transformation to the adult stage occurs during the middle or latter part of that month, but the adults remain in the soil until the following spring. When the insects become sufficiently abundant to make control methods necessary these may consist of the collection and burning of the rolled leaves during the feeding period of the larvae and the shaking of the adults from the foliage into receptacles containing oil, this being done as soon as possible after the beetles have appeared on the vines in the spring.

A single species of scolytid beetle, *Xyleborus apicalis* (*95*), is also recorded as attacking grape, though not extensively, it being primarily a pest of apple.

Gryllotalpa africana (*107*, *150*), a gryllid species of wide distribution ranging from Africa through the entire tropical and subtropical sections of Asia to Japan and Hawaii, is at times very abundant. It is recorded as a serious pest on the island of Quelpart, the injury being due to the feeding upon the tender roots of various plants. Upon grape it is of only minor importance. There is a single generation each year, though adults and nymphs are present at all times. The eggs are laid in nests in the soil and hatch in 25 days. In the first nymphal stage the young remain in the nest and are fed by the mother, but in the succeeding stages they fare for themselves.

Erythroneura (*Zygina*) *apicalis* (*91*), a cicadellid endemic in Japan, is recorded as at times causing considerable damage to grape. There are three generations per year, and the winter is passed in the adult stage in the grass along the field borders, in rubbish piles, and in other sheltered places. These adults emerge in the spring, and the females deposit their eggs singly during the latter part of April in incisions in the tissue of the leaf veins. The second generation of adults appears about the end of August and the third in the latter part of September. To a considerable extent these generations are overlapping, particularly the last two. The greatest numbers are present during the autumn months, and the infested leaves become grayish white owing to the withdrawal of sap and consequent improper functioning. A heavy infestation reduces the crop by preventing the full growth of the fruit clusters. The removal of the grassy borders along the vineyards is essential in control, as well as the destruction of fallen foliage, rubbish, etc.

In case of a serious attack developing during the early part of the season, spraying with kerosene emulsion and pyrethrum powder is recommended, this being repeated three or four times where necessary.

The grape phylloxera, *Phylloxera vastatrix* (*77*), is recorded from Japan, but no information is available as to the extent of its distribution or the amount of injury inflicted. Nine broods are produced each year at Yamanashi, and the winter is passed in the nymphal stage.

Lepidosaphes tubulorum is at times found fairly abundant upon grape, but only where the vines are grown in infested pear orchards.

A species of white fly, *Aleurolobus taonabae*, at times causes damage to grape in Japan proper and is apparently restricted in distribution to the main island of that country. An account of its life history and habits is given by Matsumoto and Watanabe (*91*), who list as its host plants cultivated grape and *Taonabe japonica*. There are three broods a year, the first appearing in late May and early June, and the last in September and early October. The winter is passed in the larval stage upon the foliage of Taonabe, and upon their emergence in the spring the adults immediately migrate to the grape, and the eggs are laid upon the upper surface of the leaves. On the varieties of grape with hairless leaves they may be placed on the lower surface. In a heavy infestation the leaves curl and fall from the vine. The eggs of the second brood of adults are also placed upon grape foliage, but those of the third are placed upon Taonabe only. Very few of the first and second generation larvae develop upon this latter host. The greatest damage to grape is done by the second generation. Control is readily effected by the removal of all *T. japonica* plants in the immediate vicinity of the vineyards when that is possible, but otherwise the burning of infested foliage is recommended.

MISCELLANEOUS DECIDUOUS-FRUIT INSECTS

Murata and Ikeda (*112*) have recently recorded a dragonfly (*Lestes temporalis*) as a pest of various deciduous-fruit trees in northern Japan. The injury produced is due to the incisions made in the young shoots for oviposition during late July and August. The eggs laid in these twigs hatch the following spring. Only such trees as are located near water are subject to attack. According to the authors cited, oviposition may be prevented by spraying with lime-sulphur.

The pentatomid *Chrysocoris grandis* (*189*) is a particular pest of *Aleurites cordata* in the Tsuruga section of Honshu. The adults and nymphs suck the juice from the fruit, causing it to fall from the tree. Two generations are produced each year, and the winter is passed in the adult stage under stones, etc. This host plant is of economic importance because of the oil secured from its fruit, and the attacks of this bug materially reduce the yield per tree.

CITRUS INSECTS

The more important of the insects attacking citrus in Japan, which were discussed by the writer in a previous paper (*11*), are here listed, with such data as have since become available, these data dealing

more particularly with the species occurring in Taiwan and Chosen. Nitobe (*133*) lists 105 species attacking citrus in Taiwan, while in a recent publication Miyoshi (*100*) records a total of 154 species upon these hosts in the main islands of Japan.

In Japan the species of general distribution which may be considered as major pests are *Melanauster chinensis*, *Ceroplastes rubens* (*8*, *66*, *174*), *Prontaspis yanonensis* (*66*), and *Phyllocnistis citrella*. *Dacus tsuneonis*, *Partatoria pergandii*, and *Aleurocanthus spiniferus* are of importance in limited areas. In Taiwan the principal species are *M. chinensis*, *Chaetodacus ferrugineus* var. *dorsalis*, *P. citrella*, *Lepidosaphes gloverii*, *P. pergandii*, and *Diaphorina citri*.

It is worthy of note in this connection that the major pests of citrus in the more tropical sections of the Far East, particularly in India and the Malay Peninsula, are the coleopterous borers (Buprestidae and Cerambycidae) rather than the scale insects, which play such a dominant rôle in the United States.

LIST OF CITRUS INSECTS

	Distribution[1]
DIPTERA	
Trypetidae:	
Chaetodacus ferrugineus dorsalis Hendel	F. O.
Dacus diversus formosanus Shir.	F.
Dacus tsuneonis Miyake	J.
LEPIDOPTERA	
Papilionidae:	
Papilio bianor Cram	J. K. F. C. O.
Papilio demolus L.	J. F.
Papilio helenus L.	J. F. O.
Papilio memnon L.	J. F. O.
Papilio polytes L.	J. F. O.
Papilio protenor Cram.	J. F.
Papilio protenor demetrius Cram.	J. K. C. O.
Papilio xuthus L.	J. K. F. C. O.
Syntomidae:	
Amata perixanthia Hamp.	F.
Lymantriidae:	
Dasychira dugeoni Swinh.	F.
Dasychira mendosa Hübn.	F.
Euproctis conspersa Butl.	F.
Euproctis flavinata Wlk.	F. C.
Euproctis latifascia postica Wlk.	F. C.
Euproctis montis Leech.	F. C.
Euproctis varians Wlk.	F.
Arctiidae:	
Amsacta lactinea Cram.	J. F. C. O.
Asura arcuata Moore.	F.
Noctuidae:	
Calpe capucina Esp.	J. K. C.
Calpe excavata Butl.	J. K. C.
Dermaleipa juno Dalm.	J. K. C.
Ophideres tyrannus Guen.	J. K. F. C. O.
Othreis fullonica L.	J. K. F. C.
Prodenia litura F.	J. F. C. O.
Tiracola plagiata Wlk.	F. C.
Geometridae:	
Hyposidra talaca Wlk.	F.
Luxiaria contigaria Wlk.	F.
Psychidae:	
Chalioides kondonis Mats.	J.
Clania destructor Dudg.	F.
Clania variegata Snell.	J. F. C.
Pyralidae:	
Dichocrocis punctiferalis Guen.	J. K. F. C.
LEPIDOPTERA—continued	
Gelechiidae:	
Lecithocera formosana Shir.	F.
Olegoresis citrella Shir.	F.
Oecophoridae:	
Depressaria culcitella H. S.	J.
Xyloryctidae:	
Acria gossypiella Shir.	F.
Lyonetidae:	
Phyllocnistis citrella Stain.	J. K. F. C.
Limacodidae:	
Cania bilinea Wlk.	F. C.
Nagoda nigricans Moore.	F.
Narosa nitobei Shir.	F.
Orthocraspeda trima Moore.	F.
Thosea sinensis Wlk.	K. F. C.
Tortricidae:	
Adoxophyes fasciata Wlsm.	F.
Cacoecia citrinella Shir.	F.
Cacoecia podana Sc.	J. K.
COLEOPTERA	
Buprestidae:	
Agrilus citri Mats.	F.
Cerambycidae:	
Apriona rugicollis Chevr.	J. K. F. O.
Cerambyx cantori Hope.	F.
Cordylomera zambeziana Perin.	F.
Melanauster chinensis Först.	J. K. F. C.O.
Priotyrannus closteroides Thoms.	F.
Scarabaeidae:	
Ectinohoplia rufipes Motsch.	K. C.
Oxycetonia jucunda Fald.	J. K. C. O
Curculionidae:	
Hypomeces squamosus Fab.	F.
Anthribidae:	
Phloebius longicornis Fab.	F.
Scolytidae:	
Xyleborus nitobei Mats.	F.
HEMIPTERA	
Pentatomidae:	
Erthesina fullo Thunb.	J. F. C. O.
Nezara viridula L.	J. F. C. O.
Rhynchocoris humeralis Thunb.	F.
Solenostethium chinense Stål.	F.

[1] Distribution symbols are as follows: J., Japan; K., Chosen(Korea); F., Taiwan (Formosa); C., China; and O., Okinawa (Loo-choo or Riukiu Islands).

List of citrus insects—Continued

	Distribution
HEMIPTERA—continued	
Cicadellidae:	
Chlorita flavescens Fab	J. K. F. C. O.
Idiocerus clypealis	F.
Idiocerus niveosparsus	F.
Motschulskia citri Mats	J.
Tartessus ferrugineus Wlk	J. F. C.
Tettigoniella ferruginea apicalis Wlk	J. K. F. C.
Tettigoniella viridis L	J. F. C. O.
Fulgoridae:	
Geisha distinctissima Wlk	J. F. C. O.
Mesepora onukii Mats	F.
Chermidae:	
Diaphorina citri Kuway	F. C.
Psylla coccinea Kuway	J.
Coccidae:	
Aspidiotus perniciosus Comst	J. K. C.
Ceroplastes ceriferus And	J. F. C.
Ceroplastes floridensis Comst	J. F.
Ceroplastes rubens Mask	J. F. C.
Chrysomphalus aonidum L	J. F. O.
Chrysomphalus aurantii Mask	J. F. C. O.
Chrysomphalus aurantii citrinus Coq	J.
Coccus elongatus Sign	F. C.
Coccus hesperidum L	J. F. C.
Coccus pseudomagnoliarum Kuw	J. O.
Hemichionaspis aspidistrae Sign	J.
Icerya aegyptiacum Doug	F.
Icerya purchasi Mask	J. F. C. O.
Icerya seychellarum Westw	J. F. C.
Lepidosaphes beckii Newm	J. F.
Lepidosaphes gloverii Pack	J. F. C.
Lepidosaphes pallida Green	J. F.
Leucaspis japonica Ckll	J.
Parlatoria pergandii Comst	J. F. C.
Parlatoria theae Ckll	J.
Parlatoria zizyphus Lucas	J. F. C. O.

	Distribution
HEPMIPTERA—continued	
Coccidae—Continued.	
Prontaspis yanonensis Kuw	J. C.
Pseudaonidia duplex Ckll	J.
Pseudococcus citri Risso	J. F. C.
Pseudococcus spp	J. F.
Pulvinaria aurantii Ckll	J.
Saissetia hemisphaerica Targ	J. F. C.
Saissetia oleae Bern	J. F.
Takahashia citricola Kuw	J.
Takahashia japonica Ckll	J. K. F.
Aphiidae:	
Aphis citricidis Kirk	J. K. F.
Aphis gossypii Glov	J. K. F. C.
Aphis somei E. and K	J.
Aphis tavaresi Del Guercio	F.
Omyzus persicae Sulz	J. K. F.
Toxoptera aurantii Boyer	J. F.
Toxoptera citrifolia Maki	F.
Aleyrodidae:	
Aleurocanthus spiniferus Q	J. C.
Aleurocanthus sp	J.
Aleurodes giffardi Kotinsky	J.
Aleurolobus marlatti Q	J. F.
Dialeurodes citri Ashm	J. F.
ISOPTERA	
Termitidae:	
Termes formosanus Shir	F. C. O.
ORTHOPTERA	
Gryllidae:	
Brachytrypes portentosus Licht	K. F. C.
ACARINA	
Eriophyidae:	
Paratetranychus citri MacG	J.
Phyllocoptes oleivorus Ashm	J. F. C.

THE PRINCIPAL CITRUS INSECTS

In addition to the three noctuid moths recorded in the previous paper as attacking citrus fruits, one other is added in the foregoing list. *Calpe* (*Oraesia*) *excavata* and *C. capucina* are recorded from Honshu, Shikoku, and Kyushu in Japan proper and from Chosen and China, *Ophideres tyrannus* from all of the islands of Japan and from Chosen, China, and India, while *Othreis fullonica* is recorded from southern Japan, Chosen, Taiwan, China, and India. In India the last-named species is a most serious pest in all of the citrus-producing sections, the annual loss ranging from 20 to 40 per cent.

The above species of Noctuidae are injurious primarily through the feeding of the adults upon the fruit causing it to drop prematurely, whereas the three remaining species, *Dermaleipa juno*, *Tiracola plagiata*, and *Prodenia litura*, feed in the larval stage upon the foliage, preferring the young shoots and newly developed leaves.

The Lymantriidae cited in the list are all from Taiwan and normally are of little consequence as citrus pests. Occasionally in the case of orchards adjoining uncultivated areas a species will become numerous, but this attack is of short duration, and the injury not great. The most common one is *Euproctis flavinata*, which occurs also in China. There are several generations of this species each year. The eggs are laid en masse upon the foliage, and pupation

takes place between leaves or in crevices in the trunk and larger branches.

The three limacodids mentioned are merely incidental pests and never become sufficiently abundant to require the employment of control measures.

The psychid moth *Clania variegata* (*133*) is met with in practically all of the citrus groves in Taiwan. The species is readily recognizable by the distinctive bag within which it is inclosed. The syntomid *Amata perixanthia*, which is found also upon guava, is likewise a minor citrus pest in the island.

The gelechiid *Olegoresis citrella*, the larva of which is a foliage feeder, is common throughout Taiwan. The larvae bind several leaves together with a light web and feed upon the older leaves. Pupation takes place within the web, and the adults emerge in March and April.

The minute lepidopterous leaf miner *Phyllocnistis citrella*, of which *Lithocolletis citricola* (*107*, *150*) of Taiwan is a synonym, is of general distribution throughout the Far East, being particularly injurious to nursery trees. This insect has heretofore been erroneously recorded as *P. saligna* Zell. (*11*, *53*, *54*.) A manuscript has been prepared by the writer in which is given a more extended account of the habits of this species.

Two geometrid moths, *Hyposidra talaca* and *Luxiaria contigaria*, are found upon citrus in Taiwan. The first is the most common, but neither is sufficiently abundant to cause appreciable injury.

Two species and one variety of Papilionidae are added to the author's previous list (*11*) as being of common occurrence, these being *Papilio demolus* (*P. erithonius* Cram.), *P. protenor*, and its variety *demetrius*. *P. xuthus*, however, which was formerly recorded as *P. xanthus*, is much the most important member of the family in Japan and is general in distribution from Japan to India, whereas *P. demolus* is the most common species in Taiwan.

One or more species of the above family is invariably present in the groves; yet they seldom become sufficiently abundant to injure the trees, though the variety *demetrius* is said by Okamoto (*150*) to be the most important citrus pest on the island of Quelpart. A number of other species are listed from Taiwan (*133*) but are less common than those mentioned.

Among the Coleoptera attacking citrus in Taiwan may be mentioned *Agrilus citri* (*133*, *169*), which is found only in the vicinity of Hozan and chiefly attacks such trees as are already in a rather weakened condition through the influence of other agencies. One generation is produced each year, the adults appearing during June. The eggs are deposited under the bark of the weakened areas, and the larvae in feeding make irregular burrows beneath it and later pupate in a cell near the surface.

The cerambycid *Cordylomera zambeziana* (*169*) is recorded from Taiwan and East Africa. The larvae burrow longitudinally through the larger branches and trunk and at times cause considerable injury in the orchards. It is presumed that two generations are produced each year, as the adults are found in March and in September. Trees which lack an adequate supply of moisture and also those suffering from heavy infestations of the various scale insects seem to be the ones most frequently attacked.

The scolytid *Xyleborus nitobei* (*133*) may be considered as a secondary pest in Taiwan in that its attacks largely follow those of other borers, principally cerambycids, and healthy trees are seldom affected. One generation is produced each year, the adult beetles appearing in August, and the eggs are laid in crevices in the bark of injured areas.

The scarabaeid beetle *Ectinohoplia rufipes* feeds quite extensively during the early part of the season upon the blossoms and young foliage of citrus in Chosen. As far as known this is the southern limit of its range, which extends northwards to Manchuria and the Amur region. A related species, as yet undetermined, has been noted feeding at the blossoms in central Honshu.

The list of fruit flies of the family Trypetidae comprises three species, and of these *Dacus tsuneonis* (*59*, *98*, *135*, *142*), which was discussed in some detail by the writer in a previous paper (*11*), is apparently limited in distribution to certain parts of the island of Kyushu. The late Doctor Miyake, who described the species originally, asserted that Japan was its native home but later came to the conclusion that this is not the case. It has not as yet been recorded, however, from any other country. *D. bezzii*, though often found in the vicinity of citrus groves in Japan, is not known definitely to attack the fruit. The adults are at times found swarming about overripe persimmons on the trees.

Dacus diversus var. *formosanus* (*133*, *169*) is a minor pest of orange in Taiwan, the most severe infestations seldom exceeding 5 per cent of the crop. In addition to citrus the mango is one of the fruits frequently attacked. The number of generations produced each year has not been determined, but there are presumably four, and the greater part of the winter is passed in the larval stage within the fruit.

The Formosan orange fly, *Chaetodacus ferrugineus* var. *dorsalis* (*80*, *83*), is recorded as occurring in Taiwan, the Philippine Islands, Burma, Ceylon, and India, and is also reported from Okinawa (*59*). Professor Maki's excellent account of this species deals at length with the life history, habits, and methods of control. Every species of citrus grown in Taiwan was found to be attacked, although the greatest injury was to pomelo and citron. The fruits other than citrus that are attacked are *Fortunella* spp., mango, peach, pear, loquat, guava, *Eugenia jambos*, and *E. javanica*. In India it is also recorded by Fletcher in the fruits of *Capsicum frutescens* and *Solanum verbascifolium*, and in Ceylon from *S. melongena*.

There are presumably three full generations each year under Taiwan conditions, with breeding more or less continuous throughout the year, though much retarded during the winter season. Additional generations may be produced in case suitable fruits are available for attack. The minimum duration of the egg, larval, and pupal stages was found to be 2, 12, and 2 days, respectively, with the maximum during the winter of 20, 46, and 41 days. The periods of greatest abundance of the larvae in the fruit were found to be in June and September, with the greatest scarcity from late April to the middle of May. Adults may be found throughout the year, but in greatest abundance from June to September.

Upon citron the eggs are deposited singly in the ripening fruit, usually below the middle of the fruit, and very few are found at either the stem or the calyx end. As many as 10 oviposition scars have been observed upon a single pomelo in the field, but 4 was the average for all of those examined.

The larvae burrow about in the fruit and when mature leave it and drop to the ground if the fruit is still on the tree. Infested fruits, however, usually fall about the time the larvae reach maturity. At the time of leaving the fruit the larvae are very active and are able to spring 2 or 3 feet into the air when disturbed. In clay soil the puparium is formed about half an inch below the surface, but under sandy conditions the larvae may penetrate to a depth of 4 or 5 inches before pupating.

The adult females have a relatively short life if suitable fruits are available in which they may oviposit, but where these are lacking, particularly during the winter, life may be prolonged to four months or more. Feeding takes place chiefly upon the juices of injured or decaying fruits. The most favorable time for oviposition is during the afternoon on warm and cloudy days, but in the early morning in case of bright sunshine.

Control experiments were conducted with poison sprays, and a spray containing sugar and lead arsenate was found to give fairly good results, though complete control was not effected, owing, doubtless, to the fact that some females oviposited before feeding upon the poison. Inclosing each fruit in a paper bag resulted in 93 per cent of them being free from injury, as compared with only 50 per cent in the case of unprotected fruit. The bags are usually placed upon the fruit in July. The main objection to the use of bags is the fact that the development of various scale insects upon the fruit itself is greatly increased.

The gryllid *Brachytrypes portentosus* (*169*) at times causes considerable damage to seedling orange trees in Taiwan, but is of little consequence upon bearing trees. This species is of most importance as a pest of melons, and an account is given of the species among those attacking truck crops.

Termes (*Cyclotermes*) *formosanus* (*133*) occasionally damages orange trees in Taiwan, plastering the trunks and branches with mud in the construction of its galleries. It is, however, primarily a pest of tea.

The scale insects added to the previous list (*11*) comprise *Coccus elongatus* (*C. longulus* Doug.), *Icerya aegyptiacum*, *Chrysomphalus aonidum*, *Lepidosaphes pallida*, and *Parlatoria zizyphus*. These species are mentioned (*169*) as infesting citrus in Taiwan, though usually not causing serious injury. Another, *Parlatoria theae*, is recorded from Japan.

Icerya seychellarum (*I. okadae* Kuw.) (*65*, *133*, *134*, *169*) is common in the southern part of Japan and in Taiwan, and in the latter island at times causes serious injury to orange. There is a single generation each year in Japan, and the winter is passed by the females in the mature stage. Oviposition begins early in June, and the eggs hatch within a few hours, in fact, living young are at times produced. This species does not show the tendency to congregate

in large masses, such as is characteristic of *I. purchasi* (*62*, *168*). *I. seychellarum* in Japan is heavily parasitized by the agromyzid fly *Cryptochaetum grandicorne* Rondani which also attacks *Drosicha corpulenta* but has never been taken as a parasite of *I. purchasi*.

Three species of leaf hoppers are at times found in some numbers upon citrus trees in Taiwan. *Tettigoniella viridis* lays its eggs in the branches of these as well as other fruit trees, and *Tartessus ferrugineus*, which occurs throughout Japan, Taiwan, and China, is at times quite abundant, being also found upon the foliage of fig trees.

Among the aphids *Toxoptera aurantii* causes considerable injury to citrus during the early part of the season, both in Japan and in Taiwan, and causes the typical curling of the young and tender foliage. The injury is accompanied by a consequent retardation of growth, this being in part due to the development of sooty-mold fungus in the honeydew. *Aphis tavaresi* also becomes very injurious at times in Taiwan.

The chermid *Diaphorina citri* (*133*, *169*) at times becomes very abundant in Taiwan and causes extensive injury to citrus trees. Its distribution extends to south China, the Malay Peninsula, Java, and India. The number of generations a year is unknown, though the nymphs are most abundant during May and June and September and October. The eggs are laid at the margin of the younger leaves. Both nymphs and adults are markedly gregarious in habit. Very extensive feeding takes place upon the under surfaces of the leaves and smaller twigs, the former turning brown, and, in the case of heavy infestations, withering.

According to information furnished by Doctor Kuwana, the citrus rust mite, *Phyllocoptes* (*Eriophyes*) *oleivorus*, was first observed in Japan in 1903, though its identification was not definitely established until 1909. It now covers the entire citrus-producing areas of Japan and Taiwan, and is also known from China, the Philippine Islands, and the Straits Settlements. In Honshu it is most abundant in Shizuoka Prefecture, and the injury produced is much more serious during periods of dry weather. When the characteristic injury to fruits by this mite was first found it was known locally as "zohibyo," or elephant skin, from the similarity in appearance to the skin of that animal, and later in Taiwan it was called akiyaki (red ware) from its resemblance to a certain type of porcelain. At Nagasaki certain women fruit venders specialize in the handling of fruit injured by this mite, and although the price is lower the claim is made that the flavor is superior to that of the normal fruit. Control may be effected by the use of lime-sulphur spray.

MISCELLANEOUS TROPICAL AND SUBTROPICAL FRUIT INSECTS

OLIVE INSECTS

A recently discovered pest of olive in central and southwestern Japan is the curculionid *Hylobius perforatus*. According to Poutiers (*157*) olive trees were very severely atacked when an attempt was made to plant them in orchards at Takamatsu and other places. The species constructs galleries which widen out from the inner bark to the sapwood, resulting at times in the complete

girdling and consequent killing of the branches. The pest existed previously in Japan upon conifers, but the newly introduced host apparently is well suited to its needs.

MANGO INSECTS

In Taiwan the insects on record as attacking mango are the Formosan orange fly, *Chaetodacus ferrugineus* var. *dorsalis*, *Dacus diversus* var. *formosanus*, *Termes* (*Cyclotermes*) *formosanus*, the leaf hoppers *Idiocerus niveosparsus*, *I. clypealis*, and *Tettigoniella viridis*, and the Florida wax scale, *Ceroplastes floridensis*. The two species of Idiocerus are important pests of mango in India. *T. viridis* causes injury to various fruit trees and shrubs through laying its eggs in the smaller branches. The nymphs feed upon other plants.

INSECTS ATTACKING COCO PALMS

The two most important pests of the coco palm in Taiwan are the red palm weevil, *Rhynchophorus ferrugineus* Fab., and the rhinocerus beetle, *Oryctes rhinocerus* L. The first is generally distributed throughout the Tropics. The injury produced by it is due to the burrowing of the larvae in the stem, which results in the death of the tree.

BANANA INSECTS

The only pests of banana and plantain recorded in Taiwan are *Cosmopolites* (*Sphenophorus*) *sordidus* Germ. and *Pentalonia nigronervosa* Coq. The eggs of *C. sordidus* are deposited singly on the stem near the crown into which the larvae bore, particularly injuring the young shoots. This species is a recent introduction into Taiwan and is becoming a serious pest.

FIELD-CROP INSECTS

LIST OF FIELD-CROP INSECTS

	Distribution [1]	Host plants
HYMENOPTERA		
Tenthredinidae:		
Dolerus hordei Rohw	J.	Barley.
Tomostethus juncivorus Rohw	J.	Juncus.
DIPTERA		
Tipulidae:		
Tipula parva Loew	J.	Rice, wheat, barley.
Tipula praepotens Wied	J. F.	Rice.
Chironomidae:		
Chironomus oryzae Mats	J.	Rice (seed beds).
Stratiomyiidae:		
Stratiomyia barca Wlk	J.	Do.
Chloropidae:		
Chloropisca circumdata Meig	J.	Rice.
Chloropisca hordei Mats	J.	Barley.
Chloropisca oryzae Mats	J.	Rice.
LEPIDOPTERA		
Pieridae:		
Colias hyale poliographus Motsch	J.	Clover.
Satyridae:		
Melanitis leda L	J. K. F. C. O.	Rice, barley, sugarcane.
Mycalesis gotama Moore	J.	Rice.
Nymphalidae:		
Polygonia c-aureum L	J. F.	Hemp.
Pyrameis cardui japonica Stich	J. K. F. C.	Do.
Pyrameis indica indica Herbst	J. K. F. C. O.	Do.

[1] Distribution symbols as follows: J., Japan; K., Chosen (Korea); F., Taiwan (Formosa); C., China; and O., Okinawa (Loo-choo or Riukiu Islands).

List of field-crop insects—Continued

	Distribution	Host plants
LEPIDOPTERA—continued		
Hesperiidae:		
Parnara guttata Brem	J. K. F. C. O.	Rice, bamboo.
Parnara pellucida Murr	J.	Do.
Arctiidae:		
Amsacta lactinea Cram	J. F. C. O.	Corn.
Arctia caia L	J. K.	Hemp.
Noctuidae:		
Acronycta consanguis Butl	J. K.	Do.
Agrotis c-nigrum L	J. F.	Buckwheat, flax.
Arcte coerulea Guen	J.	Hemp.
Barathra brassicae L	J. K. C.	Hemp, corn, clover, flax, buckwheat.
Chloridea dipsacea L	J. K. C.	Hemp, corn, clover, flax.
Cirphis loreyi Dup	J. F. C.	Sugarcane.
Cirphis unipuncta Haw	J. K. F. C. O.	Rice, barley, millet, oats, corn, buckwheat.
Erastria stygia Butl	J.	Rice.
Euxoa segetis Schiff	J. K. C.	Wheat, barley, corn, clover.
Heliothis obsoleta Fab	J. K. F. C. O	Corn.
Naranga aenescens Moore	J. K. F. C.	Rice, sugarcane, grasses.
Plusia festucae L	J.	Rice, grasses.
Sesamia inferens Wlk	J. K. F. C. O.	Rice, barley, rye, sugarcane, millet, corn, oats.
Geometridae:		
Thallassodes quadraria Guen	F.	Corn.
Pyralidae:		
Aglossa dimidiata Haw	J. K. C.	Rice.
Ancylolomia chrysographella Koll	J.	Do.
Bradina admixtalis Wlk	J.	Do.
Chilo infuscatellus Snell	F.	Sugarcane.
Chilo simplex Butl	J. K. F. C. O.	Rice, millet, barley.
Cnaphalocrocis medinalis Guen	J. K. F. C.	Rice, wheat, barley.
Diatraea striatalis Snell	F.	Sugarcane.
Nymphula vittatis Brem	J.	Rice.
Pyrausta nubilalis Hübn	J. K. C.	Corn, millet, hemp, beans.
Schoenobius incertellus Wlk	J. F. C. O.	Rice.
Schoenobius lineatus Butl	J.	Do.
Scirpophaga auriflua Zell	J. F. C. O.	Sugarcane.
Zinckenia fascialis Cram	J. K. F. C. O.	Corn, millet.
Gelechiidae:		
Pectinophora gossypiella Saund	J. K. F. C.	Hemp.
Sitotroga cerealella Oliv	J. F. O.	Rice, wheat, barley, corn.
Olethreutidae:		
Eucosma schistaceana Snell	F. O.	Sugarcane.
Hepialidae:		
Phassus excrescens Butl	J.	Hemp, corn.
TRICHOPTERA		
Leptoceridae:		
Setodes iris Haf	J.	Rice.
COLEOPTERA		
Mordellidae:		
Mordellistena cannabisi Mats	J.	Hemp.
Elateridae:		
Agriotes sericeus Cand	J.	Rice, wheat, millet, corn.
Ludius suturalis Mats	F.	Rice.
Scarabaeidae:		
Alissonotum impressicolle Arrow	F.	Rice, sugarcane.
Holotrichia diomphalia Bates	J. K. C.	Barley, millet.
Ligyrus rugiceps (Lec.)	F. C.	Sugarcane, rice.
Maladera orientalis Motsch	J. K. C.	Flax, clover.
Oryctes rhinocerus L	K. F. C.	Sugarcane.
Popillia japonica Newm	J.	Clover.
Serica similis Lewis	J. K. C.	Barley, millet.
Cerambycidae:		
Thyestilla gebleri Fald	J. K.	Hemp.
Chrysomelidae:		
Colaspidea metallica Ross	F. C.	Sugarcane.
Chaetocnema cylindrica Baly	J.	Wheat, barley, oats.
Chaetocnema japonicum Jac	J.	Do.
Crepidodera chloris Fondr	J.	Indigo.
Crepidodera japonica Baly	J.	Wheat, barley.
Donacia aeraria Baly	K.	Rice.
Haltica coerulescens Baly	J.	Do.
Haltica flavicornis Baly	J.	Hemp.
Lema melanopa L	J. F.	Rice.
Luperodes discrepans Baly	J.	Corn, clover.
Luperodes nigrobilineatus Motsch	J. K. F. C.	Rice, sugarcane.
Monolepta dichroa Har	J.	Hemp, indigo.

List of field-crop insects—Continued

	Distribution	Host plants
COLEOPTERA—continued		
Hispidae:		
Monochirus callicanthus Bates	J. F.	Rice, sugarcane, millet.
Curculionidae:		
Ceutorrynchus asper Roel	J.	Indigo.
Echinocnemus bipunctatus Roel	J. K.	Rice.
Echinocnemus squameus Billb	J. F. C.	Rice, sugarcane.
Erirrhinus oryzae Mats	J.	Rice.
Hypomeces squamosus Fab	F.	Sugarcane.
Lixus impressiventris Roel	J.	Indigo.
Lixus vetula Fab	F. C.	Sugarcane.
Rhinoncus pericarpius L	J.	Hemp.
Scepticus insularis Roel	J. K.	Barley.
Sphenophorus maculatus Mats	Ogasawara	Sugarcane.
Tanymecus rusticus Gyll	F. C.	Do.
HEMIPTERA		
Pentatomidae:		
Aenaria lewisi Scott	J. F. C. O.	Rice.
Aenaria scotti Dist	J.	Rice, wheat.
Coptosoma cribrarium Fabr	F. C.	Rice, sugarcane.
Eurydema rugosum Motsch	J. K.	Rice, millet.
Menida histrio Fab	F. C.	Rice, sugarcane.
Nezara viridula L	J. F. C. O.	Rice, barley, sugarcane.
Scotinophara lurida Burm	J. F. C. O.	Rice.
Scotinophara scotti Horv	F.	Rice, sugarcane.
Scotinophara vermiculata Horv	J.	Rice.
Coreidae:		
Leptocorisa caricornis Fab	J. F. C. O.	Rice, sugarcane.
Lygaeidae:		
Blissus saccharivorus Okajima	J. F. O.	Sugarcane.
Miridae:		
Lygus kalmi L	J.	Rice, barley.
Lygus lucorum Mayr	J. K. C.	Rice, wheat, barley, oats.
Lygus oryzae Mats	F.	Rice, sugarcane.
Lygus sacchari Mats	F.	Do.
Cicadidae:		
Mogannia hebes Wlk	F. C. O.	Sugarcane.
Cercopidae:		
Poophilus costalis Wlk	F.	Rice, wheat.
Cicadellidae:		
Balclutha viridis Mats	F.	Wheat, millet, sugarcane.
Chlorita flavescens Fab	J. K. F. C. O.	Rice, sugarcane.
Cicadula fasciifrons Stål	J. K. F. C.	Rice, wheat, oats, sugarcane.
Cicadula pallidula Mats	F.	Sugarcane.
Cicadula sexnotata Fall	J. K. F. C. O.	Rice, wheat, oats, sugarcane.
Deltocephalus dorsalis Motsch	J. F. O.	Rice.
Deltocephalus oryzae Mats	J. F.	Rice, wheat, oats.
Erythroneura circumscripta Mats	F.	Sugarcane.
Erythroneura maculifrons Motsch	J. F. C.	Rice, sugarcane.
Erythroneura subrufa Motsch	F.	Do.
Euacanthus semiglauca Leth	J. F. C.	Sugarcane.
Kolla albomarginata Sign	F.	Do.
Nephotettix apicalis Motsch	J. K. F. C. O.	Rice, sugarcane.
Nephotettix apicalis cincticeps Uhl	J. K. C. O.	Rice, wheat.
Nirvana pallida Mel	J. F. C.	Sugarcane.
Nirvana suturalis Mel	F. C.	Do.
Strongylocephalus agrestis Fall	J. K. F. C.	Rice, sugarcane.
Tettigoniella ferruginea apicalis Wlk	J. F. C.	Sugarcane, hemp.
Tettigoniella spectra Dist	F.	Sugarcane.
Tettigoniella subvirescens Stål	F.	Do.
Tettigoniella viridis L	J. F. C. O.	Rice, sugarcane.
Fulgoridae:		
Delphacodes vastatrix Bredd	J. F.	Sugarcane.
Delphax furcifera Horv	J. K. C. F. O.	Rice, millet, sugarcane.
Delphax propingua Fieb	J. F.	Sugarcane, millet.
Dicranotropis fumosa Mats	F.	Sugarcane.
Dictyophora patruelis Stål	F.	Rice, sugarcane.
Dictyophora sinica Wlk	J. F. C. O.	Do.
Diostrombus politus Uhl	J. F.	Rice, millet, sugarcane.
Geisha distinctissima Wlk	J. F. C. O.	Sugarcane, hemp.
Kamendaka saccharivora Mats	F.	Sugarcane.
Kirbyana pagana Mel	F. C.	Do.
Liburnia graminicola Mats	F.	Do.
Liburnia oryzae Mats	J. K. F.	Rice, sugarcane.
Nisia atrovenosa Leth	J. F. C. O.	Do.
Oliarus oryzae Mats	F.	Sugarcane.
Orthopagus helios Mel	F.	Do.
Perkinsiella saccharicida Kirk	F.	Do.
Phenice moesta Westw	F. C.	Do.
Ricania japonica Mel	J.	Hemp.

List of field-crop insects—Continued

	Distribution	Host plants
HEMIPTERA—continued		
Fulgoridae—Continued.		
Ricania taeniata Stål	J. F. C.	Rice, sugarcane.
Stenocranus sacchari Mats	F.	Sugarcane.
Tropidocephala formosana Mats	F.	Do.
Tropidocephala saccharivorella Mats	F.	Do.
Vekuntia nigrolineata Muir	F.	Do.
Vekuntia stigmata Mats	F.	Do.
Aphiidae:		
Aphis formosanus Takah	J. F.	Corn, sorghum.
Aphis maidis Fitch	J. F.	Corn, wheat.
Cerataphis saccharivora Mats	F.	Sugarcane.
Macrosiphum granarium Kirby	J.	Rice.
Oregma lanigera Zehn	F. C.	Sugarcane.
Phorodon asacola Mats	J.	Hemp.
Rhopalosiphum avenae F	J.	Rice, barley, wheat, millet, corn.
Tetraneura sp	F.	Sugarcane.
Yamataphis oryzae Mats	J.	Rice.
THYSANOPTERA		
Phloeothrips oryzae Mats	J.	Rice, wheat, barley, oats.
Phloeothrips publicornis Mats	F.	Sugarcane.
ISOPTERA		
Termitidae:		
Capritermes sulcatus Holmg	F.	Rice.
Procapritermes mushae O. and M	F.	Do.
Termes formosanus Shir	F. C. O.	Rice, sugarcane.
Termes vulgaris Hav	F.	Sugarcane.
ORTHOPTERA		
Gryllidae:		
Brachytrypes portentosus Licht	K. F. C.	Rice, sugarcane.
Gryllotalpa africana P. de B	J. K. F. C. O.	Rice, wheat, sugarcane.
Acrididae:		
Atractomorpha bedeli Boliv	J. K. F. C. O.	Rice, barley, sugarcane.
Locusta migratoria danicus L	J. K. F. C.	Rice, wheat, barley, millet, corn.
Locusta migratoria migratoroides Reich	F.	Rice, wheat, sugarcane.
Oxya velox Fab	J. K. F. C. O.	Rice, wheat, barley, sugarcane, cotton.
Racilia okinawensis Mats	F. O.	Rice.

RICE INSECTS

Nearly 100 species of insects are recorded as attacking rice in Japan, Taiwan, and Chosen, and of these about 10 may be considered as of major importance. Kuwayama (*77*) mentions 39 species upon this plant in Hokkaido, 14 of which are common and injurious. In most of the rice-growing sections of the Far East the two pyralid moths *Chilo simplex* and *Schoenobius incertellus* are of the most importance and are of general distribution.

In Hokkaido *C. simplex* (*9*, *42*, *43*, *51*, *119*, *146*, *149*, *206*, *209*) usually has one brood a year, though occasionally two, in which case the adults of the first brood appear in late June and July and those of the second in September and October. Hibernation is in the mature larval stage in the stems left in the field after cutting. These larvae feed in the spring upon grasses, weeds, etc. In this island the eggs are laid upon the plants in the field rather than in the seed bed, and are on the upper side of the leaf blade about 2 inches from the tip. The duration of the stage is about 20 days. The egg cluster is without a covering of felted hairs. The egg, larval, and pupal stages cover 14, 50, and 12 days, respectively. The larvae live gregariously for a short time after hatching, but after penetrating the stalk they remain therein. Pupation takes place

between the stalk and leaf sheath. Ishikawa (*43*) records the destruction of 28 per cent of the eggs in Niigata Prefecture by a hymenopteron. One of the methods of control advocated is the collection of adults by lantern trap, and in experiments at the Hokkaido Agricultural Experiment Station on an area of 1 cho (2½ acres) in which two lamps were used, the following numbers were taken during the period from the end of June to the middle of August:

Year	Females	Males
1911	163	144
1912	452	361
1913	361	334
Total	976	839

It is thus seen that a slightly greater number of females than males were caught at the traps, but whether this indicates a greater response on the part of females to light is uncertain, as the normal sex ratio in the field is not known.

Various experiments have been conducted to determine the effect upon this pest of submergence during the growing period of the host plant and the possibility of utilizing submergence as a means of control. The more extensive tests along this line have been conducted by Harukawa (*18*, *20*, *26*) in Okayama Prefecture. The embankments surrounding the rice fields are often such that flooding to a depth of from 6 to 8 inches is the maximum possible, and consequently a portion of the leaves and the tip of the stalk may remain above the water level. At the middle of July such partial submergence for 24 hours resulted in a mortality of first-brood larvae of from 50 to 60 per cent. If the plants were completely submerged, however, the proportion killed increased from 80 to 90 per cent. One of the most important factors entering into the problem is the temperature of the water, the higher temperatures being the most effective. The check plots showed a reduction in yield of from 6 to 13 per cent due to injury by complete submergence (*26*, *p. 183*).

The second generation of larvae can not be dealt with in this way, as at the time they are present the plants are higher than the embankments inclosing the fields. The general practice at this stage is to have coolies go through the paddy fields during the period in which the eggs are hatching and remove all plants upon which colonies of young larvae are feeding. This must be done before they scatter to adjacent plants and bore into the stems.

Schoenobius incertellus (*51*, *170*) in Japan is primarily a pest of rice, but is doubtfully said to occur also upon millet and other gramineous plants. It is the most important pest of rice in China and India. Three broods are produced each year in Kyushu, the first brood of adults appearing in late April and May, the second in late June and July, and the third in August and September. Hibernation takes place in the mature larval stage in the stubble. The adult females are nocturnal in habit, and the eggs are laid late in the evening, those of the first generation in the nursery bed upon the larger leaves near the tip, whereas those of the following two

are laid upon the young tender leaves in the field. The young larvae feed first upon the epidermis of the underside of the leaf, but very soon they bore into the stem. Pupation takes place within the stem below the soil surface, differing in this respect from *Chilo simplex*.

Shiraki (*170*) has published a detailed account of the life history and habits of the species in Taiwan, in which island it is a pest of rice only. From four to six generations are produced each year. There the damage amounts at times to 40 per cent of the crop, as compared with the usual damage of about 20 per cent in the Fukuoka and Saga Prefectures in Kyushu, these being the worst infested sections in Japan proper. In Taiwan as many as 50 per cent of the eggs may be parasitized by *Trichogramma japonica* Ashm., 15 per cent by *Ceraphron beneficiens* Zehnt., and 30 per cent by *Tetrastichus* sp. The total parasitism of the larvae does not exceed 10 per cent. Control measures recommended are the plowing and burning of stubble, collection of adults by lantern traps and net, and the clipping of the ends of the leaf blades at the time of transplanting, thus removing the eggs.

Considerable work has been done, particularly in Honshu, in the distribution of the egg parasites of both *Chilo simplex* and *Schoenobius incertellus* in an effort to increase the effectiveness of the various native species. Ojima (*141*) has devised an apparatus in which the field-collected egg masses, instead of being destroyed as is the usual practice, are inclosed in such a way that the emerging parasites can readily escape, while the young caterpillars can not. The work along this line to date has been confined to the liberation of the parasites from the field-collected eggs of the current generation, rather than to insectary rearings. The cumulative effect of this method may be to increase the parasitism of the later host generations, but the effect upon the first is relatively slight.

Aglossa dimidiata (*149*) is distributed throughout all of the main islands of Japan and extends from Chosen to Burma and India. In Hokkaido there is one generation per year, and the adults are found in the field during the latter part of July and August. The eggs are laid upon the head or sheath of the rice and hatch in two weeks. The caterpillars are recorded by Nishikawa as feeding at times upon the eggs of the silkworm. It is primarily a pest of stored grain.

Cnaphalocrocis medinalis (*96*) is a very common though usually not a serious pest upon rice in Japan, Chosen, Taiwan, and China. It feeds also upon wheat and barley. In northern Japan there are two or three broods each year, but in Taiwan six or seven are produced during the season. The eggs are laid in clusters upon the foliage. Hibernation is in the mature larval stage.

The pyralid *Bradina admixtalis* (*95*) at times becomes a serious pest upon rice in Japan, particularly in Kyushu and western Honshu. There are two broods each year, and the winter is passed in the mature larval stage in the straw. The adults of the two generations appear in May and from July to August, respectively. The eggs are laid in rows of three or four upon the leaf and hatch in 10 days. The larvae fold the leaves and feed upon the tissue of the underside only. The pupa has a thin, paper-like cocoon, which is formed in the rolled leaf. According to Murata (*108*) there are three generations each year in the southern sections, the adults appearing in

late May, the middle of July, and the middle of August, respectively. He states that the eggs are laid singly on the leaves. In the early stages the larvae are markedly gregarious.

Nymphula vittatis (*95*) is very common in the rice fields of Japan, but seldom becomes sufficiently abundant to cause appreciable injury. The larvae have characteristic cases within which they move about in the water surrounding the base of the plants. They feed upon the roots and softer portions of the stem.

The sugarcane butterfly, *Melanitis leda* (*95*), is common upon rice in southern Japan and Taiwan. There are two generations each year in Kyushu and possibly four in Taiwan. The larvae feed at the leaf margin. The pupa is suspended from the leaf by its caudal tip and has no covering whatever.

The most important of the Noctuidae attacking rice is *Sesamia inferens* (*93*, *96*), which is also found upon sugarcane, millet, and Indian corn. It is of general distribution throughout the Orient from Japan to India, in the latter country being an important pest of various cultivated Gramineae, in which, according to Fletcher, the larvae often bore deep into the roots. In Japan there are three broods a year, the adults appearing in early June, July, and September, respectively. Hibernation is by the larval stage in the soil. As distinguished from the other two stem borers of rice in Japan, the eggs of this species are laid within the leaf sheath rather than near the tip, and the larvae feed either within or outside the stem. Pupation takes place between the leaf sheath and the stem. Plowing in winter to destroy the larvae in the soil is the only remedy suggested.

Naranga aenescens is found commonly throughout Japan, Chosen, Taiwan, and China attacking rice and various grasses. This species has previously been referred to in literature as *N. diffusa*, but according to Okamoto (*150*) this latter is an Indian species not found in Japan. His account of the life history (*149*) gives two broods per year, the adults appearing in early June and at the end of July. The pupae of the second brood pass the winter in the soil. The eggs are laid in masses of 30 or more on the underside of the leaves and hatch in about five days, after which the larvae feed upon the leaf tissue. Pupation occurs within a chamber formed by folding a leaf upon itself and binding it with silken strands. The adults may be captured by the use of lantern traps. This is a minor pest in Japan and India, but it is one of the most important of rice pests in certain sections of China.

The hesperiid *Parnara guttata* (*95*) occurs upon rice and bamboo on all the islands of Japan except Hokkaido, and in Chosen, China, Manchuria, and Siberia. There are 2 generations a year at Tokyo, 3 in Kyushu, and 3 or 5 in Taiwan. At Tokyo the adults appear early in June and in late August and September. The larvae of the first generation feed upon the foliage of rice and those of the second upon bamboo. Hibernation is in the larval stage.

The chrysomelid beetle *Lema melanopa* is at times found abundantly in some districts of Hokkaido (*33*), as well as in parts of Honshu, and much damage may be done to rice. One generation is produced each year, and the winter is passed in the adult form in rubbish piles and in other sheltered places. These adults become

active in late May and June and feed upon leaves in the seed bed and main fields. The eggs are laid in masses of from 20 to 30 upon the leaves, and hatch in 11 or 12 days. The larvae feed upon the epidermis of the leaf, causing the foliage to assume a bleached appearance, and are distinguished by their carrying a considerable mass of excrement dorsally upon the body. This stage covers from 10 to 14 days. The pupae are formed in white cocoons upon the leaves, this stage occupying 17 or 18 days, the adults emerging in July and August. In the paddy fields control may be effected by the use of a floating tray into which the larvae and adults are knocked from the plants. The best results are secured on cloudy or rainy days when there is no wind. This is the species referred to in literature previous to Murata and Ikeda's publication (*110*) as *L. tristis* Herbst.

Another chrysomelid which is quite common in Chosen, though not a serious pest, is *Donacia aeraria* (*8*), the larvae of which feed at the roots and prevent the proper ripening of the grain. There is one brood a year, and the winter is passed by the larvae in the soil. These pupate in June, and the adults appear early in July. The food plant of the adult is *Potamogeton polygonifolius* Pourr, a weed which grows in the paddy fields. The eggs are laid on the underside of the foliage of this plant, and upon hatching the larvae immediately go down to the roots of the rice and begin feeding at the base of the stalk.

The hispid beetle *Monochirus* (*Hispa*) *callicanthus* (*95*, *108*) occurs in both Japan and Taiwan and is a serious pest of rice in the latter island. There are five generations each year in Taiwan, and the winter is passed in the adult stage. The eggs of the first generation are laid in the leaves in the seed bed, and at times considerable damage is done. The eggs hatch in from 6 to 13 days, and the larvae mine in the leaves. Pupation occurs in the mine. The later generations are produced in the field following transplanting.

A curculionid, *Echinocnemus bipunctatus* (*8*), is also found, though not as a serious pest, upon rice in Chosen and southern Hokkaido. One brood is produced each year, and the adults appear in late June and early July. The eggs are laid in groups of three or four in a hole made by the female beetle in the stem about 1 inch above the surface of the water. These hatch in five or six days, and the young larvae descend into the soil and feed at the roots. This prevents the proper maturing of the crop. The winter is passed in the larval stage, and pupation occurs in early June. Another species of this genus (*E. squameus*) attacks rice in Japan, Taiwan, and China, and its habits are similar to those of the above species.

The acridid *Oxya velox* (*96*) is found in central and southern Japan, Chosen, Taiwan, and China and attacks wheat, sugarcane, and cotton as well as rice. It does considerable damage at times by feeding upon the young plants in the field and is particularly injurious during dry periods. There is one generation a year, and the winter is passed in the egg stage in the soil of the ridges and embankments bordering the field. The collection or destruction of the eggs by cultivation during the winter is recommended for control. In India, according to Y. Ramchandra Rao, this species is largely a marsh insect and is primarily a pest of rice, though attacking also cotton and

legumes. Under marsh conditions the habits of oviposition have been modified to a considerable extent, and the egg clusters are placed upon rice stems and in clumps of grass from 1 to 2 inches above the water level. In certain cases they were also found in the folds of cotton leaves and in folded rice leaves. In India breeding is practically continuous throughout the year, and the duration of the egg stage ranges from 15 or 17 days in April to 41 days in the cold season.

Another acridid abundant in Japan, Chosen, Taiwan, and China is *Locusta* (*Pachytylus*) *migratoria* var. *danicus*, which is very injurious to rice, barley, millet, *Panicum* sp., and various other cereal and forage crops. It is of migratory habit.

A pentatomid, *Aenaria lewisi* (*108*), is at times very injurious to rice in western Honshu (Ishikawa and Fukui Prefectures) and occurs also in Taiwan and Okinawa. There is a single generation each year and the winter is passed in the adult stage under stones, in rubbish, and in other sheltered places. The eggs are laid in groups upon the foliage and hatch in about 10 days. The larvae are at first gregarious, but later solitary, and the insects in this and in the adult stage are nocturnal in habit.

Aenaria scotti (*108*), which is an important pest in Kyushu, is found less commonly northwards, not being recorded from northeastern Honshu and Hokkaido. The species is single brooded, the adults passing the winter in rubbish, grass, crevices in tree trunks, etc., and emerging during the spring to feed on various grasses. In August the nymphs and adults attack rice and wheat, feeding upon the sap of the stem and developing head. Control measures recommended are the destruction of rubbish piles and other places of hibernation in the vicinity of cultivated fields, the collection of adults by knocking them into trays containing oil, and spraying shortly after the hatching of the eggs. This last, however, is hardly practicable from the economic point of view.

Another pentatomid is *Scotinophara* (*Podops*) *lurida* (*46*, *96*) found upon rice throughout Japan, except Hokkaido, and in Taiwan, China, the Malay Peninsula, and India. It is particularly injurious in northern Honshu. There is one generation a year, and the winter is passed in the adult stage. The egg stage covers one week and the larval stage one month. The adults and nymphs gather at the base of the plant and suck the sap, but later in the season feed at the head, thus preventing the maturing of the grain. According to Kikuchi, the adults of this species are said to secrete a fluid which they discharge when disturbed and which causes blindness in human beings. A third species attacking rice and *Panicum* sp. is *Eurydema rugosum*.

Of the Cicadellidae attacking rice in Japan the most important are *Deltocephalus oryzae*, *D. dorsalis*, *Cicadula fasiifrons*, *C. sexnotata*, and *Nephotettix apicalis* var. *cincticeps*. In Taiwan the major species are the first three given above and in addition *N. apicalis* and *Erythroneura subrufa*. In Chosen they are *C. fasciifrons* and *N. apicalis* var. *cincticeps*. Schumacher (*166*) has given a full list of the Homoptera of Taiwan, with their food plants, and many species are listed as attacking rice, but only the more important ones are here mentioned. Okamoto (*151*) records 23 species as attacking this plant in Chosen, but only 3 are mentioned as of importance.

N. apicalis var. *cincticeps* (*151*) is very injurious in all of Japan, except Hokkaido, as well as in Chosen, Taiwan, and Okinawa. It is also a pest of wheat, and attacks sugarcane and other graminaceous plants. There are four generations per year in Japan (*96*). The winter is passed in the nymphal and adult stages, and the latter appear in the field in May, with the succeeding broods at intervals of about five weeks. In May the adults are found in numbers in the seed beds, where they deposit their eggs singly in longitudinal slits at the bases of the stems. These hatch in about 10 days. The first brood develops entirely in the seed bed, whereas the following ones are in the paddy fields. Owing to extraction of considerable quantities of sap from the plant the quality of grain produced is inferior. In the seed bed the adults may be collected by net if not too abundant, but where they are very numerous the plot is first flooded with water to a depth of 1 inch and the surface then covered with a film of kerosene, about 1 gallon being used for an area of 1,200 square yards. As soon as the oil is applied the nymphs and adults are caused to fall or jump into the water by striking the plants with sticks or branches. This method is in common use in Japan proper and in Chosen. In the paddy fields it is practiced only where the infestation is particularly heavy. With dry or upland rice, which is grown without irrigation, trays of kerosene are held under the plant while it is shaken, or beaten with a light branch.

Cicadula fasciifrons (*151*) is one of the most serious rice insects in Japan and Chosen, occurring also in Taiwan and China. It attacks also wheat, oats, etc. Several broods are produced each year, and the winter is passed in the nymphal stage. The eggs are laid singly in the stem upon which the young nymphs feed. This feeding causes characteristic yellow spots, the leaves soon becoming uniformly yellow in color and much weakened. In the fall the eggs are laid upon an undetermined weed, and the nymphs of this generation develop largely upon it alone. Control measures are the same as for the preceding species.

The two fulgorids *Delphax* (*Liburnia*) *furcifera* and *Liburnia oryzae* (*151*, *186*) are very serious pests of rice in Japan and Chosen. The first is most abundant and injurious in Chosen during the last half of August, and the second species during September. There are three or four broods a year, and the winter is passed in the nymphal stage. The eggs are laid in rows of from 7 to 15 longitudinally under the leaf sheath. The time required for incubation ranges from 5 days at 80° F. to 21 days at 60° F., and the nymphal period during the summer covers about 3 weeks. The adults appear toward the end of April, and they may be found continuously until the end of September. The nymphs and adults feed both on the leaves and stem, the plants often being killed, but where this does not occur the proper maturing of the grain is prevented. These species are particularly abundant during hot and dry summers, the damage at these times amounting to a considerable proportion of the crop. Usually, however, the loss is not quite so great as that caused by *Chilo simplex*.

Three species of termites are recorded as pests of rice in Taiwan (*84*), these being *Termes* (*Cyclotermes*) *formosanus*, *Capritermes sulcatus* (*nitobei Shir.*), and *Procapritermes mushae*. The first is discussed elsewhere as an important pest of tea, but it attacks rice

also, particularly in the paddy fields, whereas the last two attack the roots in dry fields only.

The tipulid *Tipula parva* (*95*, *154*) is found most commonly in Japan attacking rice, wheat, and barley, but is not a major pest. There are two broods a year, and the winter is passed in the larval stage. These larvae pupate in the spring and emerge as adults early in June. Those of the second brood appear the middle of August. According to Onuki (*154*) the first brood appears in April and the second in September. The greatest injury occurs in the seed bed. The larvae prefer a clay soil which is wet and shaded, and they feed upon the roots at night. Collection of adults by net is recommended as a means of control. Another species (*T. praepotens*) is of similar habit.

A species of thrips, *Phloeothrips oryzae* (*96*), is common upon rice and wheat in northern Japan, particularly in Nagano Prefecture, and when they are abundant the effect is to retard the growth of the plant and to give a yellowish or whitish appearance to the leaves and head. The first generation in June feeds upon the foliage, whereas the second, in August, attacks the blossoms. The winter is passed in the adult stage in sheltered places.

In Hokkaido a trichopteron of the family Leptoceridae (*1*), since determined as *Setodes iris*, attacks the roots and basal portions of the rice stalk and at times causes damage. There is a single brood each year, and the winter is passed in the nymphal stage in the stubble of rice and other plants in the field.

INSECTS ATTACKING WHEAT, BARLEY, RYE, AND OATS

The major pests of the cereal crops in Japan and Chosen are *Euxoa segetis*, *Sesamia inferens* (*Leucania innocens* Butl., *S. nonagrioides* var. *albiciliata* Snell.), *Cirphis unipuncta*, *Sitotroga cerealella*, *Locusta* (*Pachytylus*) *migratoria* var. *danicus*, *Aenaria scotti*, *Cicadula fasciifrons*, *Nephotettix apicalis* var. *cincticeps*, and *Phloeothrips oryzae*. Most of these species have been discussed as pests of other crops.

Of the species of lesser importance there may be mentioned *Chaetocnema cylindrica*, *C. japonicum*, *Crepidodera japonica*, *Tipula parva*, and *Lygus lucorum*.

The well known Angumois grain moth, *Sitotroga cerealella* (*96*, *186*), is widely distributed in Japan and Taiwan and does considerable damage. It oviposits quite generally in the field, and attacks corn and rice as well. Two broods are produced each year, and hibernation is in the larval stage in the grain.

The elaterid *Agriotes sericeus* (*96*) causes some damage to small grains in the main islands by the feeding of the larvae at the roots. It is also recorded as attacking corn and various other field crops. Each generation covers a period of four or five years, and the adults appear each year in May. The only control suggested is the collection of adults as soon after emergence as possible.

SUGARCANE INSECTS

The growing of sugarcane in Taiwan has attained large proportions in relatively recent years in an effort to offset the high cost of imported sugar, and large plantations are found in the

southern and central parts of the island. Sugarcane is grown also in Japan proper and in Chosen, but only on a small scale, as an annual crop for food purposes, rather than for the production of sugar. Consequently, all stalks are removed from the field before the end of each season, this serving to restrict considerably the increase of the various insect species which normally pass the winter in the stalk.

Ishida (*38*) lists the following six species as being the most injurious among the sugarcane pests of Taiwan: *Eucosma schistaceana*, *Chilo infuscatellus*, *Diatraea striatalis*, *Scirpophaga auriflua*, *Ligyrus rugiceps*, and *Oregma lanigera*. He adds also various termites. Several others at times cause considerable damage. Matsumura (*94*) gives an extended account of the more important species in Taiwan.

The tortricid *Eucosma* (*Grapholitha*) *schistaceana* is a serious sugarcane pest throughout the islands of Okinawa (*38*) and is now causing very extensive losses in Taiwan also (*94*), a large part of the insect injury to the crop being attributed to this species. Five generations are produced each year, breeding being practically continuous throughout the year. The eggs are laid singly upon the leaves, and the young larvae feed upon the foliage, whereas the older ones bore into the stem. Control methods consist in the collection and distribution of parasites, the removal of infested stalks, and the trapping of adult moths at lanterns.

In the islands of Okinawa and Taiwan the pyralid borer *Scirpophaga auriflua* (*38*, *94*) often causes injury to sugarcane by boring into the stem. Four rather irregular broods are produced each year, the adults of the first appearing in March and those of the last in November. Hibernation is in the mature larval stage. The eggs are deposited upon the under side of the leaf and hatch in about eight days. The larval stage lasts from 40 to 60 days and the pupal stage 10 days. After hatching the larvae feed in the growing tip of the shoot, later boring down into the stalk, and finally forming the pupation chamber therein at a point 4 or 5 inches above the ground. This may be recognized by the presence of an exit hole at that point, the opening being covered by a thin film of silky material. The greatest amount of injury is produced by the last two generations. The growth of affected stalks is considerably retarded, these averaging about 15 inches shorter than normal plants. Control methods consist chiefly in the collection of adults by hand or at lantern traps. According to Ishida and Moritsugu (*39*) this pest has in recent years infested up to 12 per cent of the sugarcane in Tainan Prefecture of Taiwan.

A second pyralid, *Diatraea striatalis* (*96*), causes serious injury to sugarcane in Taiwan. It is known also as an important pest of this plant in Java. There are four or five broods each year, and the winter, which in this latitude produces merely a retardation of development, is largely passed in the larval stage in the stalks. The young larvae feed upon the new foliage and later bore into the stem.

The noctuid *Sesamia inferens* (*S. nonagriodes* var. *albiciliata* Snell.) is a pest of sugarcane as well as of many other field crops, such as rice, corn, rye, and millet in Okinawa (*38*), as well as in

Japan, Taiwan, Chosen, and China. The injury to sugarcane is caused by the feeding of the young larvae on the younger leaves and the boring by the older ones in the upper part of the stem. Infested plants may be recognized by the time the larvae attain the third stage. These larvae migrate from plant to plant, thus appreciably increasing the amount of injury. Five generations are produced each year, and the egg, larval, and pupal stages cover 12, from 30 to 40, and 10 days, respectively.

Ligyrus rugiceps is an important pest of sugarcane and both dry and irrigated rice in Taiwan (*94*, *95*), the grubs feeding at the roots and the adults upon the foliage. There is probably one generation each year. Other scarabaeids are also present in considerable numbers, and in the aggregate their damage is often very great. In 1914 the green muscardine fungus (*Metarrhizium anisopliae* Motsch.) was introduced into the island from Hawaii for use against the various soil-inhabiting insects affecting sugarcane. According to Yasukawa (*210*) from 25 to 33 per cent mortality was effected among adult lamellicorns and from 13 to 30 per cent among the grubs in infected soil.

According to Oho (*140*) the scarabaeid beetle *Alissonotum impressicolle* is much the most injurious of this group of insects which attack sugarcane in Taiwan, and extensive damage is done in the southern part of the island. There is one brood a year, the adults emerging from early March and being most abundant in late April and May. The adults bore into the larger roots and the stalk below the soil surface. The larvae in their later stages also feed at the roots. The eggs are laid from late August to the end of October.

Locusta (*Pachytylus*) *migratoria* var. *migratoroides* (*173*) migrates in large numbers from the Philippine Islands to Taiwan, a distance of 250 miles from the northern island of Luzon, at regular 9-year intervals, the first invasion being recorded in 1896. Reproduction takes place in Taiwan, but the infestation invariably dies out within one or two years. Three broods per year are produced in that locality.

The most numerous species of Hemiptera attacking sugarcane in Taiwan, as recorded by Schumacher (*166*), are given in the list of species, the most important being *Poophilus costalis*, *Kolla albomarginata*, *Nirvana pallida*, *Cicadula sexnotata*, *Erythroneura* (*Zygina*) *subrufa*, and *Delphax* (*Liburnia*) *furcifera*. The lygaeid bug *Blissus saccharivorus* at times causes extensive injury to sugarcane in Okinawa (*38*) and is also found in Taiwan and certain parts of Japan proper. There is probably a single brood each year. Extensive feeding by the nymphs and adults results in a characteristic bleaching of the foliage and a great reduction in the sugar content of the stalk. Methods of control recommended are the use of resistant varieties, the burning of rubbish, and the distribution of an egg parasite common in that section.

CORN INSECTS

Corn is grown to a limited extent throughout Japan and Chosen, and also in Taiwan, but more particularly in northern Honshu and Hokkaido, though it is of much less importance agriculturally than

in the United States. The more injurious insects attacking it are the noctuids *Barathra brassicae*, *Chloridea dipsacea*, *Euxoa segetis*, and *Sesamia inferens*, and the European corn borer, *Pyrausta nubilalis*. Most of these have been dealt with as pests of other crops of greater importance.

Among the species of lesser consequence attacking corn are *Amsacta lactinea* and *Sitotroga cerealella* in Japan and Taiwan, and *Thallasodes quadraria* in Taiwan. *Zinckenia fascialis*, an account of which is given among the sugar-beet insects, is of general distribution in the East. *Phassus excrescens*, which bores into the stalk, *Luperodes discrepans*, and *Agriotes sericeus* infest corn in Japan, and the aphids *Aphis formosanus*, *A. maidis*, and *Rhopalosiphum avenae* attack corn in Japan and the first two in Taiwan as well.

The well-known European corn borer *Pyrausta nubilalis* (*149*) is of general distribution throughout Japan and Chosen and is commonly found in China and Siberia. In Japan this species was formerly considered primarily as a pest of millet and various beans, but in recent years more attention has been paid to it as a pest of corn. In Hokkaido and also in Chosen, there is a single brood a year, the adults appearing in August. Matsumura (*95*, *96*) reports two broods in Hokkaido and three at the latitude of Tokyo. In Hokkaido the two broods of adults are said to emerge the middle of June and August, respectively, whereas the three at Tokyo appear in May and June, July and August, and August and September, respectively. In Hokkaido the winter is passed in the larval stage in the bamboo poles used for supporting the bean stalks, and in the case of millet in the stubble in the field. The larva bores into the stalk of millet near the base, causing it to break under the weight of the developing head of grain. Three parasites are recorded as attacking this insect, all apparently endemic in Japan, namely, the tachinid *Exorista tritaeniata* Rond., and the ichneumonids *Pimpla pyraustae* Mats., and *Eugnomus pyraustae* Mats.

MILLET INSECTS

The major pests of millet in Japan and Chosen are the noctuids *Cirphis unipuncta* and *Sesamia inferens*, which have a general distribution, the European corn borer (*Pyrausta nubilalis*), and *Locusta* (*Pachytylus*) *migratoria* var. *danicus*. Others of lesser importance are *Agriotes sericeus*, *Holotrichia diomphalia*, *Serica similis* (Chosen only), *Monochirus* (*Hispa*) *callicanthus*, *Eurydema rugosum*, *Delphax* (*Liburnia*) *furcifera*, *Diostrombus politus*, and *Rhopalosiphum avenae*.

In Chosen the army worm, *Cirphis unipuncta* (*8*), is a serious pest of millet and attacks also oats, rice, barley, and *Panicum frumentosum* Roxb. This species is of general distribution throughout the areas under consideration. There are two broods each year, the adults of the first appearing the last of June and those of the second late in July. The winter is passed in the pupal stage in the soil. The eggs, which are laid in rows of from 20 to 30 on the leaves, hatch in 4 or 5 days. The larval stage of each generation covers about 25 days and the pupal stage of the first 10 days. At times very extended damage occurs through the feeding of the larvae upon

the blades. The control method employed is the digging of ditches around the borders of the fields into which the larvae fall when searching for a hiding place during the day or when migrating from one field to another.

Sesamia inferens (*95*) attacks millet, rice, wheat, and oats and is of general distribution. There are two, and at times three, generations a year, and the winter is passed either in the pupal stage or as an adult moth. The damage to millet is largely due to the feeding of the larvae upon the roots. The collection of adult moths by lantern trap is advocated as a means of control.

The European corn borer, *Pyrausta nubilalis*, is a very common pest of millet throughout Japan and Chosen and on the whole is of more importance as a pest of this crop than of corn. Its life history is discussed among the enemies of the latter crop.

CLOVER INSECTS

Upon field clover the insects on record are *Colias hyale poliographus*, *Barathra brassicae*, *Chloridea dipsacea*, *Euxoa segetis*, *Maladera* (*Aserica*) *orientalis*, *Popillia japonica*, and *Luperodes discrepans*. The more important of these are the three species of Noctuidae.

FLAX INSECTS

The insect species found attacking flax in Japan are *Agrotis c-nigrum*, *Barathra brassica*, and *Chloridea dipsacea*, of which the last two are discussed as pests of other crops.

HEMP INSECTS

Of the insects affecting hemp in Japan and Chosen the cerambycid *Thyestilla gebleri*, the chrysomelid *Haltica flavicornis*, the noctuid moth *Barathra brassicae*, and the nymphalids *Polygonia c-aureum* and *Pyrameis indica indica* are the most important.

T. gebleri (*191*) is a particularly serious pest in Chosen. There is one brood each year, and the adults appear during June. The eggs are usually laid singly in the stalk about 5 or 6 inches below the first node. Upon hatching the larva burrows about in the stem, usually descending from the point of entrance, and makes a hole in the outer wall of the stalk from 5 to 8 inches above the surface of the ground, through which the excrement is ejected from the burrow. Control is effected by the burning of infested stalks.

No information is available regarding *Haltica flavicornis;* and *Barathra brassicae*, the remaining species of major importance, is dealt with as a pest of truck crops (p. 68).

The nymphalid *Pyrameis indica indica* (*95*) occurs in practically all sections of Japan and in Chosen, Taiwan, and China as well. There are two generations each year, and the winter is passed in the adult stage. The eggs are laid on the undersides of the leaves. Adult moths are present in the field throughout the season from June to October. Another species, *P. cardui japonica*, has a similar distribution and life history.

Polygonia c-aureum (*95*) is commonly found upon hemp in Honshu, Kyushu, and Taiwan, but is not known to occur in Hokkaido. In central Japan two generations are produced each year, whereas there are three in Taiwan.

Other insect species of less consequence than those above mentioned are *Pyrausta nubilalis*, *Pestinophora gossypiella*, *Chloridea dipsacea*, *Acronycta consanguis*, *Phassus* (*Hepialis*) *excrescens*, *Geisha distinctissima*, *Rhinonchus pericarpius*, *Mordellistena cannabisi*, *Tettigoniella ferruginea* var. *apicalis*, and *Ricania japonica*.

INDIGO INSECTS

The curculionid *Lixus impressiventris* (*95*) is a common pest of indigo in Japan. There are three broods each year, the winter being passed in the egg stage on weeds in the fields. The eggs are laid in the stem of the plant in small groups and hatch in about one week. The larvae bore into the stem, preventing its development, and reach maturity in three weeks. The adults of the second brood feed upon the foliage.

Other pests recorded upon indigo are the chrysomelids *Crepidodera chloris* and *Monolepta dichroa*, and the curculionid *Ceutorrynchus asper*, but little is known regarding them, and they are of minor importance.

RUSH INSECTS

The use of rushes (*Juncus* sp.) as a material for the manufacture of matting is very extensive in Japan, and consequently the insects attacking this plant are of economic importance. The recently described sawfly *Tomostethus juncivorus* (*24*) often becomes very abundant and injurious. There are two broods each year, the adults of the first appearing in May, and those of the second in September. The winter is passed in the larval stage in a cell in the soil. The eggs are laid singly in the leaf tissue, and the young larvae feed therein from 9 to 15 days, after which feeding takes place externally. The first brood of larvae feeds at the tips of the leaves at night and rests during the day at the base of the plant, but with the second brood this habit is reversed, and feeding takes place during the day. Spraying when the larvae are in the early stages and crop rotation are recommended as measures for control.

COTTON AND TOBACCO INSECTS

Cotton is grown to a considerable extent in both Chosen and Taiwan, but only to a slight extent in Japan proper. In Chosen cotton has been cultivated for a period of less than 20 years, and the area under cultivation in 1923 was approximately 200,000 acres. Practically all the information regarding the insect pests which attack this crop in Chosen is given by Matsumoto (*89*), and Shiraki (*167*) in Taiwan has published an extended account of the cotton insects of the world, among which are a number native to that island and previously unrecorded as pests of this plant.

Tobacco is produced in central and southern Japan, Chosen, and Taiwan, but only a little information is available regarding the pests attacking it.

LIST OF COTTON AND TOBACCO INSECTS

	Distribution [1]	Host plants
LEPIDOPTERA		
Arctiidae:		
Diacrisia obliqua Wlk	J. K. F. O.	Cotton.
Noctuidae:		
Agrotis c-nigrum L	J. F.	Do.
Chloridea assulta Guen	J. K. F. C.	Cotton, tobacco.
Chloridea dipsacea L	J. K. C.	Cotton.
Cosmophila mesogona Wlk	J. K. C.	Do.
Earias cupreoviridis Wlk	J. F.	Do.
Earias fabia Stoll	F.	Do.
Euxoa segetis Schiff	J. K. C.	Cotton, tobacco.
Heliothis obsoleta Fab	J. K. F. C. O.	Do.
Prodenia litura Fab	J. F. C. O.	Cotton.
Pyrrhia umbra Hufn	J. K. F. C.	Tobacco.
Lymantriidae:		
Euproctis latifascia postica Wlk	F.	Cotton.
Euproctis montis Leech	F.	Do.
Pyralidae:		
Glyphodes indica Saund	J.	Do.
Hypsipyla formosana Shir	F.	Do.
Sylepta derogata Fab	J. K. F. C.	Do.
Sylepta multilinealis Guen	J.	Do.
Gelechiidae:		
Oecophora inopisema Butl	J.	Do.
Pectinophora gossypiella Saund	J. K. F. C.	Do.
Xyloryctidae:		
Acria gossypiella Saund	F.	Do.
COLEOPTERA		
Scarabaeidae:		
Popillia indigonacea Motsch	K. F. C. O.	Do.
Popillia quadriguttata F	K. F. C. O.	Do.
Serica similis Lewis	J. K. C.	Do.
Cerambycidae:		
Homona gossypi Mats	J. F.	Do.
Chrysomelidae:		
Chrysochus chinensis Baly	J. F. C. O.	Do.
Plagiodera versicolora distincta Baly	J. K.	Do.
Curculionidae:		
Hypomeces squamosus Fab	F. C.	Do.
Anthribidae:		
Araecerus fasciculatus deG	J. F. C.	Do.
HEMIPTERA		
Pentatomidae:		
Dolycoris baccarum L	J. K. C.	Tobacco.
Coreidae:		
Anoplocnemis phasiana Fab	F.	Cotton.
Lygaeidae:		
Cymnus tabaci Mats	F.	Tobacco.
Oxycarenus gossypii Horv	F.	Cotton.
Pyrrhocoridae:		
Dysdercus cingulatus F	F. C. O.	Do.
Dysdercus megalopygus Bredd	F.	Do.
Miridae:		
Calocoris rapidus Say	F.	Do.
Aphiidae:		
Aphis gossypii Glov	J. K. F. C.	Cotton, tobacco.
Omyzus persicae Sulz	J. K. F.	Cotton.
Coccidae:		
Pseudococcus virgatus Ckll	F. C.	Do.
Saissetia nigra Nietn	F. C.	Do.
THYSANOPTERA		
Euthrips gossypii Shir	F.	Do.
Thrips tabaci Lind	F.	Do.
ORTHOPTERA		
Gryllidae:		
Brachytrypes portentosus Licht	K. F. C.	Cotton, tobacco.
Acrididae:		
Atractomorpha bedeli Boliv	J. K. F. C. O.	Cotton.
Locusta migratoria migratoroides Reich	F.	Cotton, tobacco.
Oxya velox F	J. K F. C. O.	Cotton.
ACARINA		
Eriophyidae:		
Tetranychus telarius L	J. K. F. C.	Do.

[1] Distribution symbols as follows: J., Japan; K., Chosen (Korea); F. , Taiwan (Formosa); C., China; and O., Okinawa (Loo-choo or Riukiu Islands).

COTTON INSECTS

The worst of the cotton pests is the well-known pink bollworm, *Pectinophora gossypiella* (*89*, *167*), which, according to Okamoto, infests an average of 50 per cent of the bolls each year in Chosen. It also occurs in Japan and in Taiwan, largely in the district about Tainan, and is spreading rapidly. It was presumably introduced into the island from India, and an infestation in some cases of 50 per cent has been noted. In Chosen two broods are produced annually, the mature larvae of the second brood hibernating in cocoons in the soil or in rubbish and crevices. This is in marked contrast to the habit of the species as recorded by Gough in Egypt, where the resting stage larvae were always found to be in seed, either ginned or in abandoned bolls in the field. The adults of the first brood appear in the early part of July and those of the second in the middle of August. The eggs of the first brood are laid upon flower buds and developing bolls or on the stems near by, and the larvae feed within the flower buds and young bolls, which consequently fall. Pupation is either in these fallen bolls or in the soil. The eggs of the second brood are placed in the crevices between the sections of the boll, near the base, and the larvae penetrate and feed upon the seeds, thus preventing the maturing and opening of the boll. The affected bolls do not drop from the plant. Green hemp is mentioned as a host plant in addition to cotton, but no others have thus far been noted. The control measures recommended are chiefly cultural, and consist of cultivating and harrowing the soil to kill the larvae and pupae, the gathering of fallen buds in late July and early August, and the burning of old plants and rubbish at the end of the season.

The gelechiid *Oecophora inopisema* is recorded from Japan (*95*). The life cycle covers one year, the adults appearing during June. The larvae feed in the seed of the cotton and hibernate in the seed in the mature stage.

Earias cupreoviridis (*E. chromataria* Wlk.) (*95*) occurs in Japan and Taiwan and in the latter island has one brood each year. The winter is passed in the pupal stage. The adult moths emerge in late June and July. The eggs are deposited on the cotton squares, and the young larvae bore into the developing boll, feeding upon the seeds and lint. When mature the larva leaves the boll and forms its cocoon upon the stem of the same or of an adjoining plant.

The corn ear worm *Heliothis* (*Chloridea*) *obsoleta* is of general distribution and is mentioned as attacking cotton, tobacco, and Indian corn. In Japan there are two generations a year, the adults of the first appearing in June and July and those of the second in August and September.

The cotton leaf roller *Sylepta derogata* (*167*) ranges in distribution from the southern islands of Japan to Chosen, China, Taiwan, Australia, Burma, India, and Ceylon. In addition to cotton it attacks a number of related plants such as hollyhock and hibiscus. Though the caterpillars are common in Taiwan, the injury by this species can not be considered great. The foliage of the American varieties of cotton is affected frequently as much as 20 per cent, whereas the Indian varieties are injured relatively only half as much in the same localities. The larvae feed upon the under surface of the leaf, and after the first molt this leaf is rolled ventrally. There

are six broods each year, and the winter is passed in the larval stage. The duration of the egg, larval, and pupal stages under summer conditions is from 2 to 3, 14 to 21, and 8 days, respectively. Control measures advocated are the planting of Indian rather than American varieties and the removal and destruction of rolled leaves containing larvae found upon the plants in the field.

Glyphodes indica (*95*) has three broods a year in Japan and hibernates as a partially developed larva. Feeding takes place upon the foliage of various plants in the early spring, and pupation is in the rolled leaves. The second and third broods feed upon cotton foliage. The adults of the three broods appear in late May, early July, and the middle of August, respectively.

The pyralid *Hypsipyla formosana* (*167*) is confined in distribution largely to the eastern sections of Taiwan. Little is known regarding its habits except that the larvae feed upon the developing seed.

The cotton seed weevil, *Araecerus fasciculatus* (*167*), a more or less cosmopolitan species, is found in Taiwan but is restricted to the southern sections about Ako. The adults are present in the field from July to October, and the larvae feed upon the seed.

The curculionid *Hypomeces squamosus* (*167*) is common in Taiwan and China as a minor pest of cotton, the adults feeding upon the foliage. The larvae probably develop upon some other plant, and their habits are unknown.

The large mole cricket *Brachytrypes portentosus* (listed in early literature as *B. achatinus* Stål and *Liogryllus formosanus* Mats.) (*167*, *172*) is one of the common pests of cotton in Taiwan, particularly in the coastal sections which have a rather sandy soil. Upon cotton the injury is primarily to the young plants, the leaves being cut off and carried down into the burrow.

The cotton stainer *Dysdercus cingulatus* (*167*) is found in Taiwan and Okinawa and is an important pest. Both the nymphs and adults feed upon the sap of the plant, particularly at the bolls. It is controlled to a certain extent by a tachinid parasite.

Probably ranking next to the pink bollworm in the injury inflicted to cotton is the red spider *Tetranychus telarius*, which has a number of additional food plants. It is most abundant during August, following the ending of the rainy season, and increases rapidly during hot, dry periods. During such times it is often the cause of complete defoliation and the death of the plants. The control measures recommended are the elimination of weeds along the field borders and of beans between the rows, and in exceptional cases spraying with lime-sulphur.

The other pests listed are more or less general feeders, and their attacks upon cotton are not serious except in the case of occasional outbreaks.

TOBACCO INSECTS

The noctuid *Pyrrhia umbra* (*149*) often causes considerable damage to tobacco in Japan. An account of this species is given among the insect pests of legumes (p. 68). In both Japan and Taiwan the greatest insect injury to tobacco is due to the attacks of the various cutworms. Several other insects are listed as attacking tobacco, but they are not responsible for serious injury.

TRUCK-CROP INSECTS

LIST OF TRUCK-CROP INSECTS

	Distribution [1]	Host plants
HYMENOPTERA		
Argidae:		
Arge nipponensis Rohw	J. K. C.	Cabbage, turnip, mustard, carrot.
Tenthredinidae:		
Athalia colibri Christ	K.	Cabbage, turnip, mustard.
Athalia colibri japanensis Rohw	J.	Cabbage, turnip, radish.
Athalia japonica Klug	J. F.	Cabbage, turnip, carrot, radish.
Emphytus albicinctus Mats	J.	Strawberry.
DIPTERA		
Cecidomyiidae:		
Johnsonomyia sp	J.	Soybean.
Agromyzidae:		
Phytomyza nigricornis Macq	J.	Turnip, peas.
Anthomyiidae:		
Anthomyia flavopicta Mats	J.	Cabbage, radish, beans, peas, turnip.
Pegomyia vicina Lint	K.	Sugar beet.
Trypetidae:		
Chaetodacus sp	J.	Pumpkin.
Dacus cucurbitae Coq	F. C. O.	Cucumber, melons.
Chloropidae:		
Chloropisca cucurbitae Mats	J.	Cucumber.
LEPIDOPTERA		
Papilionidae:		
Papilio machaon L	J.	Carrot.
Vanessa io geisha Stich	J.	Hop.
Pieridae:		
Colias hyale poliographus Motsch	J.	Soybean.
Pieris napi L	J.	Cruciferae.
Pieris rapae L	J. K. C. O.	Do.
Pieris rapae crucivora Boisd	J. K. C.	Do.
Lycaenidae:		
Lampides baeticus L	J. F. O.	Beans.
Sphingidae:		
Acherontia styx Westw	J. K. F. C.	Sweetpotato, beans, peas, eggplant.
Acherontia styx crathis Roths	J.	Potato.
Protoparce convolvuli L	J. F. O.	Sweetpotato.
Theretra oldenlandiae Fab	J. K. C.	Potato, sweetpotato, beans, taro, Cruciferae.
Arctiidae:		
Amsacta lactinea Cram	J. F. C. O.	Soybean.
Arctia caia L	J.	Cabbage, rape, gooseberry.
Noctuidae:		
Agrotis c-nigrum L	J. K. F. C.	Sugar beet, cabbage, radish, turnip, soybean, peas, onion.
Agrotis plectra L	J.	Sugar beet.
Agrotis ravida Schiff	J. K. C.	Cruciferae.
Agrotis tokionis Butl	J. K. C.	Do.
Agrotis ypsilon Rott	J. K. F. C.	Sugar beet, potato, soybean, onion, carrot.
Anophia leucomelas L	J. F. C.	Sweetpotato.
Barathra brassicae L	J. K. C.	Sugar beet, soybean, peas, tomato, cabbage, carrot.
Chloridea dipsacea L	J. K. C.	Soybean, red bean.
Ephesia dissimilis Brem	J. C.	Sweetpotato.
Euxoa segetis Schiff	J. K. C.	Sugar beet, potato, soybean, carrot, burdock.
Heliothis obsoleta Fab	J. K. F. C. O.	Beans, peas.
Laphygma exigua Hübn	J. K. C.	Sugar beet.
Phytometra chalcytes Esp	K.	Do.
Polia illoba Butl	J. K. C.	Sugar beet, soybean, peas, onion, cabbage, radish.
Prodenia litura Fab	J. F. C. O.	Onion, taro.
Pyrrhia umbra Hufn	J. K. F. C.	Beans, buckwheat, rape.
Scotogramma trifolii Rott	J.	Sweetpotato.
Tiracola plagiata Wlk	F. C.	Cabbage, onion.
Lymantriidae:		
Euproctis latifascia postica Wlk	F. C.	Potato, eggplant, Cruciferae.
Euproctis montis Leech	F. C.	Beans, potato, eggplant, castor bean, Cruciferae.
Pyralidae:		
Etiella zinckenella Treit	J.	Beans, peas.
Evergestis extimalis Scopoli	J. K. C.	Turnip, rape.
Hellula undalis Fab	J. F.	Radish.
Maruca testularis Gey	J. K. F. C. O.	Beans.

[1] Distribution symbols are as follows: J., Japan; K., Chosen (Korea); F., Taiwan (Formosa); C., China; and O., Okinawa (Loo-choo or Riukiu Islands).

List of truck-crop insects—Continued

	Distribution	Host plants
LEPIDOPTERA—continued		
Pyralidae—Continued.		
Omphisa anastomosalis Guen	F. C.	Sweetpotato.
Pionea forficalis L	J.	Cruciferae.
Pyrausta nubilalis Hübn	J. K. C.	Sugar beet, pole beans, hop, chrysanthemum.
Zinckenia fascialis Cram	J. K. F. C. O.	Sugar beet, cucumber.
Pterophoridae:		
Alucita vilis Butl	J.	Beans.
Gelechiidae:		
Brachmia triannuella H. S	J. O.	Sweetpotato.
Olethreutidae:		
Laspeyresia glycinivorella Mats	J. K. C.	Soybean.
Thiodia azukivora Mats	J.	Red bean.
Plutellidae:		
Plutella maculipennis Curt	J. K. F. C. O.	Cabbage, carrot, rape, radish, turnip.
Hepialidae:		
Palpifer sexnotatus Moore	F.	Taro.
COLEOPTERA		
Meloidae:		
Epicauta gorhami Mars	J.	Soybean, red bean.
Epicauta hirticornis Haag	F.	Sugar beet, potato.
Epicauta megalocephala Gbl	J. K. C.	Sugar beet, potato, soybean.
Mylabris cichorii L	F.	Peanut.
Elateridae:		
Agriotes sericeus Cand	J.	Potato, eggplant, beans.
Coccinellidae:		
Epilachna affinis E. and S	F.	Beans, peas, eggplant.
Epilachna nipponica Lewis	J. K.	Potato, tomato, soybean, cucumber.
Epilachna 28-punctata Fab	J. K.	Potato, eggplant, cucumber.
Tenebrionidae:		
Gonocephalum reticulatum Motsch	K.	Sugar beet, ginseng.
Scarabaeidae:		
Anomala rufocuprea Motsch	J.	Legumes.
Holotrichia diomphalia Bates	J. K. C.	Sugar beet, potato, cabbage.
Holotrichia kiotoensis Brenske	K. C.	Sugar beet.
Ligyrus rugiceps Lec	F.	Do.
Maladera orientalis Motsch	J. K. C.	Do.
Oxycetonia jucunda Fald	J. K. C. O.	Do.
Popillia japonica Newm	J.	Beans, asparagus.
Serica salebrosa Brenske	J.	Sugar beet.
Serica similis Lewis	J. K. C.	Sugar beet, cauliflower, asparagus.
Chrysomelidae:		
Aspidomorpha koshunensis Mats	F.	Sweetpotato.
Cassida nebulosa L	J.	Sugar beet.
Cassida nigroguttata Gorh	J.	Do.
Ceratia atripennis Fab	F.	Beans, peas, melons.
Chaetocnema chalceola Jacoby	J.	Sugar beet.
Chrysochus chinensis Baly	J.F.C.O.	Sweetpotato, taro.
Chrysochus pretiosus F	J.	Sweetpotato.
Chrysomela exanthematica Wied	J.	Mint, hop.
Crepidodera chloris Fondr	J.	Sugar beet.
Galerucella distincta Baly	J.	Strawberry.
Luperodes discrepans Baly	J.	Sugar beet, soybean, turnip, melons, mint, chrysanthemum.
Luperodes suturalis nigrobilineatus Motsch	J. K. F.	Sugar beet, soybean.
Monolepta dichroa Harold	J.	Sweetpotato, melons, hop.
Monoxia puncticollis Say	K. C.	Sugar beet.
Phaedon brassicae Baly	J.	Cruciferae.
Phaedon incertus Baly	J. F.	Do.
Phyllotreta sinuata Redt	J. F. O.	Sugar beet, Cruciferae.
Phyllotreta vittata Fab	J. F.	Sugar beet, turnip, radish, melons.
Phytoecia ventralis Chevr	J.	Chrysanthemum.
Psylliodes angusticollis Baly	J.	Cruciferae.
Psylliodes punctifrons Baly	J.	Hop, Cruciferae.
Rhaphidopalpa fermoralis Motsch	J. K. F.	Beans, peas, melons.
Rhaphidopalpa foveicollis Kunst	F.	Do.
Bruchidae:		
Bruchus affinis Fröl	F.	Peas.
Bruchus chinensis L	J. F. C. O.	Peas, beans.
Bruchus pisorum L	J. F. C. O.	Peas.
Curculionidae:		
Amystax maculatus Mats	K. C.	Sugar beet.
Anthonomus signatus Say	J.	Strawberry.
Cleonus superciliosus Schönh	J.	Burdock.
Cneorrhinus globatus Herbst	K. F. C.	Sugar beet.
Cylas formicarius F	F. C. O.	Sweetpotato.
Dermatodes tuberculatus Gyll	J.	Ginsing.
Eugnathus distinctus Roel	J.	Soybean, red bean.

List of truck-crop insects—Continued

	Distribution	Host plants
COLEOPTERA—continued		
Curculionidae—Continued.		
Minyrus japonicus Roel	J.	Strawberry.
Phinoncus bruchoides Herbst	J.	Turnip.
Scepticus insularis Roel	J. K.	Sugar beet, soybean, ginseng, peanut.
HEMIPTERA		
Pentatomidae:		
Carpocoris purpureipennis deG	J. K. C.	Potato, radish, carrot.
Coptosoma punctissimum Mont	J.	Soybean, red bean.
Dolycoris baccarum L	J. K. C.	Sugar beet, soybean.
Eurydema pulchrum Westw	J. F. O.	Cruciferae.
Eurydema rugosum Motsch	J. K.	Do.
Graphosoma rubrolineatum Westw	J. K. C. O.	Cruciferae, onion.
Coreidae:		
Acanthocoris sordidus Thunb	J. F. O.	Sweetpotato, eggplant.
Miridae:		
Adelphocoris suturalis Jak	J.	Soybean, red bean.
Halticus minutus Reut	J. F.	Sweetpotato, cabbage, melons, peanut.
Lygus kalmi L	J.	Sugar beet.
Tuponia guttula Mats	J.	Sugar beet, potato.
Aphiidae:		
Aphis gossypii Glov	J. K. F. C.	Potato, cucumber, beans, peas.
Aphis medicaginis Koch	J. F.	Beans, peas.
Brevicoryne brassicae L	J. K. F. C.	Cabbage, mustard.
Illinoia pisi Kalt	J.	Sweetpotato, soybean.
Macrosiphum gobonis Mats	J. F.	Burdock.
Macrosiphum matsumuraeanum Hori	J.	Potato, tomato, eggplant, burdock.
Omyzus persicae Sulz	J. K. F.	Sugar beet, tomato, cabbage, radish, mustard, potato, eggplant.
Phorodon humuli Schrank	J. F.	Hop.
THYSANOPTERA		
Liothrips glycinicola Okam	J. K.	Soybean, red bean, peas.
Thrips tabaci Lind	F.	Cabbage, onion.
ORTHOPTERA		
Gryllidae:		
Brachytrypes portentosus Licht	K. F. C.	Potato, sweetpotato, eggplant, melons.
Gryllotalpa africana P. de B	J. K. F. C. O.	Sugar beet, potato.
Gryllus mitratus Burm	J. O.	Melons.
Acrididae:		
Atractomorpha bedeli Boliv	J. K. F. C. O.	Sugar beet.
Locusta migratoria danicus L	J. K. F. C.	Sweetpotato.
Oxya velox Fab	J. K. F. C. O.	Do.
Podisma pedestris sapporense Shir	J.	Sugar beet, potato, soybean, Carrot, burdock.
COLLEMBOLA		
Sminthuridae:		
Bourletiella hortensis Fitch	J.	Sugar beet, tomato, eggplant, cucumber, Cruciferae.
Sminthurus viridis L	J.	Potato, eggplant, cucumber.
ACARINA		
Eriophyidae:		
Phizoglyphus echinopus Murr	J.	Potato, bulbs.
Tetranychus telarius L	J. K. F. C.	Beans.

SUGAR-BEET INSECTS

The data regarding sugar-beet pests in Japan, particularly in Hokkaido, are given in a recent publication by Kuwayama, Kuribayashi, and Oshima (*78*), and Aoyama (*7*) and Yamada (*205*) give a summary of the information available regarding them in Chosen and Manchuria.

The beet army worm, *Laphygma exigua* (*7*), found commonly in Chosen and Manchuria as well as in Japan, is only a minor pest. Two broods are produced each year, and the winter is passed in the pupal stage in the soil. The adults of the first brood appear in early June and those of the second, late in July. The eggs are laid

en masse on the underside of the foliage and hatch in about one week. The early-stage larvae are gregarious and feed both day and night, whereas the more mature ones are solitary and feed at night only, passing the day in the soil. Control measures are the hand picking of the egg masses, the digging of ditches along the field borders as traps, and spraying with soap and pyrethrum powder when the larvae are in the early stages. In other sections of the world, particularly in the Tropics, this species is an important crop pest.

Agrotis (*Rhyacia*) *c-nigrum* (*78*) occurs in Japan, Chosen, and China as a pest of sugar beet, but is of most importance in Hokkaido. In that island there are two broods each year, the adults appearing in late June and July, and from the latter part of August, respectively. The winter is passed in the mature larval stage in the soil or among dead leaves on the surface. The eggs are laid singly during the night upon the exposed portions of the root or on the lower sides of the leaves. The larvae as well as adults are nocturnal in habit. The egg stage of the first generation is from 7 to 10 days and that of the second 5 or 6 days, while the larval and pupal stages of the first cover periods of 1 month and 2 weeks, respectively.

Polia illoba (*78*) occasionally becomes abundant on sugar beet in Hokkaido, though it is not so common as the above species. Normally two broods are produced each year, though occasionally there is only one. The life history is similar to that of *A. c-nigrum* except that the eggs are laid in groups of from 50 to 60 on the foliage and hatch in two weeks, and the winter is passed in the pupal stage in the soil. The larvae feed during the day as well as at night.

The black cutworm, *Agrotis ypsilon*, and *A. tokionis* (*7*), the first of which is distributed through practically all oriental countries, are common pests in Chosen and Manchuria. Both occur in Japan, and *A. ypsilon* in Taiwan also. Though they are found attacking many crops, the sugar beet is most seriously affected. The leafstalks are cut away, thus causing a considerable loss of foliage during periods of cutworm abundance.

The Hawaiian beet webworm, *Zinckenia fascialis* (*7*), is of general distribution and is an important pest of sugar beet in Chosen and Hokkaido. According to Eguchi (*13*) there are three or four broods per year in Chosen, and the winter is passed in the pupal stage in the soil. The duration of the egg, larval and pupal stages in the summer generations is from 2 to 7, 7 to 20, and 7 to 15 days, respectively. The adults are nocturnal in habit, and the females deposit their eggs on the lower leaf surface near the veins. The larvae feed upon the lower surfaces of the leaves only. In addition to sugar beet a variety of other Chenopodiaceae and Amarantaceae are attacked.

The method of control is fall cultivation to kill the larvae in the soil and spraying with soap and pyrethrum powder for the larvae in the earlier stages.

Among the Coleoptera probably the most important sugar-beet pests are the Scarabaeidae, both in the larval and adult form. Among these may be mentioned particularly *Serica salebrosa*, *Maladera* (*Aserica*) *orientalis*, *Holotrichia diomphalia*, and *Ligyrus rugiceps* (Taiwan only). The grubs, particularly those of Holotrichia,

feed extensively at the roots. In Hokkaido *S. salebrosa* at times causes considerable damage. There is one generation per year, and the winter is passed by the adults in the old pupation cells in the soil, from which they emerge in May and June. Rotation of crops is recommended as the best means of control. In Chosen a related species (*Serica similis*) is quite abundant and at times causes damage by the feeding of the adults upon the foliage of young plants in the early spring.

Maladera (*Aserica*) *orientalis* (*34*) is a serious pest of sugar beet in Hokkaido. There is one generation each year, and the winter is passed in the adult stage in the pupation cell in the soil, the final transformation taking place in late August and early September. The beetles feed upon the young foliage, largely during the evening. According to Yamada (*205*) the species is also a serious pest in Manchuria, and crop rotation is recommended as the most practicable means of control.

The chrysomelid *Monoxia puncticollis*, one of the well-known sugar-beet pests of the western part of the United States, is recorded as occurring in Japan and Chosen, but no information is available regarding its habit or the extent of damage inflicted.

The flea beetle *Chaetocnema chalceola* is recorded as a pest in Hokkaido, but not much is known regarding its habits. Control measures advocated are the same as for the garden springtail, which is discussed later.

The sugar-beet tortoise beetles *Cassida nebulosa* and *C. nigroguttata* (*95*) are minor pests of sugar beet in Hokkaido and northern Honshu. There is a single generation each year in that section and two farther south. The adults hibernate in sheltered places, emerging early in the spring. The females deposit their eggs upon the undersides of the leaves. The grubs feed upon the foliage, and the pupae are formed on the leaves.

Another important pest in Chosen is the curculionid *Scepticus insularis* (1), which feeds upon the foliage of many other crops in addition to sugar beets. There is one brood a year, and hibernation is in the larval stage, the adults appearing in late April and May. The larvae live in the soil and do little damage, most of the injury being due to the feeding of the adults upon the foliage of the young plants. The control method suggested is the growing of other favorite food plants along the borders of the fields.

The curculionid *Cneorrhinus globatus* (*205*) is a serious pest in southern Manchuria and is recorded also from Chosen and Taiwan. The adults, which are present in the field from March to May, feed on the leaves and buds of the young plants and often kill them.

The meloid beetle *Epicauta megalocephala* (*7*, *205*) is found commonly feeding upon the beet foliage in Chosen and southern Manchuria and is recorded also from Japan. The adults appear in May and feed throughout the summer upon the foliage. There is one generation annually. Control measures recommended are cultivation after harvesting to kill the larvae in the soil and the collection of adults during the early mornings, when they can be knocked from the plants into receptacles and killed. In Taiwan *E. hirticornis* (*85*) is recorded as attacking sugar beet, potato, and various other crops. The adults appear in May, and the eggs are laid in June

and hatch the following month. The winter is passed in the larval stage.

The tenebrionid *Gonocephalum* (*Opatrum*) *reticulatum* (*7*) causes more or less injury in Chosen by the feeding of the adults upon the young foliage and of the larvae upon the roots. There is one brood each year, and the winter is passed in the larval stage in the soil, the adults appearing late in April. It attacks also ginseng and burdock.

The anthomyiid leaf miner *Pegomyia vicina* (*7*) is common in Chosen and at times becomes abundant. There are three broods a year, the adults of which appear in early June, the middle of July, and late August. The winter is passed in the pupal stage in the soil. The eggs are laid in groups of three or four on the lower surface of the leaves. The larvae upon hatching enter the leaf tissues and begin feeding. In midsummer the egg, larval, and pupal stages cover 6, 17, and 21 days, respectively.

The acridid *Atractomorpha bedeli* (*7*), though not an important pest in Chosen, is often found feeding upon sugar beet and dry-land rice. The eggs carry over the winter, and the adult stage is reached by July. In only occasional instances are the nymphs and adults sufficiently abundant to cause any appreciable injury to the plants.

A species of pentatomid, *Dolycoris baccarum* (*7*), is in Chosen a minor pest of sugar beet as well as of soybean and tobacco. The injury results from the feeding of the nymphs and adults upon flower buds, this causing the reduction in the crop of seed produced. There are two broods each year, and the adults pass the winter in rubbish or under stones. The eggs are laid in groups of 8 or 9 on the undersides of the leaves and hatch in 7 days. As means of control the burning of all rubbish in the vicinity of the field is recommended as well as the collection of egg clusters and of adults by knocking them into trays containing kerosene.

A collemboloid pest recently discovered in Hokkaido is the garden springtail, *Bourletiella* (*Sminthurus*) *hortensis* (*pruinosus* Tullb.) (*34*, *78*), which attacks various field and vegetable crops. The damage is due to the cutting of the leaf stems of seedlings and young field plants. There are several generations per year, and the adults of the last hibernate in cells in the soil. The damage to sugar beet is greatest during dry periods, as the species does not thrive under moist conditions. Control measures used are the spraying of the young plants at 5-day intervals with kerosene containing wood ashes and pyrethrum powder, or the placing of sawdust soaked with kerosene about the plants. This pest is recorded upon a wide range of plants in the British Isles and Canada.

INSECTS AFFECTING LEGUMES

The soybean is the most important of the legumes grown in Japan, and in Manchuria it is the principal agricultural crop. Kuwayama (*76*) lists the following insect species as being the most injurious ones attacking the crop in Hokkaido: *Podisma pedestris sapporense*, *Illinoia pisi*, *Luperodes suturalis* ab. *nigrobilineatus*, *L. discrepans*, *Popillia japonica*, *Laspeyresia glycinivorella*, *Chloridea dipsacea*, *Pyrrhia umbra*, *Colias hyale poliographus*, and an undetermined cecidomyiid.

Four species of Noctuidae are recorded as important pests of various legumes as well as of many vegetables in Japan and Chosen, and though they are general feeders their economic effect is most marked upon beans and peas. *Chloridea dipsacea* (*149*) is a widely distributed species, occurring in Hokkaido, Honshu, Chosen, and China and extending westwards to Europe. In addition to various beans and peas, it attacks flax, hemp, snail clover, tobacco, and *Perilla ocimodes*. There are two broods each year, the pupae of the last passing the winter in the soil, and the adults of the first brood appearing in early June. Those of the second are present in August. The larvae of the first brood feed exclusively upon foliage, but upon soybean those of the second feed upon pods and developing seed only. These larvae are mature by the end of September and enter the soil for pupation. The durations of the egg, larval, and pupal stages of the first brood are approximately 7, 20, and 14 days, respectively.

Euxoa segetis (*96*) may be considered here among the pests of legumes though its feeding upon other crops such as cotton, tobacco, and various Cruciferae is fully as destructive. It ranges in distribution from Japan through Chosen and China, and on to Europe. In India it is a major pest of green crops, and in European Russia it is serious upon various grains, sugar beet, etc. There are two broods each year in Chosen, the adults of the first appearing in May and June and those of the second from August to October. The eggs are laid at the side of the roots or in fallen leaves, and hatch in from 7 to 14 days, depending upon temperature conditions. The larvae feed upon the foliage by night and remain concealed 2 or 3 inches below the soil surface during the day. Potato tubers beneath the ground are frequently attacked. The mature larvae of the second brood hibernate in cells in the soil. Collection of adults at lantern traps and sugar baits is suggested as a means of control.

Pyrrhia umbra (*149*, *169*) is found in Hokkaido, Chosen, and Taiwan, and extends to Manchuria, China, India, Asia Minor, and Europe. In Japan it is a serious pest of soybean, adsuki bean, and tobacco, and also attacks rape and buckwheat. A single brood is produced each year, the winter being passed in the pupal stage in the soil and the adults appearing about the middle of July. The eggs are laid the latter part of that month on the under side of the leaves and hatch in about one week. The larvae feed both by day and by night and in the earlier stages confine themselves to the foliage, but those of the third stage feed upon the pods and developing seeds. Each larva feeds at more than one pod. They mature about the end of September and pupate in a cell about 1 inch below the surface. Adult moths fly both by day and night.

The cabbage moth *Barathra* (*Mamestra*) *brassicae* (*95*), an important pest of peas and soybean in Japan, is recorded as occurring throughout Japan and Chosen, and is known to be common in China, Siberia, and Europe. Its life history in Chosen, as given by Aoyama (*7*), shows two broods a year, the winter being passed as a pupa in the soil. The first flight of adults is in early June and the second in August. The eggs are laid in large masses on the under surface of the foliage and hatch in about seven days. The larvae feed only at night. Control methods suggested are the col-

lection of egg masses, putting out molasses traps for adults, digging ditch traps along the field borders, and fall plowing and spraying with lead arsenate while the larvae are in the early stages.

A very important pest of soybean found extensively in Hokkaido and Honshu is the olethreutid moth *Laspeyresia glycinivorella* (*149*), which is also recorded by Sanga (*158*) as abundant and injurious in Manchuria, where that crop is the most important of all agricultural products. There is but one brood a year, and the winter is passed as a mature larva or prepupa in a light cocoon in the soil. Pupation takes place about the first of June, and the adults emerge toward the end of July. The eggs are laid singly or in small groups upon the developing pod and hatch in from six to eight days. The young larvae burrow into the pod and feed upon the developing seeds. When mature, at about the end of October, they enter the soil and spin the cocoon. Cultural experiments reported by Takahashi (*192*) have shown that the early maturing varieties of soybean had much lighter attacks than the later varieties. With the early-maturing varieties early planting gave a better yield as well as a lower percentage of infestation, whereas with the late-maturing varieties early planting gave a higher yield also, but the advantage was offset by the heavier infestation of Laspeyresia. The comparative figures of the injury are as follows:

Early-maturing varieties:	Percentage of grain injured
Early planting	23.7
Common planting	33.3
Late planting	66.6

Late-maturing varieties:	Percentage of grain injured
Early planting	64.7
Common planting	58.0
Late planting	44.3

For control Ishii and Okamoto (*41*) recommend fall plowing to bring the cocoons to the surface where the insects will be killed by the winter's cold.

Another olethreutid common on red bean in Hokkaido and Honshu is *Thiodia azukivora* (*95*). One or possibly two broods are produced each year, and the larvae feed much after the manner of *L. glycinivorella*. The winter is passed in the pupal stage in the soil. Hand collection of adults is the only control measure suggested.

The pierid butterfly *Colias hyale poliographus* (*76*) is a general pest of legumes in Japan. Three or four generations are produced each year, and hibernation is in the adult stage.

The lycaenid *Lampides baeticus* (*95*) is a common pest of beans in Kyushu and the island of Okinawa. There are two broods each year, and the winter is passed in the egg stage. The larvae feed upon the seed in the pod, and pupation occurs upon the leaves or stem.

The chrysomelid *Luperodes discrepans* (*149*) is a very serious pest of soybean, as well as of sugar beet and clover, throughout Japan. There are two broods a year, the winter possibly being passed in the egg stage. The life history is imperfectly known, but larvae appear in the field in the middle of May, later pupating in cells in the soil and emerging as adults in July. Feeding continues until the end of September, and much damage is done. The spring brood of larvae feed upon the newly developed main leaves of the young plant. *L. discrepans* differs from *nigripennis*, with which it is often

confused, only in wing color, and the latter is found only in Sakhalin. Matsumura (*96*) considers them to be identical.

Luperodes (*Monolepta*) *suturalis* ab. *nigrobilineatus* is a common pest of soybean in northern Japan, the adults feeding upon the foliage from June to August. One brood is produced each year, but the early stages are as yet unknown, and possibly occur upon other food plants.

The pea weevil, *Bruchus* (*Mylabris*) *pisorum* (*dorsalis* Fab.) (*149*), is a serious pest of field peas in the various islands of Japan and occurs also in Taiwan and China. A single brood is produced each year, and the winter is passed in the adult stage in the seed or in sheltered places. The beetles become active about the time the blossoms develop in the spring, and the eggs are laid singly upon the developing pods. The larva pupates within the mature seed.

The two scarabaeids most common on legumes in Japan are *Anomala rufocuprea* and *Popillia japonica*. The first feeds particularly upon soybean and red bean. In Hokkaido, however, this species does not normally attack beans. Matsumura (*95*) states that the life history extends over three years, the adults appearing about the middle of June. As regards *Popillia japonica*, a report on this species has recently been published (*12*) by the writer and others in which full data are given regarding food plants, habits, etc. In central Honshu a full generation is produced each year, whereas in Hokkaido the greater part carry over to the second year. Of the economic crops attacked, pole beans and grape occasionally are slightly injured, but soybean very seldom. These attacks occur only in case the more favored food plants are lacking. In cases of heavy infestation of either of these species the hand collection of adults is the most practical means of control.

The coccinellid *Epilachna affinis* (*169*) is recorded as an important pest of beans, as well as of eggplant, in Taiwan.

The pentatomid *Coptosoma punctissimum* (*95*) attacks both soybean and red bean, and extensive damage is frequently done by the feeding of the nymphs during June and July. There is one brood a year, the adults appearing in September and passing the winter in that stage in rubbish. The eggs are laid during the early spring and hatch in about one week.

A cecidomyiid (*Johnsonomyia* sp.), is recorded by Kuwayama (*76*) as very injurious to soybean in Hokkaido. The larvae are most noticeable late in August, at which time they bore into the leaf petioles. A single generation occurs annually, the adults appearing in late July and August.

Liothrips glycinicola Okam., in conjunction with several other species of the order, is at times very injurious to soybean in northern Japan and Chosen. The injury is particularly serious during periods of hot and dry weather.

INSECTS AFFECTING IRISH POTATO

Of the pests of potato the most important are the three species of Epilachna, which attack, in addition to potato, various other vegetables, melons, beans, etc. *E. nipponica* (*105*, *149*) is found in Hokkaido, Honshu, and Chosen, and, in the colder sections particularly, often causes complete defoliation. There is one generation a year

in northern Japan, and the adults carry over the winter concealed in rubbish and in other protected places. They emerge from hibernation in the spring and begin feeding, but egg laying does not take place until early July. The eggs are laid in groups of from 15 to 20 on the undersides of the leaves and hatch in 10 days. Pupation takes place early in August upon the foliage or stem, and emergence of the adults occurs about one week later. According to Muramatsu, there are three generations per year in Chosen, the first brood of adults emerging the middle of June, the second early in August, and the third late in the season. The larvae feed chiefly during the early morning and in the evening, remaining hidden away during the day.

E. 28-punctata (*185*) is found in Honshu, Kyushu, Chosen, and Siberia. In the first-named island there is one generation, rarely two, a year (*107*), and the habits are the same as those of the preceding species. It is most abundant in central and southern Japan. Control is by the collection of the adults.

According to Hori (*35*) the two aphids *Omyzus* (*Rhopalosiphum*) *persicae* and *Macrosiphum matsumuraeanum* are serious pests of potato and eggplant in Hokkaido and Honshu. In Hokkaido potato mosaic is spread through the agency of both of these species. *O. persicae* hibernates in the egg stage upon *Trifolium* spp., *Arctium lappa*, and *Carthamus tinctorius*.

INSECTS AFFECTING SWEETPOTATO

Of the Lepidoptera attacking sweetpotato in Japan proper the most important species is *Ephesia* (*Catocala*) *dissimilis*, which is commonly found in certain parts of Kyushu and in China. According to Oda (*139*) the yield in the Kagoshima section in 1911 was reduced an average of 3 per cent, though in some years the loss is considerably greater. There are three broods per year, but during the latter part of the season these overlap considerably. The winter is passed in the mature larval or pupal stage in the soil. The first brood of moths appears early in May, and the eggs of these are deposited on the young plants in the seed bed and hatch in about one week. When feeding is complete the larva enters the soil to a depth of 2 or 3 inches, pupates within a cell, and emerges 15 days later, this being in the latter part of July. The third brood of moths appears about the middle of September. This insect is particularly abundant in the fields upon warm, sunny hillsides, and is rarely found in low, damp places or in the mountainous sections. The collection of adults by lantern traps and sugar baits, and the killing of the pupae by winter plowing are the control measures used.

The sweetpotato army worm, *Scotogramma trifolii* (*145*), is a serious pest in southern Japan and causes extensive defoliation. There are three broods a year, and the winter is passed as a pupa in the soil. Control is largely effected by the collection of adults at lantern traps and of the larvae by hand. Kerosene emulsion and pyrethrum powder are very effective against the first two larval stages.

The sweetpotato stem borer, *Omphisa anastomosalis* (*169*), occurs in Taiwan and China as a rather minor pest of sweetpotato. The eggs are laid singly on the leaf or petiole, and the larva bores into the roots and tubers, pupating in the burrow, which is filled with excrement.

The sphingid *Acherontia styx* (*114*) is a general pest of sweetpotato as well as other vegetables throughout Japan, Chosen, and Taiwan. Its distribution extends southward to the Malay Peninsula. The variety *crathis* is frequently found upon potato in Japan, but seldom in injurious numbers. It attacks various Solanaceae and *Sesamum indicum* as well. The adults are found from June to September, and the larvae slightly later, there being only one generation per year.

Another sphingid moth *Theretra oldenlandiae* (*96*) is common upon sweetpotatoes in Japan, Chosen, and China, though usually not causing serious injury. It also attacks the potato, beans, taro, and various cruciferous plants. The life cycle extends over a period of one year, and hibernation takes place in the pupal stage in the soil. The adults emerge in June and July, and the eggs are deposited singly on the undersides of the leaves. The mature larvae enter the soil for pupation in September.

The gelechiid *Brachmia triannuella* (*95*, *165*) is a common pest of sweetpotato in Japan, though usually not a serious one. There is one, and possibly a second, brood each year, and the winter is passed in the pupal stage in dead rolled leaves.

The well-known and widely distributed sweetpotato weevil, *Cylas formicarius* (*95*, *169*), is a serious pest in Taiwan, Okinawa, and China, but has not as yet been recorded from Japan proper. According to Fletcher this insect is the worst pest of the crop in India and is endemic in that country. In Taiwan seven generations are produced each year, and the winter is passed in the adult stage. These same habits characterize the species as recorded in other countries.

A chrysomelid, *Chrysochus chinensis*, is found in Miye, Tokushima, and Tochigi Prefectures in Japan proper as an important pest of sweetpotato and taro. It occurs also in Taiwan (*169*) and China. According to Takagi (*177*) there is one generation a year, the adults appearing in late June and early July. The eggs are laid just below the surface of the ground adjacent to the stem, and upon hatching the larvae bore into the roots. The infested potatoes may be recognized by the dark green color of the skin about the puncture at the point of entrance, by the bitter taste, and by a distinctive odor. The tunnel is filled with excrement. Pupation takes place in earthen cells outside the root, the duration of the pupal period being about two weeks.

According to Maki (*82*) the mirid bug *Halticus minutus*, a serious pest in India, is becoming abundant in the Pescadores Islands. It is a well-known pest in Japan and Taiwan also. There are several generations a year, and the leaves and stalks of peanut, melon, and cabbage are attacked, as well as sweetpotato. Wet seasons are particularly favorable to the development of the pest to the point of destructiveness.

INSECTS ATTACKING CABBAGE, RADISH, TURNIP, AND CARROT

The well-known cabbage worm, *Pieris rapae* (*149*), is very abundant throughout all Japan and Chosen, extending to China, Siberia, Europe, and North America. It is not recorded from Taiwan. In Hokkaido there are two or three generations each year. Where there

are only two generations the adults of the first appear in late April and early May, and those of the second the middle of July; whereas in localities producing three generations the adults of the second emerge slightly earlier than the date given above, and those of the third come in late August and early September. The larvae of the third generation particularly are heavily parasitized by *Apanteles rapae* Ash., and Uchida records two native ichneumonids attacking it. The variety *crucivora* is found in Japan, Chosen, China, etc., feeding on various Cruciferae. Its habits are very similar to those of the original species, though it is much less abundant.

Considerable damage may at times be caused to cabbage, radish, rape, and various other cruciferous plants throughout Japan and Chosen by *Evergestis extimalis* (*149*). The data on this species were given under the name of *Perynea subrosea* Butl., but Kuwayama advises that the determination was incorrect and that the name should be given as above. There are two broods each year, the moths of the first appearing in early June and those of the second late in July. The winter is passed by the mature larva in a whitish cocoon in the soil. Eggs are deposited by the females, shortly after emergence, on the undersides of the leaves. The immature stages of this generation cover a period of six or seven weeks. The young larvae make a web of special type, within which a number of them may congregate. In the case of rape and such other Cruciferae as are grown for seed the damage results from feeding upon blossom clusters. The second-generation larvae feed also upon such Cruciferae as are available in the field. These larvae are mature and enter the soil for hibernation at the end of September.

Arctia caia (*165*) is at times injurious to cabbage and rape in northeastern Honshu and Hokkaido. A single brood is produced each year, and the insects hibernate as immature larvae in rubbish on the ground. These larvae emerge and feed upon foliage in the spring, and pupate the middle of June among the leaves on the surface of the ground. The adults appear the following month.

The pyralid *Pionea forficalis* (*96*, *149*) is at times a serious pest of radish, turnip, and carrot in Japan. There are two broods annually. The insect hibernates in the mature larval stage in the soil. In northern Japan the adults appear in June and August, whereas in central Honshu they are found in May and September. The eggs are deposited on the undersides of the leaves or on the stem, and the larvae roll the leaves and feed upon the tissue of the underside. Pupation occurs in the soil.

The diamond-back moth, *Plutella maculipennis* (*149*), is an occasional serious pest of cabbage, radish, turnip, and other garden crops in Japan, Chosen, and Taiwan, but little is known regarding its life history.

The chrysomelid *Phaedon brassicae* (*95*) is a pest of radish and turnip in Honshu and Kyushu. There are three or four generations each year, and the winter is passed in the adult form in sheltered places.

Phaedon incertus is one of the serious pests of cruciferous vegetables in northern Japan, both larvae and adults contributing to the damage. It occurs also in Taiwan. Nozu and Sonoyama (*138*) have

recently published an extended account of this insect and its habits. Two or three generations are produced each year, and the winter is passed in the adult stage in sheltered places, hibernation beginning in December and extending to the following August. The eggs are laid singly upon the foliage in wounds made by the mandibles of the female beetles. Pupation occurs in the soil. The duration of the egg, larval, and pupal stages was found to average 14, 16, and 11 days, respectively. In the laboratory the females under observation produced an average of 1,244 eggs each.

Phyllotreta sinuata (*95*) is a major pest of radish and turnip in Taiwan and Japan, particularly in northwestern Honshu, and it attacks sugar beet and melons also. Four or five generations are produced annually, and the winter is passed in the adult stage in the soil, in rubbish or in other sheltered places. The first generation in the spring is found upon wild Cruciferae whereas the following ones attack the cultivated vegetables. The eggs are laid singly on the undersides of the leaves and hatch in about 10 days. The larvae mine the leaves and mature in about one week. The pupal period of approximately 15 days is passed in the soil. The injury inflicted is largely due to the feeding of the adult beetles and is noticeably increased during periods of dry weather. According to Takahashi (*185*) the larvae feed at the roots rather than mine the leaves, and this habit is also reported by Kuwayama (*78*), who states that the species has three generations each year in Hokkaido. Upon sugar beet the injury is confined largely to the feeding of the adults upon the foliage of seedlings and of the young plants in the field.

From the divergence in habit noted above it is evident that the same name is being applied to two distinct species. *P. sinuata* in North America and elsewhere is a leaf miner, and the root-feeding form here discussed must be of some other species.

In the sections under consideration, the turnip sawfly, *Athalia colibri* (*8*), occurs only in Chosen, but it extends to Siberia and Europe. It is a particular pest of turnip, but also feeds upon other Cruciferae. Two generations are produced each year, the first brood of adults appearing early in May and the second early in August. The eggs are laid beneath the epidermis of the under side of the leaf and hatch in from 7 to 10 days. The larval stage of both generations usually covers about two weeks and the pupal stage three weeks. The variety *japanensis* (*95*), which occurs in Hokkaido and Honshu, has a similar history, though the first-generation adults appear in June rather than May. The most common species upon Cruciferae, however, is *A. japonica* (*196*), which is found throughout Japan and Taiwan. The control method suggested is the knocking of the larvae from the plants into trays and destroying them.

Anthomyia flavopicta (*95*) is a common pest of radish and turnip in Japan. Three or four generations are produced each year, and the insect hibernates in the adult stage. The eggs are laid at the base of the plant and hatch in 10 days. The young larvae burrow into the roots, and their feeding is followed by the decay of the plant.

Eurydema pulchrum (*165*) feeds extensively upon the foliage of radish and turnip in Japan and Taiwan. There are two generations each year, the adults of which, in the vicinity of Tokyo, appear in May and June and September and October.

MELON INSECTS

The most common of the melon pests in Japan, Chosen, and Taiwan are the chrysomelid beetles *Rhaphidopalpa* (*Aulacophora*) *femoralis*, *R. foveicollis*, and *Ceratia* (*Orthaulaca*) *atripennis*. The first is found throughout Japan, except Hokkaido, and in Chosen and Taiwan and causes considerable damage to young cucumber and melon plants. It also was observed on several occasions in central Honshu to attack soybean in numbers. There is one generation a year, and the adults appear in the field largely during June. According to Shiraki (*169*) the two last-named species cause much damage to cucurbits in Taiwan, and the larvae of *R. foveicollis* occasionally bore into roots, causing the plant to wither and die. The most generally employed means of control is the covering of the young plant during the first few weeks of growth with a light cloth supported by a pair of arched bamboo sticks.

The melon fly, *Dacus cucurbitae* (*169*), is one of the major pests of various cucurbits in Taiwan and southern China and is particularly injurious during the latter part of the season. Its life history has not been studied in detail, but during the summer is probably very similar to that of the same insect in Hawaii where, according to Back and Pemberton, a generation covers a period of approximately six weeks during the coolest part of the year.

A species of melon fly (apparently *Chaetodacus* sp., not *D. cucurbitae*, according to Doctor Miyake) (*187*) is reported from Gifu Prefecture as occurring in pumpkin, but nothing further is known regarding it.

The mole cricket *Brachytrypes portentosus* (*169*) is of more importance as a melon pest than as a pest of any other of the numerous and varied plants which it attacks. In Taiwan it attacks chiefly young plants of nearly all kinds, and upon young melon plants in the coastal sections feeding is so extensive as to result in complete defoliation and the destruction of the crop over large areas. The nymphs and adults cut off large quantities of leaves and young shoots and carry them into the burrows. There is one generation a year, the adults appearing in May and June, and the females depositing their eggs in September. The eggs are laid from 1 to 2 feet below the surface of the ground and hatch in about one month. The young nymphs feed only at night, and the burrows into which they carry the collected foliage extend about 6 inches under the ground. Flooding is recommended as a control measure, but in orchards, cane fields, and tea gardens this is not practicable. Poison baits give satisfactory results, and sweetpotato has been found to be the most satisfactory carrier. The buds or young shoots of bamboo are even better for this purpose, but the difficulty of collecting a sufficient quantity makes their use impracticable.

STRAWBERRY INSECTS

The strawberry weevil, *Anthonomus signatus*, is of wide distribution in Japan and attacks wild rose in addition to strawberry. According to Kinoshita and Shinkai (*47*) a single generation is produced each year, and the winter is passed in the adult stage in sheltered places. The adults emerge in April and begin feeding upon the flower buds. The eggs are laid singly in holes made in the bud

with the rostrum. As with many other weevils an additional hole is usually made immediately below this, which, however, does not contain an egg. Oviposition extends over a period of about two months. The egg, larval, and pupal stages average 6, 22, and 6 days, respectively. The adults feed upon the young foliage to some extent following emergence, but they become dormant about June and continue so until the following season.

The chrysomelid *Galerucella distincta* (*185*) is a common pest of strawberry in central Japan. Three or four generations are produced each year, and the winter is passed in the mature larval stage among weeds bordering the gardens. The damage is due to the feeding of both larvae and adults upon the foliage.

MISCELLANEOUS TRUCK-CROP INSECTS

Of the insects attacking hop vines in northern Japan three may be mentioned as of some importance, these being *Psylliodes punctifrons*, *Pyrausta nubilalis*, and *Vanessa io geisha*. The well-known hop aphid, *Phorodon humili* (*77*), occurs in this section, but its feeding here is of minor importance as compared with the injury it does to the crop in western North America.

The weevil *Scepticus insularis* which is known primarily as a pest of sugar beet in Chosen, has become seriously injurious to peanut in Chiba Prefecture, Honshu (*44*). The loss to this crop in 1919 was estimated to be 17 per cent. In this section there is a single generation each year, the adults appearing in April and May and persisting until September. They feed upon the buds and fresh shoots of the young plants.

The hepialid moth *Palpifer sexnotatus* is, according to Maki (*86*), a serious pest of taro in Taiwan, 50 per cent of the crop often being damaged. Several broods are produced each year. Fumigation with carbon disulphide is suggested as a means of control.

The acarid mite *Rhizoglyphus echinopus* attacks various vegetables as well as bulbs, cereals, orchids, and grape. The nymphs bore into the tissue of bulbs, often causing decay, and into the roots of grape in greenhouses. According to Yagi (*203*), 10 generations are produced each year, the cycle during the summer being completed in from 10 to 20 days. This species is a serious pest in many countries. In Australia it is recorded as attacking many kinds of stored vegetables and fruits, and when the attack is upon growing roots and seedlings it usually results in the death of the affected parts.

Burdock (*Arctium lappa*) is grown generally in Japan as a vegetable, and its insect enemies are therefore of some importance. Those of most consequence are *Podisma pedestris sapporense*, *Macrosiphum gobonis*, and *Cleonus superciliosus*. According to Murata and Ikeda (*111*) the last-named species has a single generation each year, the adults passing the winter in sheltered places and emerging early in the spring. Oviposition occurs in May and June and the larvae bore into the roots. The egg, larval, and pupal stages cover 10, 50, and 9 days, respectively, and the adults go into hibernation almost immediately following emergence.

TEA INSECTS

According to Shiraki (*172*) and Sonan (*175*), the most injurious insects upon tea in Taiwan are *Andraca bipunctata*, *Euproctis con-*

spersa, *Adoxophyes privatana*, *Biston marginata*, *Clania variegata*, *Gracilaria theaevora*, *Homona menciana*, and *Chlorita flavescens* though about 50 species are recorded as attacking the plant, of which 15 may be considered as of major importance. Though tea is also an important crop in Japan, most of the information regarding the insects which attack it is presented in publications from Taiwan.

The damage to tea by various insect pests consists not only in direct physical injury to the plant, but also in a damaging of the quality of the young foliage which is plucked for manufacture into the tea of commerce. With certain of the pests, considerable damage may be done even though the insects are relatively few. The sucking insects in general are of more consequence than upon other plants, owing to the fungus growth which develops in the honeydew and excrement deposited by many of them. A number of the lepidopterous species inflict injury out of proportion to their numbers by inclosing a shoot or even an entire branch in a silken web, and the amount of foliage actually eaten may be very small compared with that rendered unfit for use by the web.

LIST OF TEA INSECTS

	Distribution[1]
DIPTERA	
Chloropidae:	
Oscinis theae Lef.	F.
LEPIDOPTERA	
Syntomidae:	
Amata perixanthia Hamp.	F.
Lymantriidae:	
Dasychira dudgeoni Swinh.	F.
Dasychira mendosa Hübn.	F.
Euproctis conspersa Butl.	J. F.
Euproctis latifascia postica Wlk	F. C.
Euproctis montis Leech	F. C.
Euproctis varians Wlk.	F. C.
Redoa cygna Moore	F.
Bombycidae:	
Andraca bipunctata Wlk.	F. C.
Limacodidae:	
Cania bilinea Wlk.	F. C.
Nagoda nigricans Moore	F.
Narosa nitobei Shir.	F.
Orthocraspeda trima Moore	F.
Setora nitens Wlk.	F.
Thosea sinensis Wlk.	K. F. C.
Gracilariidae:	
Gracilaria theaevora Wlsm.	J. F.
Noctuidae:	
Tiracola plagiata Wlk.	F. C.
Drepanidae:	
Oreta theae Mats.	F.
Geometridae:	
Biston marginata Mats.	F.
Boarmia theae Mats.	J.
Gonodontis obliquaria Moore	J.
Jankowskia fuscaria Leech	J.
Lycia robustum Butl.	J.
Megabiston plumosaria Leech	J.
Psychidae:	
Clania destructor Dudg.	F.
Clania variegata Snell.	J. F. C.
Xyloryctidae:	
Acria gossypiella Shir.	F.
Tortricidae:	
Adoxophyes fasciata Wlsm.	F.
Adoxophyes privatana Wlk.	K. F. C.
Homona menciana Wlk.	J. F. C.
Cossidae:	
Zeuzera coffeae Nietn.	F.
COLEOPTERA	
Cerambycidae:	
Aeolesthes induta Newm.	F.
HEMIPTERA	
Miridae:	
Helopeltis cinchonae Mann.	F.
Helopeltis fasciaticollis Popp.	F.
Helopeltis pallidus Popp.	F.
Cicadellidae:	
Chlorita flavescens Fabr.	J. K. F. C. O.
Parabolocratus okinawensis Mats.	F. O.
Penthimia theae Mats.	F.
Fulgoridae:	
Ricania simulans japonica Melich.	J. F.
Aphiidae:	
Toxoptera aurantii Boyer	J. F.
Coccidae:	
Ceroplastes ceriferus And.	J. F. C.
Ceroplastes floridensis Comst.	J. F.
Ceroplastes rubens Mask.	J. F. C.
Fiorinia fioriniae Targ.	J. F. C.
Hemichionaspis aspidistrae Sign	J.
Hemichionaspis theae Mask.	J. F.
Lepidosaphes camelliae Hoke	J.
Lepidosaphes kamakurensis Kuw.	J.
Parlatoria pergandii Comst.	J. F. C.
Parlatoria theae Ckll.	J.
Phenacoccus pergandei Ckll.	J.
Pseudaonidia paeoniae Ckll.	J. F.
ISOPTERA	
Rhinotermitidae:	
Leucotermes speratus Kolbe	J. K. F. O.
Termitidae:	
Termes formosanus Shir.	F. C. O.
ORTHOPTERA	
Gryllidae:	
Brachytrypes portentosus Licht.	K. F. C.
ACARINA	
Eriophyidae:	
Tetranychus sp.	J. F.

[1] Distribution symbols as follows: J., Japan; K., Chosen (Korea); F., Taiwan (Formosa); C., China; and O., Okinawa (Loo-Choo or Riukiu Islands).

DISCUSSION OF THE TEA INSECTS

The bombycid *Andraca bipunctata* (*172*) is a well-known pest of tea and is now distributed throughout Taiwan. It extends also to China, the Dutch East Indies, and India, in the last-named country being a very serious pest in the extensive tea-growing sections of Assam. In Taiwan there are three broods a year, and the short winter period is passed in the pupal stage, the cocoons being found among rubbish on the ground or in protected places on the stem of the plant. The adults of the first brood appear in late February and March, those of the second in May, and those of the third from late August to October. A curious condition commented on by Shiraki is that the early adults of this last generation, those emerging during August and September, never produce eggs, the species being perpetuated solely by the late-appearing individuals. The eggs are laid in compact clusters of from 15 to 72 in a single layer upon the under sides of the leaves, each female depositing a total of from 50 to 150.

The eggs hatch in from 8 to 10 days, and the young larvae, which are very gregarious, begin feeding upon the foliage. They feed during the night, the younger stages resting during the day on the under sides of leaves, while the more mature ones rest on the twigs. In the early stages only the lower epidermis is eaten, but later feeding is at the leaf margin, and the bushes are often completely stripped. The larvae are most abundant and injurious during May, June, and July. The larvae of the second brood, which are active during June and July, are attacked very seriously by several undetermined bacterial diseases and a tachinid fly, and the combined effect of these is often sufficient to cause the almost complete disappearance of the insect at this time. When this does not occur extensive areas are completely defoliated, the yield being consequently greatly reduced, and with such defoliation for two successive years the bushes wither and may die. The most effectual method of control is the collection by hand of the larvae of the first brood, and this practice is quite general in the tea gardens.

Euproctis conspersa (*172*), which is found in all the tea-growing sections of Taiwan and in Japan, often causes complete defoliation. In the early stages feeding is upon the lower epidermis only, but after the third molt the entire leaf tissue except the midrib and main veins is consumed. There are two color forms among the larvae and adult males. The generations overlap considerably, but the general life cycle covers a period of about two months. The eggs are laid on the under side of the leaf in the same manner as by other lymantriids, and these hatch in about 10 days. The newly hatched larvae are gregarious, but become solitary in habit when more mature. The only method of control thus far practiced is the hand picking of egg clusters and larvae.

Homona menciana (*172*), at times very destructive in Taiwan and occurring also in Japan and China, occasionally causes losses amounting to more than 50 per cent of the crop, the greater part of the damage being done during February and March. The outbreaks are sporadic, though heavy infestations occur every year in one or more sections, and in some localities there is great loss year after year. The web formed by the larvae may inclose an entire shoot, thus rendering it unfit for plucking. One month is required

for the completion of the life cycle in the summer and six weeks in the winter. The eggs are laid in masses of 200 or more on the upper sides of the leaves. The newly hatched larvae feed upon the epidermis, but shortly inclose a number of leaves in the light web and feed upon these and the buds. As development proceeds the web is enlarged, and often every shoot in the garden is inclosed. Pupation takes place within a folded leaf. Control is effected by the collection of egg masses during the early winter and the removal of all twisted leaves containing larvae and pupae. The first method of control is the most effective, and the second must be undertaken in the early stages of the attack when only relatively few of the shoots are involved. This species is recorded by H. C. Woodworth as a minor pest of cotton in the Philippines.

Another tortricid which occasionally causes severe injury is *Adoxophyes fasciata.* Its life history is nearly identical with that given for the preceding species.

The red coffee borer, *Zeuzera coffeae* (*172*), is recorded from Taiwan upon tea, but only a little information is available regarding its habits. Upon other hosts the larvae bore in the trunk and branches, and pupation occurs in a cell near the surface of the bark. According to Shiraki this is the species referred to in early literature as *Z. pyrina.*

The tea leaf roller, *Gracilaria theaevora* (*31*, *175*), is a common pest in Taiwan and is recorded also from Japan. It is one of the most injurious of the insects attacking tea in Java. The eggs are laid singly upon the leaves, and the young larvae mine the leaf tissue. When partially grown they emerge from the mine and roll the leaves, after which feeding is external. Pupation occurs in a cocoon on the lower surface of the leaf.

The geometrid *Biston marginata* (*172*) is found most commonly in the field during April, and in the northern part of Taiwan complete defoliation of entire plantations often occurs at that season. Though tea is extensively attacked, the preferred food plant is acacia. Because of the size of the larvae only a few are required to strip a bush entirely of its foliage. There is one brood each year, and the winter is passed in the pupal stage in the soil. The eggs are laid en masse upon the trunk or branches during March, and the larvae feed until May. Control is easily effected by the destruction of the adult moths and the egg clusters during the early spring.

In Japan the most common of the geometrids is *Jankowskia fuscaria* (*30*), which is at times a serious pest. The eggs of this and certain other species of the family are laid under the bark of pine trees adjoining the tea gardens, and the larvae migrate to the tea bushes. For control, spraying against the young larvae with insect powder and soap solution is recommended.

The two species of Psychidae listed, *Clania variegata* and *C. destructor* (*169*, *172*), are widely distributed in Taiwan and at times appear in great abundance, the entire crop in some cases being lost. *C. variegata* occurs in Japan also. Its preferred host plant, aside from tea, is the acacia. There is one brood a year, and the adults are found only in the early spring. From 40 to 150 eggs are laid by the wingless female in its case, and these hatch in from two to three weeks. The larval case is composed largely of bits of leaves,

with occasionally a few twigs. The habit of *C. destructor* is quite similar to that of *variegata*, but the larval case can be readily recognized by the fact that it is largely composed of twigs rather than leaves. In India this species is most destructive, particularly in the Darjeeling areas. When control is necessary the hand picking of the cases containing the pupae is resorted to during the winter, though when the attack is exceptionally heavy the bushes are trimmed nearly to the ground and the branches destroyed by burning.

The remaining Lepidoptera listed may be considered as minor pests and are of consequence only in occasional isolated outbreaks.

The mole cricket *Brachytrypes portentosus* (*169*, *172*) is particularly injurious to young plants, as the newly developed leaves and shoots are destroyed, thus affecting the growth of the bush. In the tea gardens the pest is controlled by the use of poison baits, sweetpotato serving as the poison carrier.

The most serious of the termite species attacking tea in Taiwan is *Termes* (*Cyclotermes*) *formosanus* (*133*, *169*, *172*). It is injurious to many fruit and field crops as well. It ranges in distribution from Okinawa to Taiwan, China, and the Malay Peninsula. The central nest is from 6 inches to 10 feet underground, depending upon the nature of the soil, and is connected with others by long, narrow galleries often extending as far as 500 feet. Damage to tea bushes is often quite extensive, nearly the whole of the plant being plastered over by mud, causing it to wither badly. Control is effected by the destruction of the central nest, though the process of locating it and digging it out is difficult and laborious.

Leucotermes (*Reticulitermes*) *speratus* (*172*), which occurs in Japan, Chosen, Taiwan, and Okinawa is much less injurious than the above species.

The leaf hoppers upon tea in Taiwan are represented by *Chlorita flavescens*, *Parabolocratus okinawensis*, and *Penthimia theae*. The first named occurs upon many fruit trees and field crops as well, and its distribution is general from Japan to India, where it is at times injurious. The period of greatest abundance and injury is during May and June, and the loss sustained in localized areas amounts to from 30 to 40 per cent of the crop. The quality, however, of tea produced from bushes attacked by this insect is said to be superior.

Of the mirid bugs *Helopeltis fasciaticollis* and *H. cinchonae* are the most common in Taiwan, but rank only as minor pests. An extended account of the first-named species is given by Sonan (*175*). They deposit honeydew upon the foliage, rendering it unfit for use, and severe attacks cause extensive wilting and discoloration of the young foliage, this being attributed by Sonan to the acidity of the insect's saliva. The favored host plants of *fasciaticollis* are tea and Gordonia, but it is found upon many other plants as well. All stages are found throughout the season, and from four to eight generations are produced each year. *H. cinchonae* does only slight damage to tea and is of more importance upon other crops. Another species of the genus, *H. theivora* Waterh., is the destructive "tea mosquito bug" of India.

Among the Coccidae probably the most injurious in Japan is the ruby wax scale, *Ceroplastes rubens* (*66*), heavy infestations of which have been observed by the writer in Kyushu. This is a pest of com-

paratively recent introduction and is especially destructive to citrus. Its effect upon tea is to produce a growth of sooty-mold fungus on the foliage, thus rendering it unfit for plucking. *C. floridensis* was noted quite commonly on tea in several localities in Honshu, but the infestations were of very limited extent. *Pseudaonidia paeoniae* is at times a serious pest in certain sections of Honshu.

FOREST INSECTS

LIST OF FOREST INSECTS

	Distribution [1]	Trees
HYMENOPTERA		
Xiphydriidae:		
Xiphydria eborata Konow	J.	Pine, fir.
Siricidae:		Do.
Sirex antennatus Marl	J.	
Sirex japonicus Smith	J.	Pine, fir, Cryptomeria.
Sirex matsumurae Rohw	J.	Pine, fir.
Tremex similis Marl	J.	Do.
Diprionidae:		
Diprion basalis Mats	J. K. C.	Pine.
Diprion japonicus Marl	J.	Do.
Diprion nipponica Rohw	J.	Pine, larch.
Tenthredinidae:		
Eriocampa mitsukurii Rohw	J.	Black alder.
Trichiocampus populi Okam	J.	Poplar.
Eurytomidae:		
Aiolomorphus rhopaloides Wlk	J. C.	Bamboo.
Eurytoma laricis Yano	J.	Larch, arborvitae.
Harmolita phyllostachites Gahan	J.	Bamboo.
Callimomidae:		
Callimome tsugae Yano	J.	Hemlock.
Megastigmus borriesi Crosby	J.	Fir.
Megastigmus cryptomeriae Yano	J.	Cryptomeria, cedar.
Megastigmus inamurae Yano	J.	Arborvitae.
Megastigmus thuyopsis Yano	J.	Do.
DIPTERA		
Trypetidae:		
Acroceratitis plumosa Hendel	F.	Bamboo.
Gastrozona macquarti Hendel	F.	Do.
LEPIDOPTERA		
Papilionidae:		
Papilio saperdon L	J. K. F. C. O.	Camphor.
Satyridae:		
Melanitis leda L	J. F.	Bamboo.
Lycaenidae:		
Thecla w-album Knoch	J.	Alder, elm, maple.
Zephyrus enthea Jans	J.	Walnut.
Sphingidae:		
Hyloicus caligineus Butl	J.	Pine.
Marumba sperchius Men	J. O.	Oak.
Saturniidae:		
Dictyoploca japonica Butl	J. F.	Oak, chestnut, camphor.
Arctiidae:		
Diacrisia infernalis Butl	J.	Oak, birch, camphor.
Hypsidae:		
Camptoloma interiorata Wlk	J. C.	Oak.
Noctuidae:		
Acronycta incretata Hamp	J. K. C.	Willow.
Acronycta leporina leporella Staud	J.	Birch, poplar.
Oligia vulgaris Butl	J. C.	Bamboo.
Notodontidae:		
Cerura lanigera Butl	J. K.	Poplar, willow.
Dicranura erminia menciana Moore	J. K. C.	Do.
Dicranura vinula felina Butl	J. F. C.	Do.
Drymonia manleyi Leech	J. K.	Oak.
Melalopha anastomosis L	J. K. C.	Poplar, willow.
Stauropus perdix Moore	J.	Oak, birch, chestnut.
Lymantriidae:		
Arctornis chrysorrhoea L	J. K. C.	Oak.
Dasychira pseudabietis Butl	J.	Cryptomeria.
Dasychira pudibunda L	J. K. F. C.	Oak, birch, walnut, poplar, willow.
Lymantria furva Leech	J.	Juniper.

[1] Distribution symbols as follows: J., Japan; K., Chosen (Korea); F., Taiwan (Formosa); C., China; and O., Okinawa (Loo-choo or Riukiu Islands).

List of forest insects—Continued

	Distribution	Trees
LEPIDOPTERA—continued		
Lymantriidae—Continued		
Nygmia flava Brem	J. K. C.	Oak, chestnut, beech.
Porthetria dispar L	J. K. C.	Pine, oak, chestnut, larch, Cryptomeria, elm, poplar.
Porthetria dispar japonica Motsch	J.	Oak, larch, poplar.
Porthetria mathura Moore	J. K. C.	Pine, oak, Abelicea.
Stilpnotia salicis L	J. K. C.	Poplar, willow.
Lasiocampidae:		
Cosmotriche albomaculata Brem	J. K. C.	Bamboo.
Cosmotriche potatoria L	J. K. C.	Bamboo, reeds.
Dendrolimus albolineatus Mats	J.	Pine, fir, larch, spruce.
Dendrolimus spectabiliis Butl	J. K. C.	Oak, pine.
Dendrolimus superans Butl	J.	Pine, spruce, fir.
Dendrolimus undans excellens Butl	J. K. F. C.	Oak.
Kunugia yamadai Nagano	J.	Do.
Malacosoma neustria testacea Motsch	J. K. C.	Oak, birch.
Odonestis pruni L	J. K. C.	Oak.
Drepanidae:		
Callidrepana japonica Moore	J.	Do.
Macrauzata fenestraria Moore	J.	Do.
Oreta calida Butl	J.	Viburnum.
Geometridae:		
Abraxas sylvata miranda Butl	J.	Elm, poplar, willow.
Biston marginata Mats	F.	Acacia.
Zethenia rufescentaria Motsch	J.	Cryptomeria.
Psychidae:		
Clania variegata Snell	J. F. C.	Camphor, acacia.
Fumea niponica Hori	J.	Pine.
Pyralidae:		
Dichocrocis punctiferalis Guen	J. K. F. C.	Chestnut.
Pyrausta coclesalis Wlk	J.	Bamboo.
Xyloryctidae:		
Acria gossypiella Shir	F.	Camphor.
Tortricidae:		
Cacoecia xylosteana L	J. K. F. C.	Oak, poplar, willow.
Pandemis heparana Schiff	J.	Oak, willow.
Coleophoridae:		
Coleophora laricella Hübn	J.	Larch.
Gracilariidae:		
Gracilaria azaleella Brants	J.	Azalea.
Hepialidae:		
Phassus camphorae Sasaki	J.	Camphor.
COLEOPTERA		
Buprestidae:		
Agrilus spinipennis Lew	J.	Elm, Zelkowa.
Chalcophora japonica Gory	J. F. O.	Pine, oak.
Chrysobothris succedanea Saund	J.	Oak, maple.
Chrysochroa elegans Thunb	J. O.	Oak, pine.
Chrysoderma amabilis Voll	J.	Pine.
Dicerca aino Lewis	J.	Fir.
Trachys griseifasciata Saund	J.	Zelkowa.
Bostrichidae:		
Dinoderus japonicus Lesne	J.	Bamboo.
Dinoderus tsugae Mats	J.	Fir, cypress, Cryptomeria, hemlock.
Sinoxylon japonicum Lesne	J.	Oak.
Scarabaeidae:		
Heptophylla picea Motsch	J.	Forest seed beds.
Maladera orientalis Motsch	J. K. C.	Larch, poplar.
Melolontha japonica Burm	J.	Forest seed beds.
Popillia japonica Newm	J.	Oak, chestnut, poplar.
Cerambycidae:		
Aegosoma sinica White	J.	Poplar, willow.
Asemum amurense Kraatz	J.	Timber.
Batocera lineolata Chevr	J.	Oak.
Chlorophorus annualaris L	J.	Bamboo.
Chloropisca figuratus latifasciatus Fisch	J.	Do.
Criocephalus rusticus L	J.	Pine, Cryptomeria, cypress.
Dere thoracica White	J.	Oak.
Distenia gracilis Bless	J.	Pine, fir.
Leptura succedanea Lew	J.	Alder.
Mallambyx japonicus Bates	J.	Oak, chestnut.
Megasemum quadricostulatum Kraatz	J.	Fresh timber.
Melanauster chinensis Först	J. K. F. C. O.	Willow, Casuarina.
Mesosa japonica Bates	J.	Elm.
Monochamus tesserula White	F.	Pine.
Niphona furcata Bates	J.	Bamboo.
Prionus insularis Motsch	J.	Pine, elm, Cryptomeria.
Pyrestes sp	J.	Camphor.

List of forest insects—Continued

	Distribution	Trees
COLEOPTERA—continued		
Cerambycidae—Continued		
Rosalia batesi Har	J.	Walnut.
Semanotus rufipennis Motsch	J.	Cryptomeria.
Spondylis buprestoides L	J.	Pine, fir, Cryptomeria.
Stenygrinum 4-notatum Bates	J.	Oak, chestnut.
Sternoplistes temmincki Guer	J.	Bamboo.
Sympiezocera japonica Lac	J.	Cryptomeria.
Chrysomelidae:		
Galerucella maculicollis Motsch	J.	Elm.
Melasoma aenea L	J.	Poplar.
Melasoma populi L	J.	Do.
Nodostoma sp	J.	Pine, cypress, Cryptomeria.
Plagiodera versicolora distincta Baly	J. K.	Willow.
Curculionidae:		
Attelabus jekeli Roel	J.	Oak, chestnut.
Curculio camelliae Roel	J.	Do.
Curculio dentipes Roel	J.	Do.
Cyrtotrachelus longimanus F	F.	Bamboo.
Hylotius abietis L	J. K.	Pine, spruce.
Hylobius macilentus Bohem	J.	Camphor.
Hylobius perforatus Roel	J.	Pine, spruce, fir.
Phyllobius japonicus Faust	J.	Cryptomeria.
Pissodes nitidus Roel	J.	Pine, larch.
Rhynchaenus excellens Roel	J.	Oak.
Sipalus gigas L	J.	Oak, chestnut, elm.
Scolytidae:		
Crossotarsus externedentus Fairm	J. F.	Camphor, Melia.
Crossotarsus rengetensis M. and N	J.	Camphor.
Crossotarsus sp	J.	Oak.
Cryphalus cryptomeriae Niis	J.	Cryptomeria.
Cryphalus satonis Mats	J.	Bamboo.
Myelophilus minor Htg	J.	Pine, fir, larch.
Myelophilus piniperda L	J.	Do.
Platypus lepidus formosanus M. and N	F.	Camphor.
Polygraphus jesoensis Niis	J.	
Scolytus esuriens Blandf	J.	Elm.
Xyleborus apicalis Blandf	J.	Elm, alder.
Xyleborus mutilatus Blandf	J.	Camphor.
HEMIPTERA		
Coreidae:		
Notobitus meleagris F	F.	Bamboo.
Pyrrhocoridae:		
Dysdercus cingulatus Fab	F. C. O.	Paulownia.
Tingitidae:		
Stephanitis azaleae Horv	J.	Azalea.
Stephanitis pyrioides Scott	J.	Do.
Cicadellidae:		
Parabolocratus guttatus Uhl	J. F.	Camphor.
Chermidae:		
Mesohomotoma camphorae Kuway	F.	Do.
Trioza camphorae Sasaki	J. F. C.	Do.
Aphiidae:		
Eriosoma japonica Mats	J.	Elm.
Kurisakia juglandicola Takah	J.	Walnut.
Aleyrodidae:		
Aleurocanthus spinosus Kuw	F.	Camphor.
Aleurodes azaleae Baker	J.	Azalea.
Coccidae:		
Aspidiotus perniciosus Comst	J. K. C.	Walnut, birch.
Asterolecanium bambusae Bdv	J. F.	Bamboo.
Ceroplastes rubens Mask	J. F. C.	Camphor, maple.
Drosicha corpulenta Kuw	J.	Oak, chestnut, Pasania.
Fiorinia fioriniae Targ	J. C.	Pine, elm, silk oak.
Fiorinia japonica Kuw	J.	Pine, fir, Podocarpus.
Gossyparia spuria Mod	J.	Elm.
Kermes miyasakii Kuw	J.	Oak.
Kermes nakagawae Kuw	J.	Do.
Lepidosaphes crawii Ckll	J.	Do.
Lepidosaphes pallida Green	J. F	Oak, juniper, Cryptomeria, Podocarpus.
Lepidosaphes ulmi L	J.	Willow, hawthorn.
Parlatoria proteus Curt	J. F. C.	Pine.
Parlatoria theae Ckll	J.	Maple, Podocarpus.
Phenacoccus azaleae Kuw	J.	Azalea.
Phenacoccus pergandei Ckll	J.	Oak, camphor, laurel.
Poliaspis pini Mask	J.	Pine, Podocarpus.
Pseudaonidia duplex Ckll	. F.	Camphor, Camellia, azalea.
Pulvinaria horii Kuw	J.	Maple.
Xylococcus napiformis Kuw	J.	Oak.

List of forest insects—Continued

	Distribution	Trees
THYSANOPTERA		
Liothrips floridensis Wats	F.	Camphor.
Liothrips setinodis Reut	J.	Do.
Phloeothrips nigra Sasaki	J.	Do.
ISOPTERA		
Rhinotermitidae:		
Coptotermes formosanus Shir	J. F. C.	Timber.
Leucotermes flaviceps Osh	F.	Do.
Leucotermes speratus Kolbe	J. K. F. O.	Timber, bamboo.
Termitidae:		
Termes formosanus Shir	F. C. O.	Camphor, Cryptomeria, pine, bamboo, timber.
ORTHOPTERA		
Gryllidae:		
Brachytrypes portentosus Licht	K. F. C.	Camphor, Cryptomeria, acacia.

INSECTS ATTACKING PINE

The various species of pine are the trees of most common occurrence in the forests of Japan, and a number of insects are present upon them which at times inflict serious injury. Among these may be mentioned the two lasiocampids *Dendrolimus spectabilis* (often referred to in literature as *D. remota* Wlk.) and *D. albolineatus*. The first named is distributed throughout the main islands of Japan, and through Chosen, Manchuria, and Siberia. In Chosen (*8*) particularly the trees are frequently completely stripped of foliage. In Japan the species is seldom sufficiently abundant to produce this effect. There is one brood per year, and the winter is passed in a half-grown larval condition in rubbish and grass, or just beneath the surface of the soil, about the base of the tree. These larvae ascend the trees and begin feeding about the middle of April; maturity is reached in June, and the cocoon is spun among foliage, on the trunk of the tree, or on weeds or grass stems near by. The duration of the pupal stage is about 20 days, and the adult emerges toward the end of July. The eggs are laid shortly thereafter in rows or irregular masses upon the foliage, and hatch in about two weeks. The larvae feed from the time of hatching until October, when they descend for hibernation. Occasionally two broods per year are produced (*117*). Effective control measures are not as yet known, though in certain cases of severe infestation hand picking of the larvae has been resorted to.

The second species, *D. albolineatus*, has come into prominence only during recent years in connection with outbreaks in Hokkaido and Sakhalin. Its distribution ranges from Sakhalin to Hokkaido and the Kurile Islands. This species was originally determined as *D. sibiricus*, but according to Matsumura the range of that species does not extend to Hokkaido. The damage in all of these places has been very great during recent years. In 1920 an area of 86,000 acres was almost completely defoliated in Sakhalin. The preferred hosts in that section were *Abies sachalinensis* and *Picea ajanensis*, and upon these trees defoliation was complete. An account of this infestation was published by Kuwayama and Kuwahara (*79*) in 1922. They attribute the outbreak to climatic changes, these seasons

having been characterized by unusually high temperatures and a lack of rainfall, conditions apparently favorable to the development of the insect. There is one brood a year, though according to Aizawa (*4*) some larvae carry over for two winters. The adult moths appear during July and August, and the winter is passed in the half-grown larval stage in the same manner as by *D. spectabilis*.

Dendrolimus superans is found only in Honshu and is a pest of fir and occasionally of pine. There is one brood, but at times two, each year. The winter is passed in the early larval stages. Where there is only one brood the adults appear in late August and September, but where there are two the first adults appear in June, and they are then present in greater or smaller numbers throughout the season until October.

Two Scolytidae, *Myelophilus minor*, the well-known lesser pine-shoot beetle of Europe, and *M. piniperda*, the large pine beetle, are found primarily upon pine. According to Yano (*207*) the first-named is so abundant as often to cause the death of trees in Japan. There are probably three generations per year. The second species is common on the island of Honshu. It tunnels under the bark of the branches, and the newly emerged adults bore into the pith of the young shoots.

A number of species of sawflies attack pine in various sections, the most common one being *Diprion basalis* (*8*, *207*). This species ranges in distribution over Japan, Chosen, Manchuria, and China. In central Japan two broods are produced each year, whereas in Chosen there is only one. This pest causes considerable damage in Japan from April to August. The eggs are laid in rows in incisions in the leaves. The larvae are gregarious in habit and strip the foliage from one branch before moving to the next. In Chosen particularly the young trees are seriously damaged. The larvae are black and, when assembled in large numbers upon a single twig or branch, are very conspicuous. The winter is passed in the mature larval condition in a cocoon in the soil.

The most common of the scale insects found on pine trees is *Poliaspis pini*, but none of those mentioned as occurring upon pine are sufficiently abundant to cause noticeable injury.

INSECTS ATTACKING OAK

Among the insects attacking oak those of most importance are *Porthetria* (*Lymantria*) *dispar*, *P. mathura*, *Drymonia manleyi*, and the scale insects *Kermes nakagawae* and *K. miyasakii*.

The gipsy moth, *Porthetria dispar*, is a common pest of oak and various other forest trees, particularly larch and poplar, in Hokkaido and Chosen, and attacks also apple, pear, cherry, and other related fruit trees. In Japan proper this species is restricted to the island of Hokkaido, but according to the various entomologists in that section the periods of abundance of the gipsy moth occur approximately only every five years, and it is only during these periods that injury is produced. According to Okamoto (*149*) the eggs hatch early in May, and the adults are present from the middle of July to the end of August. In that section the larval stages cover a period of from 7 to 8 weeks, and the pupal stage about 18 days. The egg masses contain only from 150 to 350 eggs, a much

smaller number than is recorded for the eastern part of the United States. The egg parasite *Anastatus bifasciatus* is particularly abundant in Hokkaido.

In Chosen the adults emerge somewhat earlier than in Hokkaido, usually during the last week of June, owing to the higher temperatures prevailing there during the late spring and early summer. At times this species becomes very abundant upon apple; and some measure of control is necessary, this usually consisting of the collection of egg masses during the winter.

In Honshu and Kyushu the variety *japonica*, considered by some authors to be a distinct species, replaces *P. dispar*. It is commonly found upon oak, larch, and poplar, and in occasional instances has been noted to effect complete defoliation in small plantings of the last-named tree. In general, however, it is of little consequence as a pest.

P. mathura (*130*) is of common occurrence upon various trees, particularly oak, in northern and central Japan, being especially abundant in northern Honshu. It occurs also in Chosen and China. A single brood is produced each year, and the winter is passed in the egg stage upon the trunks of the host trees. The eggs hatch in May, and the larvae are mature by the end of July. The adults first appear early in August and persist for about one month.

Drymonia manleyi (*8*) is found commonly in Japan and Chosen upon various species of oak. One brood per year is produced, and the adults appear about the middle of October. The eggs are laid in large irregular masses upon the twigs, and these carry over the winter and hatch about the middle of May. The larvae are mature in one month, and pupation takes place in the soil.

The hypsid *Camptoloma interiorata* (*197*), recorded from Japan and China, occurs upon a number of forest trees in addition to oak. The adults emerge in June and July, and the larvae feed upon the lower surface of the leaves, covering them with a web. Hibernation is in the larval stage under the web on the trunk or branches, 200 or more larvae being inclosed by one web. These larvae pupate at the end of May among fallen leaves or rubbish on the ground.

Dendrolimus undans excellens (*117*) is found upon oak in Honshu only, of the main islands of Japan, but it ranges to Chosen, China, Siberia, Taiwan, and India. One brood is produced annually, the adults of which appear in October and November. The eggs are deposited upon the trunk of the tree, and in this stage the winter is passed. The eggs hatch in May, and the larvae are mature by the middle of August. The cocoon is spun in a folded leaf.

Kunugia yamadai (*117*) is found upon various species of oak and only in Honshu. There is but one brood each year, and the winter is passed in the egg stage upon the trunk. The life cycle and habits are practically identical with those of *D. undans excellens* except that the larvae feed nocturnally, and rest upon the trunk during the day.

The two scale insects *Kermes nakagawae* and *K. miyasakii* are particularly abundant in central and southwestern Honshu, where the trunks and larger branches are often heavily encrusted with scales each year. An undetermined species is common upon oak in Chosen.

The monophlebine coccid *Drosicha* (*Warajicoccus*) *corpulenta* (*64*) is a common pest of oak, chestnut, and *Pasania* spp. in central Japan. There is a single brood each year, the eggs being laid in rubbish beneath the tree in May and June and hatching in early December. In the spring of some years the adult females may be observed in large numbers upon the trunk and larger branches of the host plants. They are very conspicuous because of their unusual size, as they often attain a length of 16 millimeters.

INSECTS ATTACKING CHESTNUT

Among the Lepidoptera the species most frequently found upon chestnut are *Nygmia flava*, *Dichocrocis punctiferalis*, *Dictyoploca* (*Caligula*) *japonica*, and *Stauropus* (*Quadricalcarifera*) *perdix*. The only one of these of any consequence is *D. punctiferalis*, which has already been discussed (p. 27) as a pest of peach and cherry.

Of the beetles attacking this host the most important from the commercial point of view are the various species of weevils which infest the nuts. *Curculio* (*Balaninus*) *dentipes* (*95*) is the most serious of these and in some sections attacks a large portion of the nuts. One brood is produced each year, and the winter is passed in the mature larval stage in the soil. The adult beetles appear in June and July, and the eggs are deposited in holes eaten into the bur. When mature, the larvae leave the nuts and enter the soil. *C. camelliae* (*184*) and *Attelabus jekeli* are also at times quite serious pests, the former having a life history identical with that of *C. dentipes*.

The cerambycid *Stenygrinum 4-notatum* is frequently found in Japan boring in the trunk and larger branches. During June and July the adult beetles of *Popillia japonica* feed quite extensively upon the blossom clusters, and occasionally *Drosicha corpulenta* may be seen in fairly large numbers upon the trunk and branches.

INSECTS ATTACKING CAMPHOR TREES

The most important pest of camphor in Japan is the chermid *Trioza camphorae* (*161*, *163*) which ranges in distribution from Honshu, Shikoku, and Kyushu in Japan proper, to Taiwan and China. It was first referred to in literature under the above name by Sasaki in 1905, but was not described until five years later. This pest is found on practically every camphor tree within its range, and in many cases causes serious injury. There is one brood a year, and the winter is passed in the pupal stage within the gall on the leaf. The most serious injury occurs on young trees, and growth may be retarded to a considerable extent, or in severe cases the tree may be killed. In practically all instances the attack is limited to those portions of the trees within 10 feet of the ground, as the powers of flight of the adult female are relatively weak. The adults appear during April and May, being most abundant during April. Dispersion is largely brought about by the wind. A short time after emergence oviposition is begun, and during this period the adults are often present in clouds about the trees. The eggs are laid singly or in small groups on the under sides of the leaves and hatch within

a few days. The gall begins to form after the first molt, and grows to from 2 to 3 millimeters in diameter when mature. An excessive number of galls on a single leaf causes it to fall from the tree. Pupation occurs within the gall during late June and early July.

An allied species, *Mesohomotoma camphorae*, is reported to be abundant in Taiwan and the Bonin Islands, but no further information is available regarding it.

Aside from the Chermidae mentioned, probably the most common of the sap feeding pests are the thrips, of which two, *Phloeothrips nigra* and *Liothrips setinodis*, are of frequent occurrence in southern Japan. These are found largely upon the buds and younger foliage, and the effect is similar to that produced by thrips on other plants.

Hitoka has recently reported from Kyushu a cerambycid (*Pyrestes* sp.) which bores into the branches of the younger camphor and allied trees. There is apparently one generation per year, and the adults emerge in May and June.

The curculionid *Hylobius macilentus* (*96*) at times causes injury to camphor in central and southern Japan, occasionally killing the tree. The adults oviposit at the roots, and the larvae tunnel through the inner layer of bark.

Though a considerable number of other insects are listed as attacking camphor, they seldom cause appreciable injury, and this tree is relatively lightly attacked by insects as compared with other forest trees.

INSECTS ATTACKING POPLAR AND WILLOW

A considerable number of insect species are recorded as attacking poplar and willow in Japan and Chosen, and according to Hori and Oshima (*36*) the most important of those upon poplar are *Porthetria* (*Lymantria*) *dispar*, *Stilpnotia salicis*, *Melalopha anastomosis*, *Melasoma populi*, *Popillia japonica*, and *Trichiocampus populi*.

The satin moth, *Stilpnotia salicis* (*149*), is found in Japan, Chosen, and China, and ranges in distribution westwards to Europe. Recently it has become established in certain parts of North America, having been found near Boston in 1920, in British Columbia the same year, and in Washington in 1922. Two broods a year are produced in Japan, the adults appearing early in July and the middle of September. The eggs are laid upon the leaves and hatch in 10 days. The larval stage of the midsummer brood covers about six weeks and the pupal stage two weeks. Hibernation is in the early larval stage in a bag attached to a twig or branch, or in crevices in the bark. In the middle of May these larvae leave the bag and begin feeding, reaching maturity in one month. The cocoon is spun in a folded leaf, or between a group of twigs bound together with silk, in which case several cocoons are contained in each web.

Cerura lanigera (*149*) is found throughout all of the main islands of Japan and also in Chosen and Siberia. There are two broods a year, and the winter is passed in the pupal stage on the trunk or in a sheltered place. The adults appear late in May and in July. The egg, larval, and pupal stages cover 15, 30, and 14 days, respectively.

Dicranura (*Cerura*) *vinula felina* (*149*) is distributed throughout the Far East and to Europe as well. A single brood is produced

each year, the adults appearing at the end of May. The eggs are laid singly upon the trunk and hatch in two weeks. The larvae are mature at the end of August, when the cocoons are formed, and pupate one month later. The winter is passed as pupae. The cocoon may be formed either in a crevice in the trunk, in which case fragments of wood are used in its composition, or in the soil.

The noctuid *Acronycta leporina leporella* (*149*) occurs throughout Hokkaido, Honshu, and Siberia, and feeds upon birch as well as poplar. There is one brood a year, the adult moths appearing early in June and laying their eggs singly or in small groups on the undersides of the leaves. These eggs hatch in about seven days, and the larvae are mature by the end of July. Pupation occurs early in August, and the winter is passed in the pupal stage.

Melalopha anastomosis (*149*) occurs as a pest of poplar and willow throughout Japan, Chosen, China, and Siberia and ranges westward to Europe. In Hokkaido two or three broods occur each year. Where there are two broods the adults are found in late May to June and early in August. Where there are three broods the first two coincide in time with the above, and the third appears the latter part of September. The eggs are laid in masses of from 300 to 400, from 4 to 6 layers deep, on the undersides of the leaves. These hatch in 1 week, and the larvae are mature in 5 or 6 weeks. Pupation is in a thin cocoon within a folded leaf. The adults of the early broods emerge in one week, but the pupae of the last brood go into hibernation.

The gipsy moth, *Porthetria dispar*, is found very generally upon poplar in northern Japan, and this tree is the preferred host of the variety *japonica* in Honshu and Kyushu.

The chrysomelid beetle *Plagiodera versicolora* var. *distincta* (*8*) is common upon willow in Chosen. There are two generations each year, and the winter is passed in the adult stage in rubbish and in other sheltered places. The adults appear in the field in early May and the females deposit their eggs about two weeks later. The larvae feed upon the lower epidermis of the leaf, and are mature in about 17 days. The pupal stage, also passed upon the foliage, covers only 4 days. The adults emerge the latter part of June, but those of the following generation, which live over the winter, reach maturity about the first of September.

Popillia japonica, the Japanese beetle of the United States, feeds extensively upon poplar, this being, next to Polygonum, the favored food plant. In Hokkaido the beetles were observed each year in large numbers feeding upon the foliage of the uppermost branches, and these were often stripped of leaves when the beetles from a considerable area had congregated upon a relatively small number of trees, but the foliage of the lower and middle part of the trees was seldom damaged.

The sawfly *Trichiocampus populi* (*149*) is abundant in Hokkaido and Sakhalin. The adults appear the middle of June, and eggs are laid in an incision made in the leafstalk. These hatch in about two weeks, and the larvae feed upon the lower surfaces of the leaves. They are gregarious in habit, feed chiefly at night, and move from tree to tree, often producing complete defoliation. The winter is passed in the mature larval stage in a rough cocoon in rotten wood or in the soil, the pupa being formed at the end of May.

INSECTS ATTACKING BAMBOO

Both in Taiwan and Japan bamboo is one of the most important of forest products, the wood being used for a multitude of purposes and the young shoots forming a staple and very palatable article of food. Of the many species grown commercially four are used for food, the shoots of these being gathered early in the spring when they break through the surface of the ground.

The most important pests of bamboo (*102*) are the noctuid *Oligia* (*Polydesma*) *vulgaris* in Japan, and *Cyrtotrachelus longimanus* (*longipes* F.) and *Acroceratitis plumosa* in Taiwan. *O. vulgaris* is very injurious in the central and southern sections of Japan, and the damage inflicted, according to Okada (*144*), ranges from 30 to 90 per cent each year. The most valuable varieties are the most seriously attacked. There is a single brood each year, and the winter is passed in the egg stage upon the foliage. The injury is noticeable only during June and early July, at which time the larvae are nearly mature. There was for some time considerable doubt as to the habits and host plants of the early stages, as the eggs hatch in May, at which time no shoots of the commercial varieties are available. It has since been found that the early stages are passed in the shoots of the smaller forest bamboos, as these appear above the ground much earlier in the season than those of the commercial varieties, and that the larvae later migrate to them. The larvae bore into the apex of the shoot when it is from 1 to 2 feet in length, and from 1 to 10 larvae may be found in each. The result of the feeding is a gradual yellowing and finally the death of the shoot. Pupation occurs in the soil, and the adults appear in late July and early August. Shortly thereafter the eggs are laid in rows upon the leaves. No practical means of control has as yet been developed, though it may possibly be effected by the removal of the shoots of the forest varieties in the vicinity of the commercial plantings during the early spring.

The curculionid *Cyrtotrachelus longimanus* (*87*) is the cause of considerable damage to young shoots in Taiwan. The adult female makes a slit in the young shoot from 1 to 4 inches from the tip, and in this 1 or 2 eggs are laid. Hatching occurs in four days, and the larvae tunnel about in the growing stem, killing it and rendering it unfit for food. When mature, the larvae leave the stem and pupate in the soil. No means of control is as yet known except the collection of adults, and this is somewhat encouraged by the fact that they are used as food by the natives.

The trypetid fly, *Acroceratitis plumosa* (*87*), a species endemic in Taiwan, is responsible for very extensive injury to the shoots in the island. The adult flies are found throughout the year, but the number of generations produced annually is not known. The eggs are laid under the sheath of the young shoot, and the maggots bore about in the tissue, causing it to decay.

The nymphs of *Notobitus meleagris* (*87*), a coreid bug, at times causes some damage by sucking the sap of the young shoot, though usually they are not sufficiently abundant to seriously affect growth. The eggs are laid on the sheath.

Two phytophagous chalcids of the family Eurytomidae are recorded by Ishii (*40*) as attacking bamboo in southern Japan, these being

Harmolita phyllostachites and *Aiolomorphus rhopaloides*. They occur, however, upon species of no great commercial value. According to Ishii, the first named was probably introduced into Japan from the United States.

TERMITES IN WOOD PRODUCTS

Aside from the damage produced by termites upon growing trees, there are, according to Oshima (*155*, *156*), three species which seriously attack cut timber, wooden buildings, etc. These are *Coptotermes formosanus*, *Leucotermes* (*Reticulitermes*) *flaviceps*, and *L. speratus*. The first occurs in Japan, China, and Taiwan, the second in Taiwan only, and the third in Japan, Taiwan, and Chosen. Experiments were conducted to determine the cause of the relative immunity of various kinds of wood and to find a method of treating those susceptible to protect them from attack. It was found that teak (*Tectonia grandis*) and cypress pine (*Calletris glauca*) were absolutely immune to injury owing to the presence of organic compounds inimical to the termites. The principal constituent having this quality was found to be sesquiterpene alcohol, and the same protection was secured when other woods were treated with a preparation of this compound. Though teak wood is evidently the most resistant of all tropical woods to termite attack, the growing trees are not entirely immune, as is shown by the extensive damage done to teak forests in Java by *Calotermes tectonae* Damm., which apparently confines its attacks to this tree alone.

MISCELLANEOUS FOREST INSECTS

The cerambycid *Melanauster chinensis*, which is known largely because of its injury to orange and mulberry trees, is a serious pest of *Casuarina stricta* in the forests of Taiwan. According to Maki and Rin (*88*) the eggs are laid from April to July in crevices in the bark of the trunk. It has been determined that the larvae remain from one to three weeks under the bark before boring into the wood, and this habit has been utilized in devising control measures. The location of a larva is detected by the presence of excrement at the point of entrance, and a small section of bark is removed at this point, thus exposing the larva. One man is able to examine and treat 250 trees a day in this way.

Seed-feeding chalcids are particularly numerous in some parts of Japan, and counts made by Yano and Koyama (*208*) from 1913–1916 gave the following percentages infested:

	Per cent
Chamaecyparis obtusa	94
Cryptomeria japonica	3.6–13
Larix leptolepes	2
Thujopsis dolabrata	2

On the basis of observations covering a period of years, Yano (*207*) has come to the conclusion that infestations of forest insects are much more severe in pure plantings than in mixed, this being attributed to the fact that the parasites have less chance of finding an intermediate host upon which to perpetuate themselves during the time when the primary host is at the lowest point numerically of its cycle. In support of this conclusion he cites observations in 1917

when only 10 per cent of the eggs of *Dendrolimus spectabilis* (listed as *remota* Wlk.) were parasitized in pure plantings of pine, whereas 68 per cent were attacked in mixed plantings.

STORED-GRAIN INSECTS

The insect pests of stored grain here listed are largely of general distribution throughout the world, and their general habits are too well known to require repetition. The more extended publications upon them are by Okuni (*153*) in Taiwan and Takasugi (*195*) and Kazui (*45*) in Japan and an anonymous article (*2*). These give extended accounts of the life histories of the more important species, particularly of the weevils, with control experiments and measures adapted to the methods of storage used in the various localities. Such species as occur both in the field and in storage are discussed among the field pests of the various crops.

LIST OF STORED-GRAIN AND PLANT-PRODUCT INSECTS

	Distribution [1]
LEPIDOPTERA	
Pyralidae:	
Aglossa dimidiata Haw	J. K. C.
Ephestia glycinivora Mats	J.
Ephestia kuehniella Zell	J.
Paralipsa modesta Butl	J. C.
Plodia interpunctella Hübn	J.
Pyralis farnalis L	J. K. F. C.
Gelechiidae:	
Sitotroga cerealella Oliv	J. F. O.
Oecophoridae	
Anchonoma xeraula Meyr	J.
COLEOPTERA	
Ostomidae:	
Tenebroides mauritanicus L	J. F.
Cucujidae:	
Laemophloeus pusillus Schön	J.
Oryzaephilus surinamensis L	J. O.
Tenebrionidae:	
Hypophloeus floricola Mars	J.
Latheticus oryzae Waterh	J.
Palorus ratzeburgi Wissm	J.
COLEOPTERA—continued	
Tenebrionidae—Continued.	
Tenebrio obscurus Fab	J.
Tenebrio tenebrioides Beauv	J.
Tribolium confusum Duv	J.
Tribolium ferrugineum Fab	J. F. C. O.
Bostrichidae:	
Rhizopertha dominica Fabr	J.
Rhizopertha hordeum Mats	F.
Bruchidae:	
Bruchus chinensis L	J. F. C. O.
Bruchus obtectus Say	J.
Bruchus pisorum L	J. F. C. O.
Bruchus quadrimaculatus Fab	J. F.
Bruchus theobromae L	F.
Curculionidae:	
Sitophilus granaria L	J. F.
Sitophilus oryzae L	J. K. F. O.
Anobiidae:	
Lasioderma sericorne Fab	J. F. C. O.
Sitodrepa panicea L	J.
ACARINA	
Tarsonemus hordei Kishida	J.

[1] Distribution symbols are as follows: J, Japan; K, Chosen (Korea); F, Taiwain (Formosa); C, China; and O, Okinawa (Loo-choo or Riukiu Islands).

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