PESTS NOT KNOWN TO OCCUR IN THE UNITED STATES OR OF LIMITED DISTRIBUTION, NO. 45: ARROWHEAD SCALE

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Pest

ARROWHEAD SCALE
Unaspis yanonensis (Kuwana)

Order: Family

Homoptera: Diaspididae

Economic Importance

The arrowhead scale is listed by Talhouk (1975) as a citrus pest of major economic importance in Japan and of economic importance in China. Kuwana (1923) considered it the most injurious scale insect of citrus in Japan. Heavy infestations cause dieback of terminal branches or under extreme circumstances, death of trees. Clausen (1927) reported many dead trees in the Nagasaki area of Japan and a large number of groves that had sustained serious damage. Miyahara and Yamada (1969) indicated that pesticide control is required three times a year in Japan if the overwintering population of adult females is greater than 0.2 per leaf. In 1963, the scale was found in France at Beaulieu-sur-mer on the Cote d'Azur (Commeau and Sola 1964). Dispersal from the original infestation was steady, and the damage was serious enough to require use of pesticides for control (Benassy and others 1976).

A limited number of studies have been conducted on the resistance of certain cultivars and species of citrus to this pest. Results have demonstrated resistance in Citrus junos and the cultivar Natsudaidai. Resistance apparently is caused by different factors in each citrus taxon (Fukuda and Koremura 1954, 1956).

Furuhashi (1974) has shown that crawlers from females reared on Satsuma mandarin will develop normally, but when transferred to 'Natsudaidai' or 'Kawano-Natsudaidai,' few crawlers, if any, survive to maturity, while crawlers from females reared on 'Natsudaidai' will develop normally on that host as well as on 'Kawano-Natsudaidai' and Satsuma mandarin. Furuhashi concluded that his data "proved" that there are two "strains" of arrowhead scale. An alternative hypothesis is that there are

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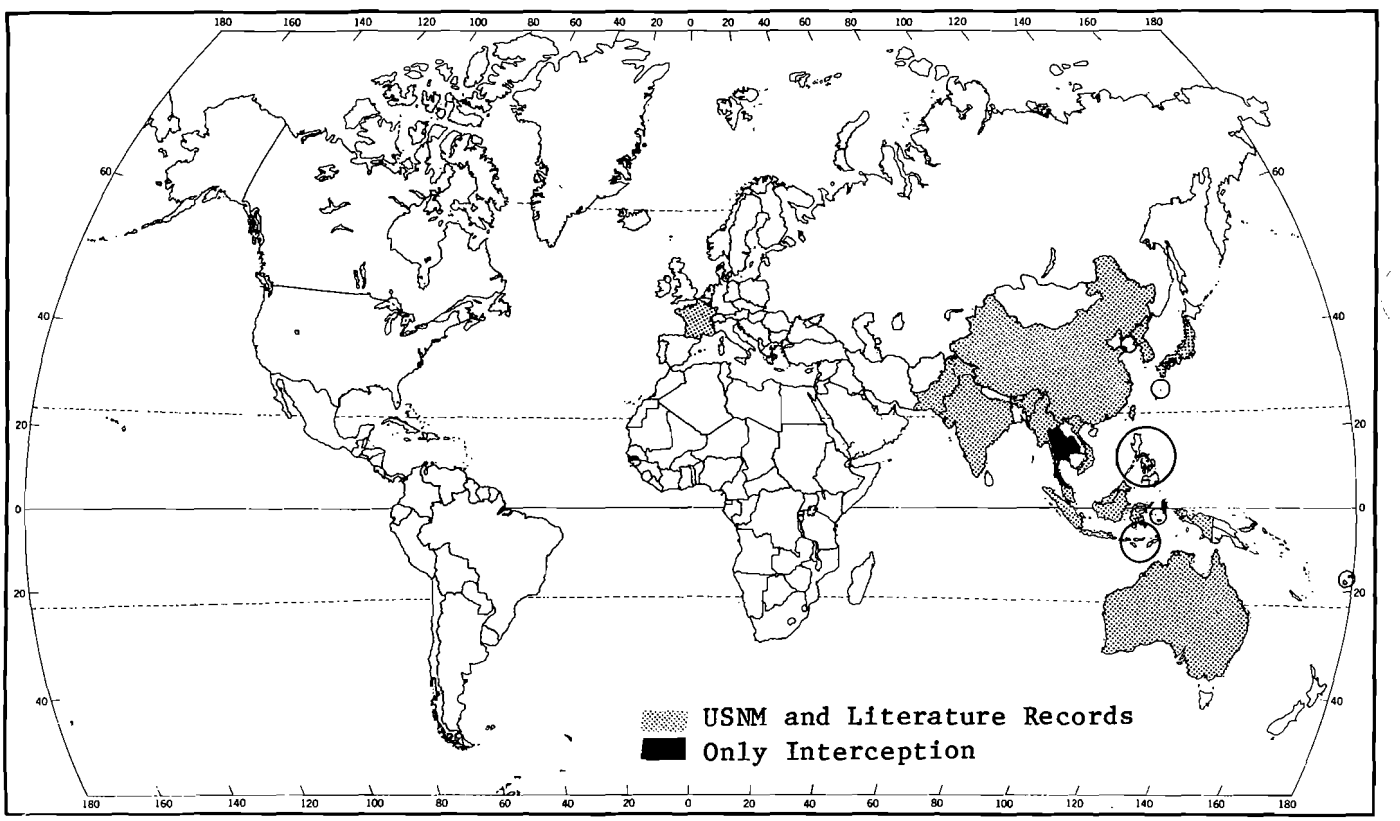
demes of arrowhead scale that are adapted to certain host cultivars in a manner similar to the system described by Edmunds and Alstad (1978). The latter research differed, however, in that the scale demes were adapted to individual trees and not to host cultivars.

Hosts

This scale insect feeds almost exclusively on citrus. It has been reported also from Damnacanthus (Wang 1981) in the Rubiaceae, and from Fortunella (Murakami 1970) and Poncirus (Borchsenius 1966) in Rutaceae.



Unaspis yanonensis distribution map prepared by Non-Regional Administrative Operations Office and Biological Assessment Support Staff, PPQ, APHIS, USDA

General Distribution

We have examined specimens that are deposited in the Collection of the United States National Museum of Natural History, Beltsville, MD, from the following locations: Australia, China (including Taiwan), Fiji, Hong Kong, Japan (including Okinawa), and Philippines.

Additional records from the literature and from plant quarantine records follow. The area of origin of quarantine records (cited as U.S. Department of Agriculture) are subject to error. It is not always possible to determine if a product originated in the country of purchase or if an importer reported the true origin of a cargo. Therefore, we have included only plant quarantine records that are substantiated by at least two independent interceptions.

ASIA - Burma (Kukhtina 1978), China (Cheo 1935), India, Indonesia (Kukhtina 1978), Japan including Okinawa (Kuwana 1923, Murakami 1970), Korea (Paik 1978), Malaysia (Kukhtina 1978), Pakistan, Philippines (Kukhtina 1978), Thailand (U.S. Department of Agriculture 1979, 1982), and Vietnam (Kukhtina 1978); EUROPE - France (Commeau and Sola 1964); OCEANIA - Australia (Kukhtina 1978, U.S. Department of Agriculture 1979, 1982).

Characters

ADULTS - Female scale cover (Figs. 1, 2A). Length 2.5-3.6 mm, oyster-shell shaped, wax blackish brown, margin paler, dorsomedial longitudinal ridge wrinkled on sides. Exuviae terminal, brownish yellow.

(Fig. 1)

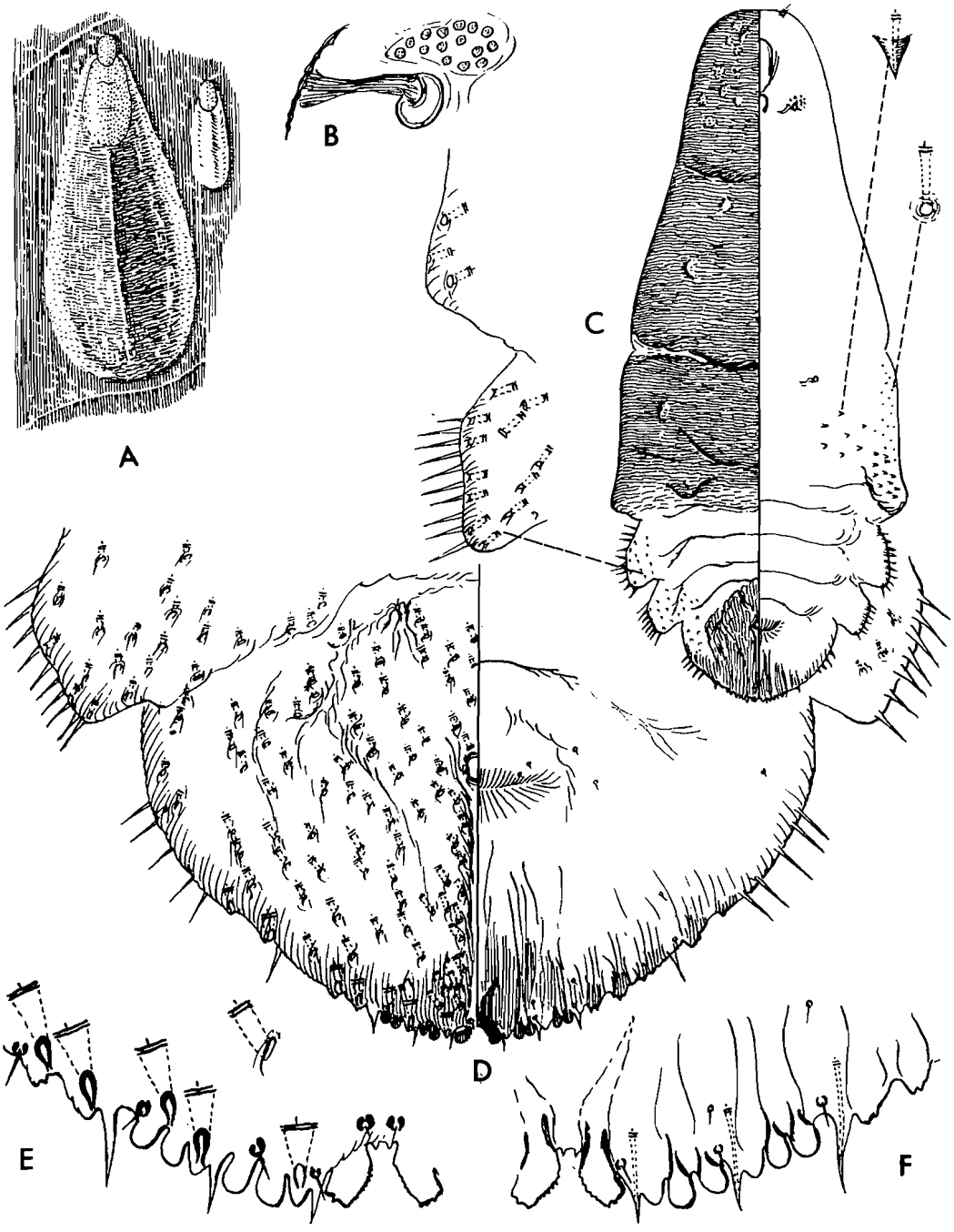
Unaspis yanonensis cover of second instars.

Male scale cover (Fig. 2A). Elongate, length 1.3-1.6 mm, felted, white, 2 or 3 longitudinal ridges. First-instar exuviae brownish yellow, situated at anterior end of cover (Kuwana 1923, Rao 1949).

Diagnosis of adult female. Body elongate (Fig. 2C), pygidium (Figs. 2D-F, 3) with 3 pairs of definite lobes, fourth lobes weakly indicated. Median lobes with conspicuous, paraphysislike sclerotizations attached to both margins, without basal sclerotization or yoke, medial margins diverging apically and with conspicuous notches, medial margin noticeably longer than lateral margin; second lobes bilobed, slightly smaller than median lobes, protruding beyond apex of median lobes, without notches; third lobes bilobed, without notches; fourth lobes inconspicuous, simple or bilobed, represented by low series of notches. Paraphyses represented by slender, converging sclerotizations attached to medial and lateral margins of both lobules of second lobes and medial lobule of third lobes. One gland spine between median and second lobes, second and third lobes, third and fourth lobes (Figs. 2E, F); 51-76 gland spines on each side of body from prothorax to segment 4. Macroducts of two sizes, larger in marginal areas of pygidium, smaller in submarginal areas from mesothorax or metathorax to segment 7, in submedial areas from segment 2 or 3 to segment 7, without duct between median lobes; 48-64 macroducts on each side of body on pygidial segments 5 to 7. Perivulvar pores absent. Perispiracular pores with 3 loculi, anterior spiracles each with 10-16 pores (Fig. 2B), posterior spiracles each with 7-15 pores. Anal opening located 8-15 times length of anal opening from base of median lobes, anal opening 15-20 um long. Older adult females with prosoma heavily sclerotized (Fig. 4). Posterolateral margins of segments 3 and sometimes 2 with dentate process.

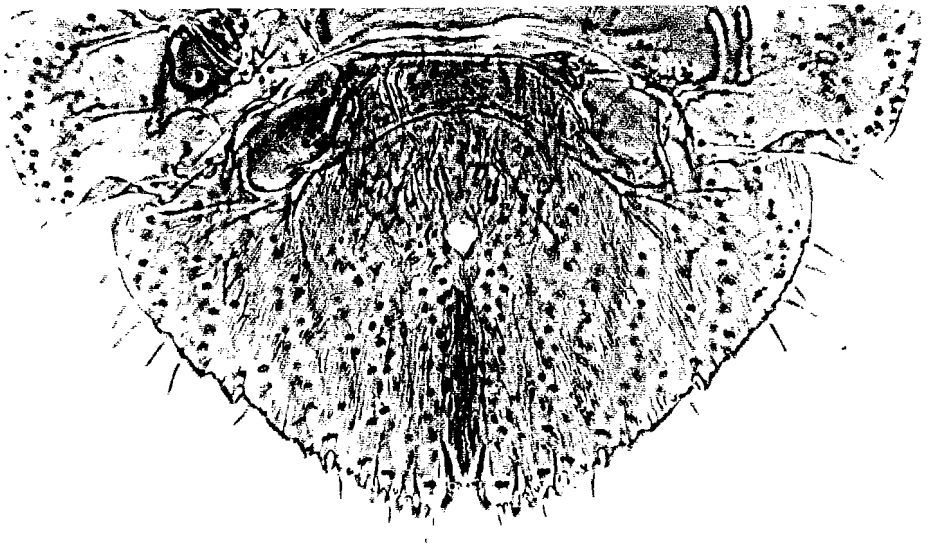
Arrowhead scale is similar to citrus snow scale, Unaspis citri (Comstock), but can be distinguished from it by having 48-64 macroducts on each side of the pygidium, 1 gland spine between the pygidial lobes, strongly diverging median lobes, and 51-76 gland spines on each side of the body anterior of segment 4. Citrus snow scale has 18-35 macroducts on each side of the pygidium, 2 gland spines between the second and third lobes and between the third and fourth lobes, slightly diverging median lobes, and 27-39 gland spines on each side of the body anterior of segment 4.

(Fig. 2)



Unaspis yanonensis adult: A. Covers - left, female and right, male; B-F. Female. B. Anterior spiracle with perispiracular pores, ventral view; C. Body, dorsal and ventral views; D. Pygidium, dorsal and ventral views; E-F. Pygidial margin. E. Dorsal, and F. Ventral views (From Rao 1949).

(Fig. 3)



Unaspis yanonensis adult female pygidium.

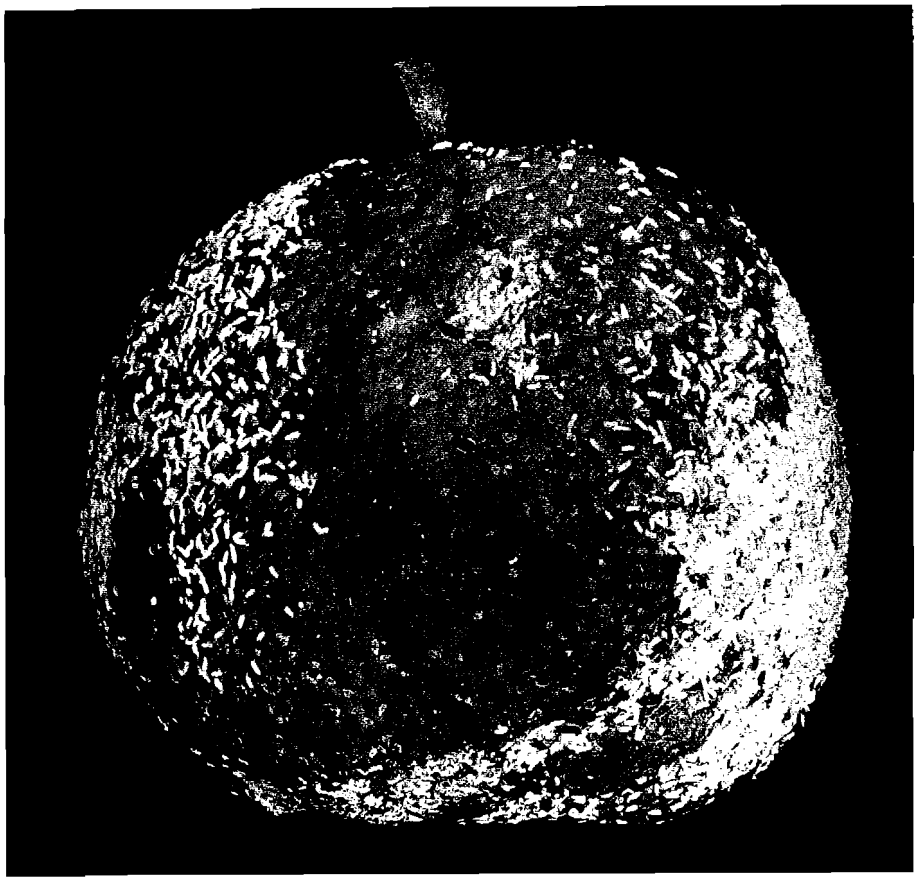
(Fig. 4)

Unaspis yanonensis adult female body.

Characteristic Damage

In Japan, plants damaged by this scale typically have the leaves and green twigs withered and whole branches dead; in some cases entire trees may be killed (Kuwana 1923). Feeding by the scale seems to cause inordinate amounts of damage; Clausen (1933) reported that very lightly infested leaves would wilt and die. Heavily infested trees are easily recognized by the large masses of white male scale covers on the twigs, leaves (Clausen 1927), and fruit (Fig. 5).

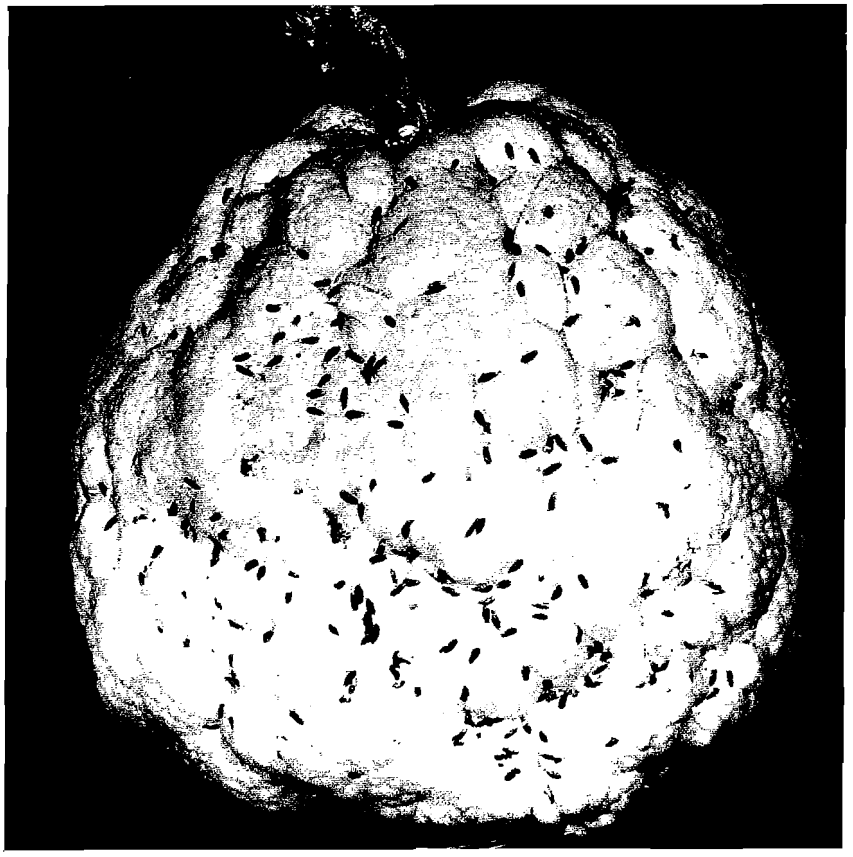
(Fig. 5)



Unaspis yanonensis: Citrus fruit with clusters of white male covers (Courtesy C. Benassy, Directeur Adjoint de Recherches a 1'INRA, Institut National de la Recherche Agronomique, Antibes, France).

A laboratory study of the scale in France (Benassy and Pinet 1972) showed that feeding of adult females caused circular, yellowish blotches on the leaves; 10-15 adult females per leaf resulted in almost total necrosis. Infestations of 40 adult females per sq cm on leaves or 30 per sq cm on twigs caused complete withering. Attack of the fruit usually occurred after the leaves and stems were withered. Fruit distortion can be severe under certain conditions (Fig. 6).

(Fig. 6)



Unaspis yanonensis: Citrus fruit showing fruit distortion and adult female scale covers (Courtesy C. Benassy, Directeur Adjoint de Recherches a l'INRA, Institut National de la Recherche Agronomique, Antibes, France).

Damage symptoms consisted of inhibited growth, short branches, small deformed fruit (Fig. 5), cessation of all growth, and death in small trees.

Detection Notes

Unauthorized importation of nursery stock in the plant family Rutaceae presents the most likely risk of establishment of U. yanonensis in new areas. Title 7, Part 319.19, of the Code of Federal Regulations prohibits the entry of citrus nursery stock into the United States because of other exotic pests. Citrus nursery stock may, however, be imported under USDA permit but must be free of all exotic plant pests.

1. Examine leaves, stems, and fruit for the various stages of the scale.

2. When forwarding material for identification, leave the scales attached to the host material. Be sure that the specimens are dead.

3. Mount specimens on a slide and examine with a compound microscope for positive identification.

Biology

In Nagasaki, Japan, there are usually three generations each year. This scale overwinters primarily as fertilized adult females although about 20 percent of the population overwinters as second instars. Males overwinter either as embryos within the adult female or as second instars. Male first instars, prepupae, pupae, and adults are not found in the winter. The number of eggs produced during each generation varies. The average production for a female of the first, second, and third generations, respectively, is 177, 133, and 196 eggs. Eggs hatch soon after they are laid; at 20° C eclosion occurs about 1 hour after oviposition. Crawlers usually settle about 3 hours after hatching. A complete life cycle takes about 65 days for the first generation, 55-64 days for the second, and about 245 for the third or overwintering generation. Crawlers appear in late May in the first generation, in August in the second generation, and in September and early October in the third generation (Kuwana 1923).

In Shizuoka Prefecture, Japan, a complete life cycle of the first generation requires 75 days with crawlers appearing from May 2 to 17. Crawlers of the second generation occur from July 18 to August 2, and the third from September 13 to 30. Crawlers of the first generation rarely infest the fruit; when they do settle at this location, scale development is poor. Crawlers of the second generation, on the other hand, are more abundant on the fruit than on the leaves (Okudai, Korenaga, and Sakagami 1969).

Winter survival is variable but generally low in Japan. For example, in Kagoshima, survival rates were 34 percent for adult females, 23 percent for newly molted adult females, and 6 percent for second instars. In Kanagawa, overwintering is exclusively as adult females (Murakami 1970).

Recent studies on the biology of this species have produced enough biological data to allow models to be developed. These models basically have been used to predict future population levels so that control measures can be taken before significant damage is inflicted (Sakagami and Korenaga 1982, Korenaga, Hirosaki, and Shiyomi 1981).

In France, there are two generations each year, and the overwintering stage is the fertilized adult female. Crawlers appear in April and July. Natural survival is about 57-60 percent during the first generation and 41-43 percent during the second generation (Benassy and Pinet 1972).

Natural Enemies

The following natural enemies have been recorded from this pest.

Parasites: Insecta, Hymenoptera -- Aphelinidae - Aphytis lignanensis Compere (Takagi and Rosen 1981), A. melinus DeBach (Benassy, and others 1976), A. yanonensis DeBach and Rosen (DeBach and Rosen 1982), Aspidiotiphagus citrinus (Craw) (Benassy and Pinet 1972), Physcus fulvus Compere and Annecke (Tanaka 1981).

Fungi - Fusarium coccophilum (Desmazeires) Wollenweber and Reinkeing (Gao and Quyang 1981), F. oxysporum Schlechtendal (Nakao 1978), Microcera rectispora Cooke and Massee, Sphaerostilbe coccophila Tulasne (Noguchi 1941), Podonectria coccicola (Ellis and Everhart) Petch (Gao and Quyang 1981).

Predators: Acari, Stigmaeidae - Agistemus terminalis (Quayle) (Ehara 1962). Insecta, Coleoptera -- Coccinellidae - Chilocorus amammensis Kamiya (Nakao 1978), C. bipustulatus (Linnaeus) (Benassy and Pinet 1972), C. kuwanae Silvestri (Nakao, Nohara, and Ono 1974), Cryptogonus orbiculus (Gyllenhal) (Murakami 1970), Lindorus lophanthae (Blaisdell) (Benassy and Pinet 1972), Propylea japonica Thunberg (Nohara 1963), Pseudoscymnus hareja Weise (Ishii 1931), P. quinquepunctatus okinawanus Kamiya, Rodolia pumila Weise (Nakao 1978), Scymnus (Neopullus) hoffmanni Weise, S. (Nephus) phosphorus (Lewis) (Nohara 1963), S. (Nephus) ryuguus Kamiya (Nakao 1978), S. (Pullus) dorcatomoides Weise (Nohara 1963), S. (Pullus) ishidai Araki

(=S. hilaris Motschulsky) (Noguchi 1941), Stethorus japonica Kamiya (Murakami 1970), Sukunahikona bicolor Kamiya, Telsimia chujoi Miyatake (Nakao 1978), T. nigra (Weise) (Ishii 1931); Endomychidae - Saula japonica Gorham (Nakao, Nohara, and Ono 1974); Nitidulidae - Cybocephalus gibbulus Erichson; Neuroptera -- Chrysopidae - Chrysopa boninensis Okamoto (Ishii 1931), and C. carnea Stephens (Noguchi 1941).

Aphytis lignanensis can be used as an effective biological control agent if periodic releases are undertaken (Takagi and Rosen 1981).

Considerable caution should be exercised when using the above list of natural enemies since it is based solely on literature records. We feel certain that some of the references are misidentifications of the natural enemies or the scale. In several instances, natural enemies have been reared from host material infested not only with the arrowhead scale but also with other herbivorous contaminants.

Acknowledgments

We give special thanks to A. Y. Rossman, Mycology Laboratory, Plant Protection Institute, ARS, USDA, and R. D. Gordon, SEL, IIBIII, ARS, USDA, for checking and correcting names of fungi and coccinellids, respectively. We are grateful to D. M. Anderson, S. Nakahara, and M. B. Stoetzel, SEL, for reviewing and criticizing the manuscript. We also thank J. A. Davidson, Department of Entomology, University of Maryland, College Park, for his comments. We appreciate the time that each of these scientists has taken to help us with this publication.

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September 1984
GPO 912-895