

MORPHOLOGY AND SYSTEMATICS OF THE
COCCIDAE OF VIRGINIA
WITH NOTES ON THEIR BIOLOGY
(HOMOPTERA: COCCOIDEA)

PUBLICATIONS in this series are intended to serve as scientific contributions for a better understanding of the **living environment** in Virginia.

Recognizing the basic economic importance of faunistic studies, our goal is to survey methodically the local insect fauna through preparation of inventories designed to show the geographic and seasonal occurrence of insects in the Commonwealth, and to provide keys, descriptions, and illustrations to facilitate their recognition.

Insofar as possible, these studies will include data on biology and life cycles to aid in the formulation of control recommendations and information on ecological interactions—including host relationships, parasites, and predators—and the potential of various species as possible biological control agents. Knowledge gained from such studies will be used to evaluate the impact of future changes in our environment.

COMPOSITION AND PRESSWORK BY
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
BLACKSBURG, VIRGINIA

The Insects of Virginia No. 5

MORPHOLOGY AND SYSTEMATICS OF THE

COCCIDAE OF VIRGINIA

WITH NOTES ON THEIR BIOLOGY

(HOMOPTERA: COCCOIDEA) *

by

Michael L. Williams

*Assistant Entomologist, Office of State Entomologist
Maryland State Board of Agriculture, University of Maryland
College Park, Maryland 20742*

and

Michael Kosztarab

*Professor of Systematic Entomology
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061*

RESEARCH DIVISION BULLETIN 74

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

* This research was supported by the Research Division, Virginia Polytechnic Institute and State University, Project 2002370. Equipment used was purchased through National Science Foundation Grant NSF-GB 6885X.

CONTENTS

	Page
Abstract	vi
Acknowledgments	vii
List of Abbreviations	viii
Introduction and Review of the Literature	1
The Family Coccidae	10
Economic Importance of the Coccidae	17
Material and Methods	17
General Morphology of the Adult Female	23
Key to Genera of Coccidae in Virginia	32
Generic Discussion, Keys to Species, and Descriptions	35
Genus <i>Ceroplastes</i> Gray	35
<i>Ceroplastes ceriferus</i> (Fabricius)	36
<i>Ceroplastes floridensis</i> Comstock	43
<i>Ceroplastes sinensis</i> Del Guercio	48
Genus <i>Coccus</i> Linnaeus	54
<i>Coccus hesperidum</i> Linnaeus	55
Genus <i>Eriopeltis</i> Signoret	62
<i>Eriopeltis festucae</i> (Fonscolombe)	63
Genus <i>Lecanium</i> Burmeister	68
<i>Lecanium caryae</i> Fitch	70
<i>Lecanium corni</i> Bouché	76
<i>Lecanium fletcheri</i> Cockerell	82
<i>Lecanium nigrofasciatum</i> Pergande	84
<i>Lecanium persicae</i> (Fabricius)	91
<i>Lecanium quercifex</i> Fitch	97

Genus <i>Neolecanium</i> Parrott	99
<i>Neolecanium cornuparvum</i> (Thro)	99
Genus <i>Physokermes</i> Targioni-Tozzetti	105
<i>Physokermes hemicyphus</i> (Dalman)	106
Genus <i>Protopulvinaria</i> Cockerell	106
<i>Protopulvinaria pyriformis</i> (Cockerell)	107
Genus <i>Pseudophilippia</i> Cockerell	112
<i>Pseudophilippia quaintancii</i> Cockerell	113
Genus <i>Pulvinaria</i> Targioni-Tozzetti	118
<i>Pulvinaria psidii</i> Maskell	119
<i>Pulvinaria acericola</i> (Walsh and Riley)	120
<i>Pulvinaria citricola</i> Kuwana	125
<i>Pulvinaria ericicola</i> McConnell	130
<i>Pulvinaria floccifera</i> (Westwood)	135
<i>Pulvinaria hydrangeae</i> Steinweden	141
<i>Pulvinaria innumerabilis</i> (Rathvon)	146
<i>Pulvinaria</i> sp. near <i>occidentalis</i> Cockerell	152
Genus <i>Saissetia</i> Deplanche	157
<i>Saissetia coffeae</i> (Walker)	157
<i>Saissetia miranda</i> (Cockerell and Parrott)	157
<i>Saissetia oleae</i> (Olivier)	158
Genus <i>Toumeyella</i> Cockerell	158
<i>Toumeyella cerifera</i> Ferris	160
<i>Toumeyella liriodendri</i> (Gmelin)	164
<i>Toumeyella parvicornis</i> (Cockerell)	171
<i>Toumeyella pini</i> (King)	177
<i>Toumeyella virginiana</i> Williams and Kosztarab	182
Selected References	189
Index to Host Plants	205
Index to Parasites, Predators, and Ants Associated with Coccidae in Virginia	209
Index to Scale Insect Taxa	211

ABSTRACT

This study on the Coccidae of Virginia is the first attempt to study the soft scale fauna of the State, and it is the first modern comprehensive morphological study on the family by North American workers since 1929.

Thirty-two species in 11 genera are included, one of which is a new species. Nine species are here recorded from Virginia for the first time; 4 species are new for the United States and North America. Many new county records and additional host plant records from Virginia are established. Adult females of 24 species are fully described and illustrated, and measurements are given for various morphological characters. Keys are provided for the separation of species. Biological notes and synoptic descriptions of the other stages are included for most species studied. Laboratory procedures are discussed.

The external morphology of the adult females is varied. In general, they possess anal plates located at the anterior end of an anal cleft; well-developed anal ring, with numerous pores and 0 to 12 anal ring hairs; a marginal fold dividing the dorsal and ventral surfaces of the body, this fold normally bearing marginal setae of various forms and sizes; spiracular pore bands are present; spiracular setae are usually present; legs and antennae are variable; abdominal spiracles, brachii, dorsal ostioles, or circuli are absent.

A large number of publications is cataloged for each species described.

ACKNOWLEDGMENTS

The authors wish to express their sincere appreciation to J. B. Steinweden, scale insect specialist, for reviewing the manuscript before publication. Appreciation is also extended to J. McD. Grayson, Head, Department of Entomology, Virginia Polytechnic Institute and State University, for providing financial assistance to the first author during his graduate work.

To the following persons, the authors are especially indebted for providing information, advice, and loan of specimens without which this study would not have been possible: L. M. Russell and D. R. Miller, and to B. D. Burks for parasite determinations, Systematic Entomology Laboratory, U. S. Department of Agriculture; S. Nakahara, Animal and Plant Health Inspection Service, Agricultural Quarantine Inspection, USDA; G. W. Dekle, Bureau of Entomology, Florida Department of Agriculture and Consumer Services; R. F. Wilkey, Bureau of Entomology, California Department of Agriculture; and H. H. Tippins, Department of Entomology, University of Georgia. Major collections and the names of the curators providing material for our study are given under the *List of Abbreviations*. R. L. Hoffman of Radford College, and S. Nakahara read parts of this manuscript and made valuable suggestions before the final typing.

Our colleagues at VPI&SU, R. C. Brachman, A. D'Ascoli, J. O. Howell, P. L. Lambdin, R. S. Mitchell, D. K. Pollet, E. C. Turner Jr., and J. A. Weidhaas provided assistance with this project.

In addition to the photographs prepared by the authors, a number were lent by other workers and institutions: W. T. Johnson, Cornell University (Nos. 11, 34, 37, 44, and 45); F. L. Smith, U. S. Department of Agriculture (Nos. 1, 2, 3, 4, and 39 [part]); G. W. Dekle and H. A. Denmark, Bureau of Entomology, Division of Plant Industry, Florida Department of Agriculture and Consumer Services (Nos. 6, 8 [photo by F. W. Mead], 12, 14, 23, 27, 28, 29, 36, 38, 39 [part], 42, and 43). Polaroid photographs taken by M. L. Williams, through electron scanning microscope (Nos. 5, 20, and 21), are the courtesy of the Center of Materials Research, Electron Microscope Central Facility associated with the Department of Mechanical Engineering and the Engineering Materials Groups at the University of Maryland.

Finally, the authors would like to acknowledge the technical assistance of M. E. Moses, M. Stoetzel, C. G. Williams, and M. P. Kosztarab. R. J. Klare edited the publication.

LIST OF ABBREVIATIONS

(Collections, with names of curators in charge)

- CDA—California Department of Agriculture, Sacramento (formerly R. F. Wilkey, presently R. J. Gill).
FDA—Florida Department of Agriculture, Gainesville (G. W. Dekle).
MKC—Michael Kosztarab's Collection, Blacksburg, Virginia.
MLWC—Michael L. Williams' Collection, College Park, Maryland.
UGAES—University of Georgia Agricultural Experiment Station, Experiment, Ga. (H. H. Tippins).
UM—University of Maryland, College Park (J. A. Davidson).
USNM—United States National Museum of Natural History, Washington, D. C. (L. M. Russell and D. R. Miller).
VPI—Virginia Polytechnic Institute and State University, Blacksburg (M. Kosztarab).

(Names of frequently mentioned collectors)

- | | |
|---------------------|----------------------|
| AD—A. D'Ascoli | JAW—J. A. Weidhaas |
| AMW—A. M. Woodside | JOH—J. O. Howell |
| DKP—D. K. Pollet | MK—M. Kosztarab |
| DPI—D. P. Innes | MLW—M. L. Williams |
| DWC—D. W. Clancy | RCB—R. C. Brachman |
| FRF—F. R. Freund | RNH—R. N. Hoffmaster |
| HSM—H. S. McConnell | |

(Other)

- | | |
|----------------|---------------|
| Co.—county | let.—letter |
| col.—collected | rec.—received |

INTRODUCTION AND REVIEW OF THE LITERATURE

The family Coccidae is a very difficult group to classify, not only because of the lack of available literature and species keys, but because of the wide range of variation within the species. Many species of Coccidae are polyphagous and often exhibit morphological differences from host to host. Such variability led many early workers to describe the same entity from different hosts as separate species. For example, the European fruit lecanium, *Lecanium corni* Bouché, alone has over 130 synonyms.

Many species of Coccidae, commonly called coccids or soft scales, become heavily sclerotized and often very convex with age, a condition which renders them almost useless for distinguishing morphological characters, much less identifying them at species level. Young adult females are desired and needed in most cases to insure suitable slide mounts for identification or description. Since, in most cases, this stage lasts only a short period of time in the spring, useful material for mounting is limited. Consequently, classification of the group in the past has been based chiefly upon the gross appearance of the fully mature female. Because of this practice, many genera are poorly defined, and in some cases they are quite artificial. Only an extensive review of the entire family will remedy this situation.

Because of the previously mentioned problems and the difficulty encountered in the identification of the large number of soft scale specimens sent to the VPI&SU Department of Entomology for determination, the authors decided to study the family Coccidae in Virginia. Even the more common species lacked suitable descriptions which would enable workers to separate them easily from other species of soft scales, though they often belonged in different genera.

The available literature on this family was reviewed and a brief chronological summary is given below.

Thro (1903) in his "Characteristics of the species of the Genus *Lecanium*," actually included in the genus *Lecanium* 12 species which today are considered to belong in 4 different genera. Marchal (1908a, 1908b) studied many species of *Lecanium* in Europe, and his paper is of fundamental importance for the classification of the genus. Sanders (1909) clarified much of the confusion concerning synonymy in 17 common soft scale species which occur in the United States, after reviewing types and cotypes in the USNM collection. Green (1904, 1909) in "The Coccidae of Ceylon," parts III and IV, published keys to and described many of the 29 genera and

33 species of Coccidae under the old subfamily name Lecaniinae. The illustrations in Green's works are excellent, although the morphological descriptions lack the details of modern studies.

The first comprehensive treatment of the family was completed by Steinweden (1929) who reviewed 32 different genera and established a classification for the family Coccidae based on the morphological characters of the adult female and first instar nymphs. Up until this time most descriptions had been based on general appearance. This study is a classic, and is considered to be the beginning of a modern classification of Coccidae on a world-wide basis. To date, this publication remains the only world-wide treatment of the family.

Sulc (1932) published a critical study of the anatomy and classification of 10 Bohemian *Lecanium* species, with keys to subgenera and some species. In this study, Sulc presented a new approach and proved that some species could be separated by certain characteristics of the male puparia. Steinweden (1946) studied the North American species of the genus *Pulvinaria* and presented descriptions, illustrations and keys to 13 species. This is the most comprehensive generic revision of soft scales presented by an American author. Another fine work is that of Zimmerman (1948) who, with the aid of Professor G. F. Ferris, reviewed the soft scales of Hawaii. Many species which are not commonly found in the continental United States are described and illustrated in his study.

Wax Scales

Photo 1. *Ceroplastes ceriferus* (Fab.), nymphs on *Ilex cornuta* var. *burfordii* stem.

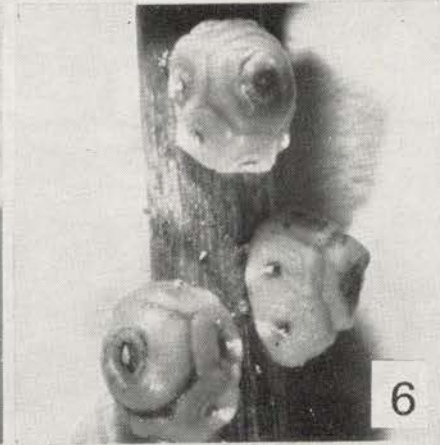
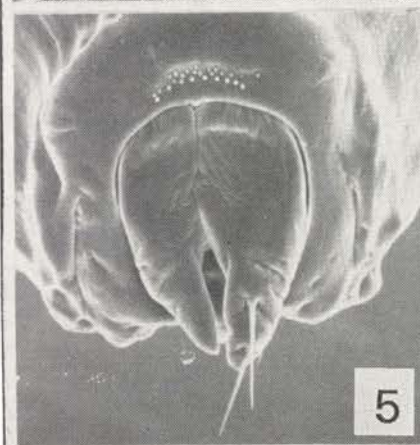
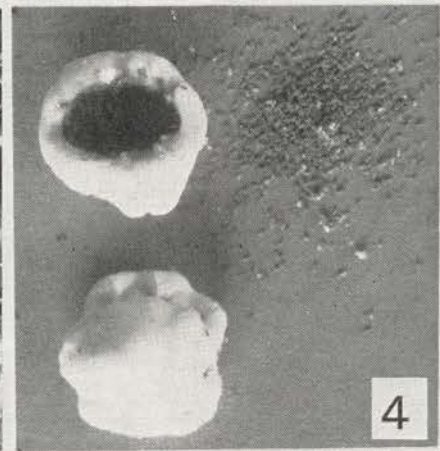
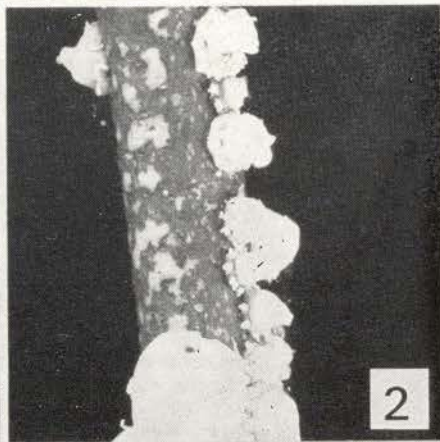
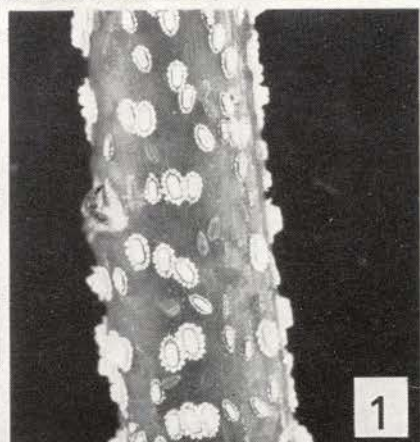
Photo 2. Same; females on *Euonymus* sp. stem.

Photo 3. Same; all stages, heavy infestation on a potted *Ilex cornuta* plant.

Photo 4. Same; females, one turned over, showing mass of eggs produced.

Photo 5. Same; sclerotized anal plates of the female, one with apical setae; conical disc pore group anterior of plates. Polaroid photograph taken through electron scanning microscope; 200X magnification.

Photo 6. *Ceroplastes cirripediformis* Comst., females.



The soft scale faunas of the Palearctic and the Ethiopian regions are probably better known than those of any other region of the world. Borchsenius (1949, 1952, 1953) studied the Coccidae of USSR and presented a comprehensive study (1957) of the family. Some of Canard's publications (1958, 1965a, b, c) included species which are also present in North America. In a series of papers, De Lotto (1965, 1966, 1967, 1968a, 1968b) and Hodgson (1967a, 1967b, 1967c, 1967d, 1968, 1969a, 1969b) revised many of the genera of Coccidae found in the Ethiopian region. Ezzat and Hussein (1967) redescribed the Coccidae of the United Arab Republic, including 16 genera and 22 species.

Very little work had been done on the morphology of adult male Coccidae until Giliomee (1967) studied the males of 23 species in 19 genera. He also made comments on the possible species relationships based on the males studied. Most other papers which mention male soft scales do not go into much detail and are of little use in classifying the family, utilizing male morphology.

No previous studies have been undertaken on the Coccidae of Virginia but there are numerous faunistic studies on soft scales from other states such as: Sanders, 1904 (Ohio); Carnes, 1907 (California); Herrick, 1911 (Mississippi); Dietz and Morrison, 1916 (Indiana); Lawson, 1917 (Kansas); Pettit and McDaniel, 1920 (Michigan); Hollinger, 1923 (Missouri); Merrill and Chaffin 1923, and Merrill, 1953 (Florida); Trimble, 1925 (Pennsylvania); and Zimmer-

Wax Scales and the Brown Soft Scale

Photo 7. *Ceroplastes floridensis* Comst., females and nymphs with characteristic waxy covering, on *Ilex cornuta* var. *burfordii* leaf.

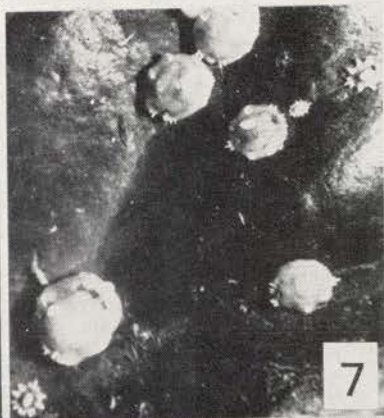
Photo 8. Same; females with waxy covering enlarged.

Photo 9. *Ceroplastes sinensis* Del Guercio, females and nymphs with waxy covering, on *Ilex cornuta* and *I. crenata* var. *microphylla* stems.

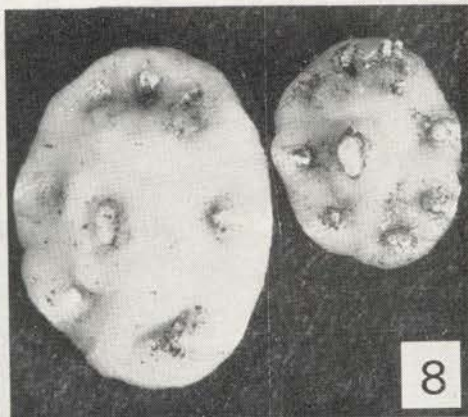
Photo 10. Same; female with waxy covering, enlarged, on *Ilex cornuta* stem.

Photo 11. *Coccus hesperidum* Linn., females and nymphs on leaf surface.

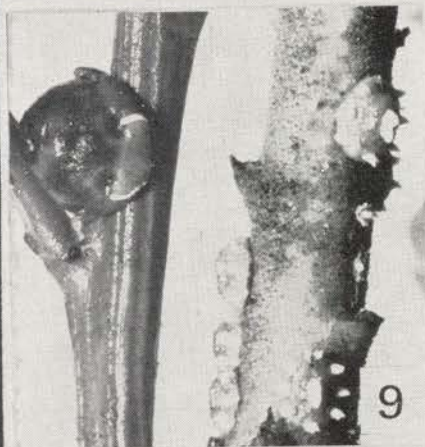
Photo 12. Same; females enlarged.



7



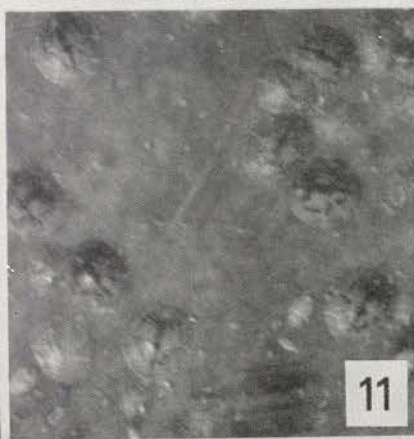
8



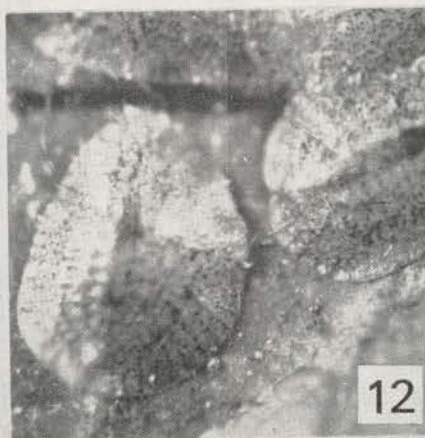
9



10



11



12

man, 1948 (Hawaii). Most of these works deal with distribution, hosts, and other biological data of the included species, and do not discuss morphology and systematics. Zimmerman's study is probably the most detailed taxonomic publication for the group relative to state faunistic studies.

We are presenting here descriptions, illustrations, and keys suitable for the identification of adult females in the genera and species of Coccidae recorded in Virginia, based primarily on their morphology.* A total of 32 species in 11 genera are treated, including a new species (*Toumeyella virginiana*). Nine species are recorded from Virginia for the first time (*Ceroplastes sinensis*, *Physokermes hemicyphus*, *Pulvinaria citricola*, *P. ericicola*, *P. hydrangeae*, *P. near occidentalis*, *Saissetia miranda*, *Toumeyella cerifera*, and *T. virginiana*). Four species are new for the United States and North

NOTES:

* *Lecanium corni*, *L. fletcheri*, and *L. quercifex* all come out in the same couplet of the "Key to Species of *Lecanium*" because the authors could not find consistent morphological differences separating these 3 species. A more comprehensive study of the genus *Lecanium* is needed before an adequate understanding of the status of this "species complex" can be obtained.

Physokermes hemicyphus, because of its late discovery (1972), is not illustrated in this publication. The key to the genera will assist in the determination of this species.

Lecanium Scales

Photo 13. *Lecanium caryae* Fitch, female and male test on *Quercus rubra* twigs.

Photo 14. *Lecanium corni* Bouché, old mature females on a twig.

Photo 15. Same; displaying host-induced variation. Left to right, young female on *Acer* sp. twig, short and globose, on *Salix* sp., almost circular, and partly globose, on *Tilia* sp., long and flat.

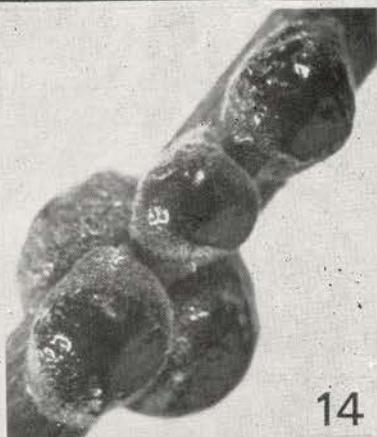
Photo 16. *Lecanium fletcheri* Ckll., of the "corni-complex," on *Taxus* sp. Note young females distinctly different from the ones in Photo 15.

Photo 17. *Lecanium nigrofasciatum* Perg., females on *Prunus persica* twig.

Photo 18. Same; male test, (enlarged), on *Prunus persica* leaf.



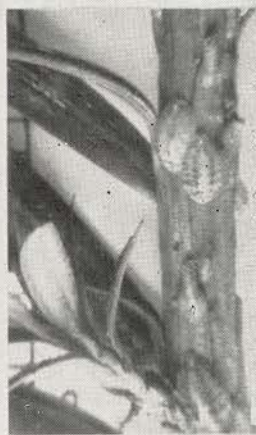
13



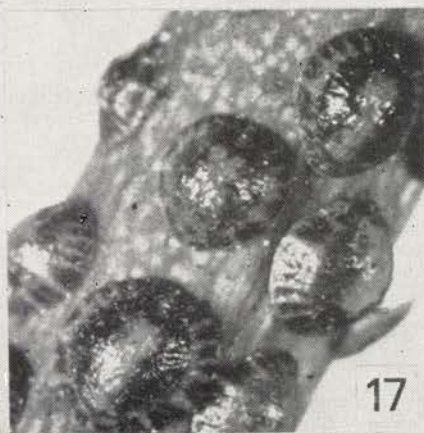
14



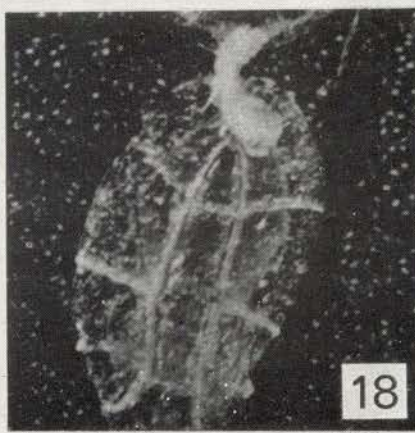
15



16



17



18

America (*Ceroplastes sinensis*, *Physokermes hemicryphus*, *Toumeyella cerifera* and *T. virginiana*). Many new records and additional host plant records from Virginia counties are also included. Twenty-four species are fully described and illustrated. A series of measurements for various morphological characters is given for each species illustrated and described.

In addition, we have provided synoptic descriptions of the other stages of soft scales where material was available for study. Notes are given on the biology, ecology, distribution, hosts, parasites, predators, and economic importance of most species included.

Much of the literature for each species studied has been cataloged to facilitate further research by other workers. The large volume of literature on the Coccidae is found in many different, and often obscure, journals. Therefore, a catalog of the literature would be useful to anyone working on the group. We hope that the information provided toward cataloging the literature of the Coccidae will stimulate other workers to continue this work.

Lecaniums and the Magnolia Scale

Photo 19. *Lecanium nigrofasciatum* Perg., part of a female body after turning it over, with first instar nymphs ("crawlers") emerging from underneath.

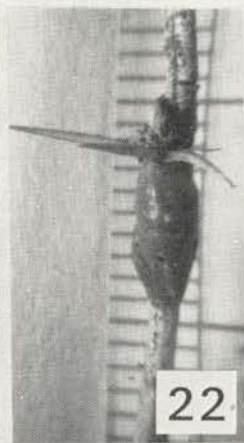
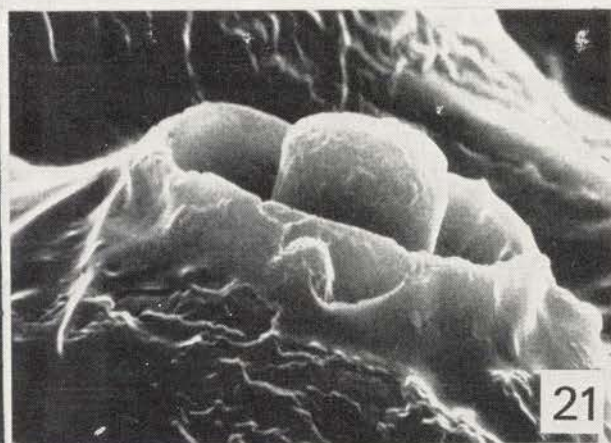
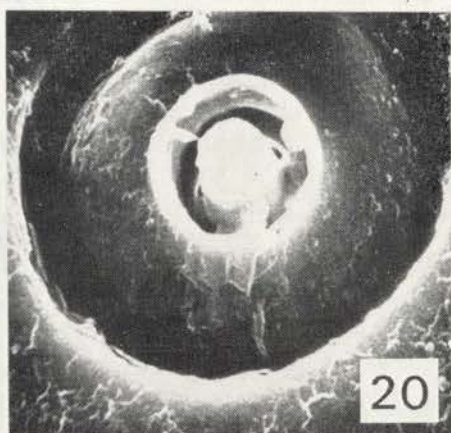
Photo 20. *Lecanium persicae* (Fabr.), dorsal submarginal tubercle of female top view. Polaroid photograph taken through electron scanning microscope; 2,000X magnification.

Photo 21. Same; lateral view; 5,000X magnification.

Photo 22. Same; female on *Berberis julianae* stem.

Photo 23. *Neolecanium cornuparvum* (Thro), adult females and male tests.

Photo 24. Same; old females covered with a characteristic white powdery wax.



THE FAMILY COCCIDAE

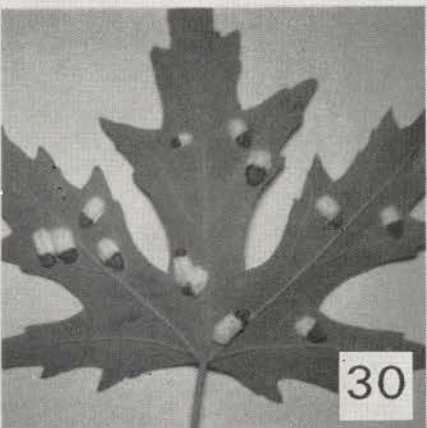
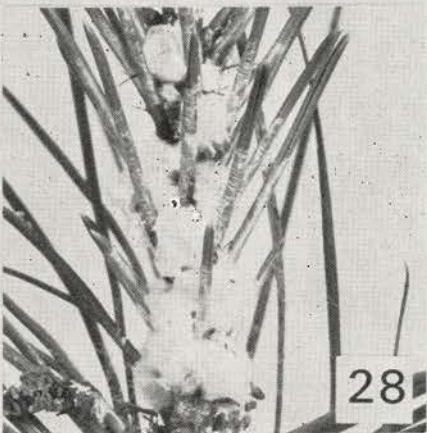
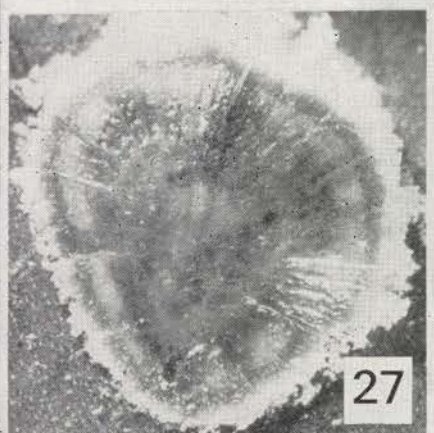
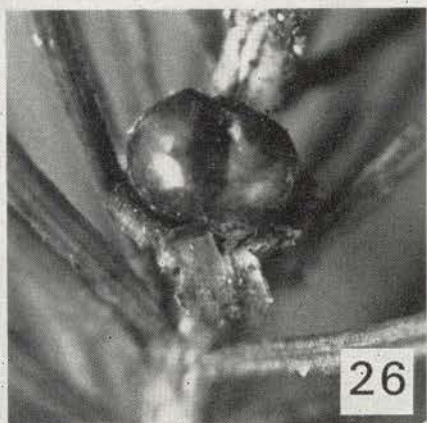
Originally, all scale insects were included under the family name Coccidae. G. F. Ferris, writing in Chamberlin (1923), had the opinion that the name should be elevated to the superfamily level; he suggested the name Coccidoidea. Morrison (1927) and Steinweden (1929) supported Ferris' idea that the Coccidae should be elevated to the superfamily level although Steinweden changed the spelling of the superfamily name to Coccoidea. Williams (1969) in studying the family-group names of the scale insects stated that the scale insects are currently regarded as forming the superfamily Coccoidea and the family Coccidae is restricted to those insects resembling *Coccus hesperidum* L., the type species. The name Coccidae has thus become accepted as the family name of soft scales and will be used as such in this publication.

The family Coccidae has a world-wide distribution. The number of species totals nearly 1,000, and there are approximately 100 genera. According to Borchsenius (1957) there are about 120 species in 25 genera in the Nearctic Region. Even though many representatives of the family are important pests of cultivated agricultural crops and ornamental plants, very little is known about the taxonomy of the group. The generic classification of the family also needs revision.

As mentioned by Steinweden (1929), there are two theories concerning the relationships of the Coccidae with other families of the

Common Soft Scales

- Photo 25. *Physokermes hemicryphus* (Dalman), females at the branching of *Picea abies* twigs.
- Photo 26. Same; female enlarged. Note characteristic bud shape.
- Photo 27. *Protopulvinaria pyriformis* (Ckll.), female enlarged.
- Photo 28. *Pseudophilippia quaintancii* Ckll., females in white cottony secretion on *Pinus* sp. twig.
- Photo 29. Same; section of stem enlarged to show the white cottony secretion.
- Photo 30. *Pulvinaria acericola* (Walsh & Riley), females with cottony egg sac on *Acer saccharinum* leaf.



Coccoidea. One maintains that they are most closely related to the Eriococcidae; the other suggests affinities with the Asterolecaniidae.

The premise of relationship to the Eriococcidae is based principally upon the similarity of the anal plates of the Coccidae to the anal lobes in the former group. The anal lobes of first instar *Eriococcus* are sclerotized and similar to the anal plates of first instar Coccidae. Also, the anal lobes possess a long apical seta as do the anal plates of first instar Coccidae. Hypothetically, the anal lobes could become retracted into the anal area and finally form plates at the anterior end of a cleft.

In support of the theory of relationship to the Asterolecaniidae, certain Coccidae possess 8-shaped pores that resemble those of the Asterolecaniidae, although they apparently are not identical in structure. Reference is also made by Steinweden (1929) to the similarities between Coccidae and members of the genus *Lecanodiaspis*, which was considered a genus of the Asterolecaniidae until 1959. In an evolutionary study of the Coccoidea, Borchsenius (1958) placed the family Coccidae in a group with the Asterolecaniidae, Acleridae, and Beesoniidae. He stated that the group was characterized by the development and perfection of a method of fastening the females and nymphs to the surface of the food plant. This possibly resulted in the emergence of the marginal fold which sharply divides the

Pulvinaria Scales

Photo 31. *Pulvinaria acericola* (Walsh & Riley), females with cottony egg sac, enlarged.

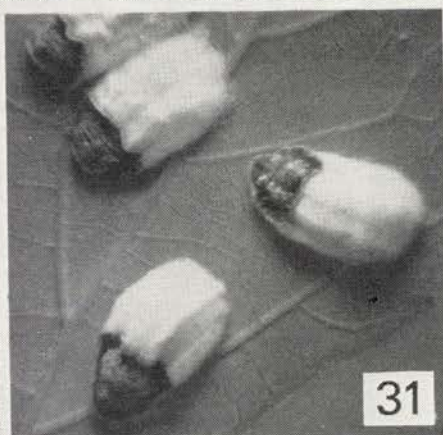
Photo 32. *Pulvinaria ericicola* McConnell, females, some beginning to form ovisac on underground portion of stem of *Vaccinium vacillans*.

Photo 33. *Pulvinaria floccifera* (Westw.), females forming ovisac on leaf of *Camellia* sp.

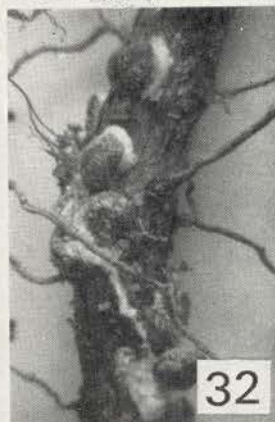
Photo 34. *Pulvinaria innumerabilis* (Rathv.), old females with ovisac, on branches of *Acer saccharinum*.

Photo 35. Same; young female, before oviposition, on twig of *Quercus rubra*.

Photo 36. *Pulvinaria psidii* Mask., female on ornamental leaf.



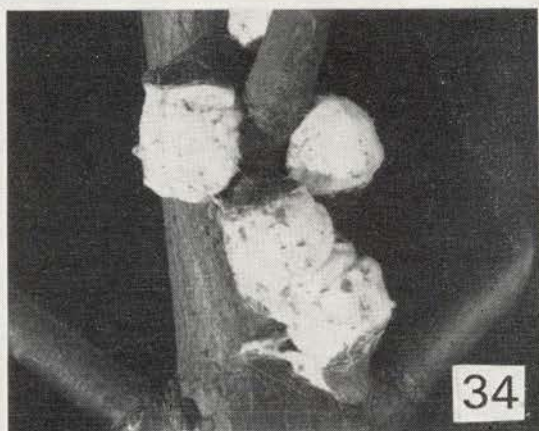
31



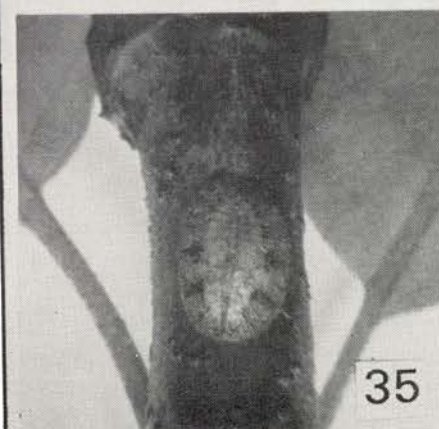
32



33



34



35



36

body into dorsal and ventral surfaces, and the development of marginal setae, spines, and spiracular setae.

Borchsenius (1959) erected and separated the family Lecanodiaspididae from the Asterolecaniidae because of the presence of an anal cleft. Therefore, based on a study of the first instar nymphs of *Lecanodiaspis* (Williams and Kosztarab, 1970) and a study by Howell and Kosztarab (1972) on the adult females of this genus, we believe that the Coccidae are most closely related to the family Lecanodiaspididae. The adult females share the following morphological characters: usually with slight stigmatic depressions; usually with distinctive spiracular setae; with spiracular pore bands; presence of an anal cleft (although short in *Lecanodiaspis*); presence of sclerotic processes at the base of the anal cleft; anal ring well developed, with numerous wax-secreting pores and anal ring hairs; with characteristic tubular ducts; and with similarity between the cribriform plates of Lecanodiaspididae and the discoidal pores of Coccidae. Specimens of the coccid, *Ceroplastodes deani* Lawson produce a brittle, waxy test; and during gestation, they shrink into the anterior half of the test as do members of the genus *Lecanodiaspis*. In this species, the bases of anal plates are fused, as in many Lecanodiaspididae.

The adult males share the following characters: general body form; scutum with a clear area; and a penial sheath which is fused dorsally. Williams and Kosztarab (1970) found that first instar nymphs of *Lecanodiaspis* possessed anal plates and spiracular setae

Saissetia and Toumeyella Scales

- Photo 37. *Saissetia coffeae* (Walk.), females and nymphs on a leaf.
Photo 38. Same; females on stem; lateral view.
Photo 39. *Saissetia miranda* (Ckll. & Parr.), females on Poinsettia (= *Euphorbia* sp.) stem, also two enlarged females from leaves of an undetermined host.
Photo 40. *Saissetia oleae* (Oliv.), females on plant stem.
Photo 41. *Toumeyella cerifera* Ferris, females on stem of *Cephalanthus occidentalis* on left. Shelter built over the scale insects by *Crematogaster* ants on right.
Photo 42. *Toumeyella liriodendri* (Gmelin), young females.



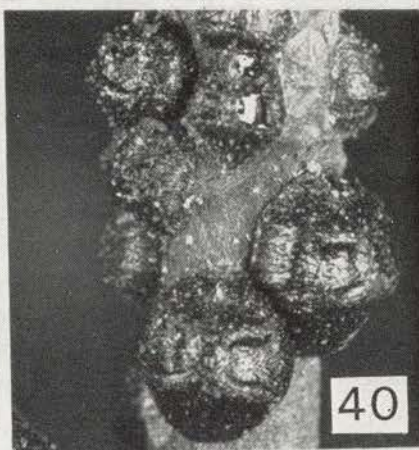
37



38



39



40



41



42

similar to, but less developed than, those found in the Coccidae. Boratynski (1970), and Boratynski and Davies (1971), after completing numerical studies on the value of taxonomic characters of the adult male Coccoidea in classification of the Coccoidea, also concluded that the Coccidae were very near the Lecanodiaspididae.

Several persons have attempted, with little success, to reclassify the Coccidae into natural or related groups. Steinweden (1929) divided 13 of the 32 genera he studied into 3 groups around the 3 genera *Coccus* L., *Toumeyella* Ckll., and *Exaerotopus* Newst., but left the remaining 19 genera ungrouped. Bodenheimer (1953) divided the Coccidae of Turkey into 4 subfamilies: the Coccinae, Filippiinae, Ceroplastinae, and Eriopeltinae. A more comprehensive study is that of Borchsenius (1957), in which he divided the family into 3 subfamilies: the Filippiinae, Coccinae and Ceroplastinae. He further divided the subfamily Coccinae into the tribes Coccini and Pulvinariini. His classification was based on a study of 194 species in 37 genera from the Palearctic Region. He used a number of morphological characters and in establishing his groupings, emphasized the way in which the body of the female and the eggs were protected. Giliomee (1967) found that the males of 19 genera of Coccidae exhibited an entirely different relationship than that suggested by Borchsenius, based on studies of females. According to Giliomee, the morphology of males suggested dividing the Coccidae into the following 4 groups: *Eulecanium* group, *Eriopeltis* group, *Inglisia* group, and *Coccus* group.

Because of the regional scope and limited material of our investigations, we do not feel justified in attempting to reclassify the family Coccidae. We believe that the family should be divided into subfamilies, but only after all stages have been adequately studied.

Although the morphology of the species in the family Coccidae is varied, members of the family can generally be recognized by the following characters: adult females with anal plates (except *Physokermes* Targ.) which are located at the anterior end of an anal cleft; anal ring usually well developed, with numerous pores and 0 to 12 anal ring hairs; body with a marginal fold which divides the dorsal and ventral surfaces (this fold normally bears marginal setae of various forms and sizes); spiracular pore bands present; spiracular setae usually present; legs and antennae variable; without abdominal spiracles, brachii, dorsal ostioles, or circuli.

ECONOMIC IMPORTANCE OF THE COCCIDAE

Because of its large number of pest species and their cosmopolitan distribution, the family Coccidae represents an economically important group of insects. Many species of soft scales attack agricultural, ornamental, and greenhouse plantings throughout the world. The economic importance of the group is perhaps considerably underestimated because of the many isolated infestations in ornamental plantings. Unless there is a widespread attack in an area, it is usually overlooked, and often the reason for death of the plant involved is attributed to some other cause. In addition to the loss of plant juices caused by the soft scales feeding, they excrete a large amount of honeydew which serves as a medium for the growth of sooty mold fungi. The sooty mold fungus not only inhibits photosynthesis by the plant, but also greatly reduces the aesthetic qualities of the plant due to its dirty or sooty appearance. There are insufficient observations of their role as transmitters of plant viruses.

The brown soft scale, *Coccus hesperidum* L., and the black scale, *Saissetia oleae* (Oliv.), are very significant pests in citrus groves. The state of Florida maintains an economic evaluation of the black scale throughout the year by periodically recording its population fluctuation.

The Japanese wax scale, *Ceroplastes ceriferus* (Fabr.), is becoming a more serious pest of ornamentals along the East Coast where it has extended its range northward and has rapidly increased in numbers.

Most species of economic importance in the United States belong to the following 4 genera: *Ceroplastes* Gray, *Coccus* Linnaeus, *Lecanium* Burmeister, and *Saissetia* Deplanche.

Where records are available, the economic importance of particular species is discussed in more detail under the treatment of each species.

MATERIAL AND METHODS

MATERIAL

A large portion of the material studied was collected since 1967 by the authors and their associates. Specimens on slides and dry material were borrowed from several institutions and private collections. Sources of the material are given under "Acknowledgments" and

"List of Abbreviations Used." Representative mounted specimens were returned to the appropriate lending institution and individuals, the remaining slides were retained in the VPI&SU Collection and in the personal collection of M. L. Williams.

COLLECTING

In addition to the material borrowed from different sources listed in "List of Abbreviations," live specimens were collected from various localities representing the major climatic, altitudinal, and faunistic areas of Virginia during 1969-1972. In addition to obtaining specimens for study, the collecting trips enabled the authors to compile notes on the biology and ecology of many species studied. The insects were collected *in situ* by detaching pieces of bark, twigs, or other plant parts. Specimens were placed in collecting bags along with appropriate data. Where the host plant could not be cut, the scale insect specimens were removed individually from the plant and preserved in 70% ethyl alcohol or Carnoy II solution until mounted. Living material was used in the laboratory for color description, egg counting, rearing, and mounting.

COLOR DESCRIPTION

(Adapted from Kosztarab [1964]): The pocket edition of "Munsell Book of Color" was used as an aid in determining the color of

Toumeyella Scales

Photo 43. *Toumeyella liriodendri* (Gmelin), old females with nymphs ("crawlers") and a Coccinellidae predator feeding on nymphs.

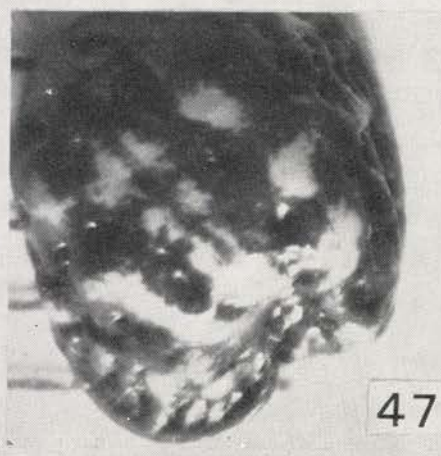
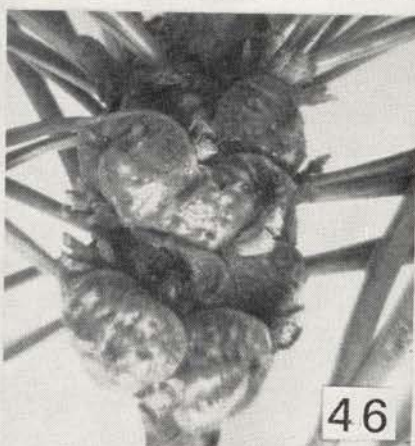
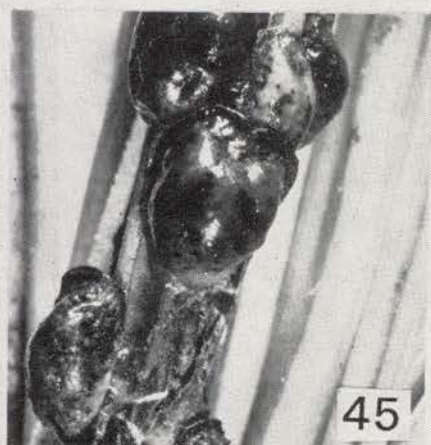
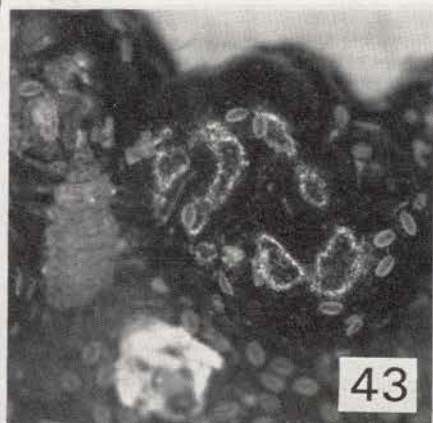
Photo 44. *Toumeyella parvicornis* (Ckll.), females on *Pinus virginiana* twig.

Photo 45. Same; females enlarged.

Photo 46. *Toumeyella pini* (King), old females on *Pinus virginiana* twig.

Photo 47. Same; young female enlarged.

Photo 48. *Toumeyella virginiana* n. sp., female in left lower corner, and male tests above; on *Pinus virginiana*.



different stages and species. The color charts in the book are easily removed. Specimens to be color coded were placed on a microscope slide and that was placed on a chart which included the range of hues which nearly matched the color of the specimens under investigation. Under a binocular microscope, the slide with the specimens was moved above the chart until the most similar color pattern was obtained. The technical description of the color was recorded (e.g., reddish yellow on chart 22.5, color value No. 8, chroma No. 10, which was designated 22.5RY 8/10). The advantage of this method is that there is less chance for bias in the color determination, and the color can be recalled at any time and any place.

REARING

Samples of the freshly collected material were placed in small cellophane bags and sealed with paper clips. The bags were checked every 1 to 3 days for any parasites and/or predators which might have emerged from the sample. All parasites and predators were then pinned or preserved in 70% alcohol for future identification. Male Coccidae were also reared in the same way and preserved in 70% alcohol. The sealed bags must be closely watched, and if moisture appears in them, they should be opened and allowed to dry; otherwise, mold may form and ruin the specimens.

MOUNTING METHODS

Specimens preserved either dry, or in 70% ethyl alcohol or Carnoy II solution, were mounted on microscopic slides with the aid of an AO Spencer binocular dissecting microscope.

Freshly collected material was kept in 70% ethyl alcohol or Carnoy II solution for at least 2 hours before mounting in order to fix the tissues.

Both alcohol- and Carnoy-preserved specimens were mounted according to the following procedure:

1. The specimens were transferred to Essig's Aphid Fluid and heated at about 94°C until the body began to clear (for older specimens, a small incision was made on the side of the body to speed the clearing process).
2. All the body contents were expelled while in the Essig's Aphid Fluid by slightly pressing the insect.

3. After all body contents were removed and the specimens became transparent, they were transferred to a dish of clean Essig's Aphid Fluid to which a few drops of stain * had been added.
4. The specimens were stained for about 30 minutes at a temperature of 94°C. (Most specimens may be left in the stain for hours without becoming overstained.)
5. The specimens were then transferred to 95% ethyl alcohol for 5 to 15 minutes, or until all excess stain was washed out.
6. The specimens were transferred to clove oil for 10 minutes or longer.
7. The specimens were mounted in Canada balsam under a 15- or 18-mm round cover glass.
8. The slides were permanently marked with a diamond point pencil.
9. Slides were kept in a drying oven at a temperature of approximately 40°C for about 2 weeks before labeling.

Dry material was placed in 10% KOH solution until the body expanded or became soft. It was then transferred to Essig's Aphid Fluid and mounted according to the previously described procedures.

To obtain satisfactory slide preparations for microscopic study, the unstained or badly mounted specimens on old slides were often released and remounted. They were released by soaking in xylene until the cover glass could easily be removed. After the specimens were released in the xylene, they were passed through a series of decreasing alcohol concentrations starting with absolute or 95% to 70% and finally to distilled water. They were then mounted according to the previously described mounting technique.

NOTE:

* The formula used in preparing the staining solution is as follows:

Essig's Aphid Fluid		15 ml.
Acid Fuchsin	(2% aqueous solution)	20 drops
Lignin Pink	(2% aqueous solution)	20 drops
Erythrosin	(2% aqueous solution)	20 drops

MEASUREMENTS

All measurements are in microns unless stated otherwise. Measurements of slide-mounted specimens were made by using an ocular micrometer and a Zeiss RA phase contrast microscope. Magnif-

ication used was from 35X to 2,000X. The measurements in the text show the average, followed by the range in parentheses. When available, 10 specimens were measured for all characters mentioned. An attempt was made to select good specimens from different hosts and localities in order to show a more accurate range of variation if and when it occurs within a species. Quantitative data concerning structures which vary in size or number within the genera or species, such as the size of specimens, pores and setae, and the number of submarginal tubercles, are presented to show the range observed in the material examined. When many examples of a species have been studied, the range recorded should cover the range of variation one would expect in that species; but in cases where only a small number of specimens are studied, it may be expected that, as additional material is studied, the quantitative limits presented here will be widened.

ILLUSTRATIONS

Many members of the family Coccidae become distended and heavily sclerotized with age, a matter which obscures the arrangement and appearance of dermal structures. Therefore, the illustrations have been made from preparations of young adults.

Drawings were outlined using a Leitz-Prado 500 microslide projector. The details and enlargements were drawn by using a Zeiss RA phase contrast microscope. Each figure has a central drawing for the whole adult female with the left half representing the dorsal surface and the right half the ventral surface. Around this central drawing, certain taxonomic features are drawn to a much larger scale, in order to show the details of the more important morphological characteristics. The drawings are not made to the same scale in all species, neither are the dermal structures and enlargements in direct proportion to each other. This was done to use available space most economically.

TERMINOLOGY

The morphological terminology used, with a few exceptions, was adapted from Steinweden (1929). For each species, under "Material Studied" the first number indicates the number of slides, the second number in parenthesis the number of specimens from the same collection, e.g., 1(3); all localities listed are from Virginia, unless stated otherwise.

Coccid common names included in the list *Common Names of Insects Approved by the Entomological Society of America*, are used wherever possible or when available. Additional common names suggested by the authors are marked with an asterisk(*).

GENERAL MORPHOLOGY OF THE ADULT FEMALE

Body shape: The body as it appears on the slide (plate 1, fig. A) is usually subcircular, elliptical, or pyriform, varying both with the species and the age of the specimens studied. At the posterior end of the body is the anal cleft (plate 1, fig. B) which extends into the body as far as the anal plates (plate 1, fig. J₁, J₂). Usually the anal cleft is only about 1/6 the body length; but in the genus *Protopulvinaria*, the anal cleft extends almost to the center of the body (plate 14). Spiracular depressions are usually found on the margin at the spiracular setae. These may be well-developed as in the genus *Ceroplastes* (plate 4) or absent as in some of the *Toumeyella* (plate 24).

Derm: The derm in immature specimens and young adult females is usually membranous. The dorsal derm of many species of Coccidae becomes heavily sclerotized with age, particularly after oviposition. The appendages, mouthparts, and anal plates of all species studied were sclerotized in all stages. Often the sclerotized dorsal derm has clear areas around some of the dorsal pores, giving the derm a cell-like appearance. This character is especially developed in the genus *Saissetia*.

Segmentation (plate 1): No indication of segmentation is found on the dorsal derm of the Coccidae. In most species, ventral segmentation is very obscure, but usually can be detected in the mid-abdominal region.

As in many other coccoid groups the head and thoracic segments of the Coccidae are closely fused. However, certain structures are present which indicate segmentation. The antennae and mouthparts are on the head; and in many species, eyes are also present. The legs, spiracles, spiracular pore bands and spiracular setae mark the thoracic segments.

The abdominal segments are indicated in the mid-ventral region of most species and are evident, except near the anal area.

In the insects, the anal opening is found on the 11th abdominal segment, and usually the 11th as well as the 10th segment is re-

duced. The only fixed abdominal structure is the gonopore (Farris, 1955), therefore the vulva of the Coccidae lies on the 8th abdominal segment. As for the rest of the segmentation, we agree with Sulc (1932), that the 9th segment is composed of the anal plates; the 10th segment is the anal ring and fold; and the 11th segment is the membrane covering the anal opening. Counting forward from the anal ring to the metathorax, segment 2 can be recognized as the first visible abdominal segment. Apparently segments 1 and 2 are fused.

DORSAL SURFACE AND MARGIN

Setae: Marginal setae (plate 1, fig. C) occur in all Coccidae, although they are very difficult to detect in some species. Marginal setae in most species are slender and acute, but in others they are extremely variable (plate 2, fig. A), being conical, stout, hair-like, bifid, fringed, or dentate and acute or blunt, curved or straight, or expanded near the apex. The number of marginal setae around the head, counted between the anterior spiracular setae is of taxonomic value. Body setae (plate 1, fig. D), normally scattered randomly over body, but occasionally, as in *Lecanium corni* (plate 10), forming 1 or 2 longitudinal, mid-dorsal rows. Usually body setae are short and slender, but again they are quite variable (plate 2, fig. B). The most striking form of body setae is the truncate setae of *Eriopeltis festucae* (plate 8, fig. B₁).

Spiracular setae (plate 1, fig. E): All species studied, except *Eriopeltis festucae*, *Physokermes hemicryphus*, *Pseudophilippia quaintancii*, and *Toumeyella parvicornis* had spiracular setae which could be differentiated from marginal setae. In most cases the spiracular setae are in groups of 3, terminating each spiracular pore band; but in the genus *Ceroplastes* (plate 4), they may number 90 or more. There are various shapes and sizes (plate 2, fig. D) throughout the family Coccidae. The shape and number of spiracular setae are of taxonomic importance in separating genera and species.

Submarginal tubercles (plate 1, fig. F, photos 20, 21): These are round tubercles surrounding a central invaginated tube; they occur in the dorsal submarginal area around the body. These tubercles are present in some genera and species, and absent in others. They are usually quite large and vary in number, even within the same species. *Lecanium persicae* (plate 12, fig. B) may have up

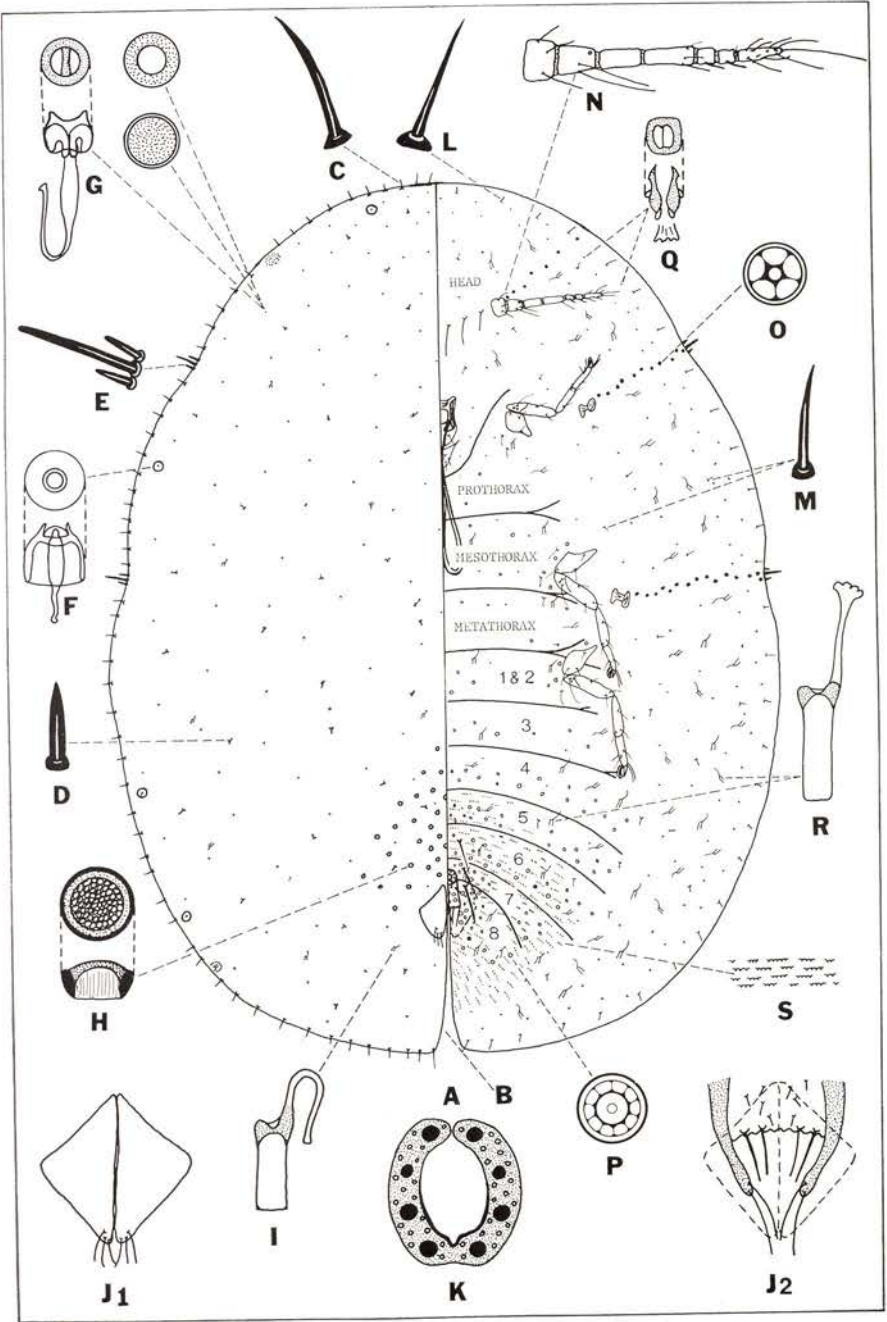


Plate 1. - General morphology of adult female

to 17 pair. The number of submarginal tubercles serves as a good character to separate some species.

Pores: Dorsal pores (plate 1, fig. G) are numerous and quite variable. Usually dorsal pores are scattered randomly over the entire dorsum without any particular pattern, but in the genus *Ceroplastes*, there are a varying number of large, clear areas on the dorsal derm in which pores are apparently absent (plate 4). In addition to the pores which occur generally over the dorsum, many species possess discoidal pores in the area around or anterior to the anal plates (plate 1, fig. H). Discoidal pores are usually much larger, and may be simple and rather flat, convex, or even conical (plate 2, fig. G). Various types of dorsal pores are illustrated in (plate 2, fig. E, F). Types of dorsal pores include: monolocular ring pores (plate 4, fig. I), bilocular pores (plate 12, fig. F), barred bilocular pores (plate 5, fig. G), irregular bilocular pores (plate 5, fig. H), 8-shaped pores (plates 13, fig. E), triangular trilocular pores (plate 4, fig. E), oval or irregular trilocular pores (plate 6, fig. F), quadrilocular pores (plate 4, fig. F), cruciform pores (plate 7, fig. G), quinquelocular pores (plate 9, fig. F), simple disc pores (plate 7, fig. F), thick rimmed disc pores (plate 9, fig. E), and conical disc pores (plate 4, fig. J). Specialized types of invaginated pores were found in two species of Coccidae studied: in *Pseudophilippia quaintancii*, the dorsal derm is covered with numerous invaginated 8-shaped tubercles (plate 15, fig. E₁), and in *Toumeyella parvicornis*, the bilocular pores are invaginated and tend to aggregate into groups or form pore plates (plate 25, fig. D) on the dorsal derm. The arrangement, number, and types of dorsal pores are taxonomic characters used to separate some genera and many speices of Coccidae.

Ducts: Tubular ducts (plate 1, fig. I) with slender inner filaments are scattered randomly over the dorsum of several species of *Lecanium* and *Pulvinaria*. They are occasionally found in limited numbers around the margin of *Coccus hesperidum*. Filamentous ducts (plate 4, fig. K) are found around the margin of *Ceroplastes ceriferus*.

Anal plates (plate 1, fig. J₁, J₂, photo 5): The anal plates are located at the anterior end of the anal cleft above the opening of the anal tube. They vary in shape, but are most often triangular. They are generally supported by two sclerotic, internal pro-

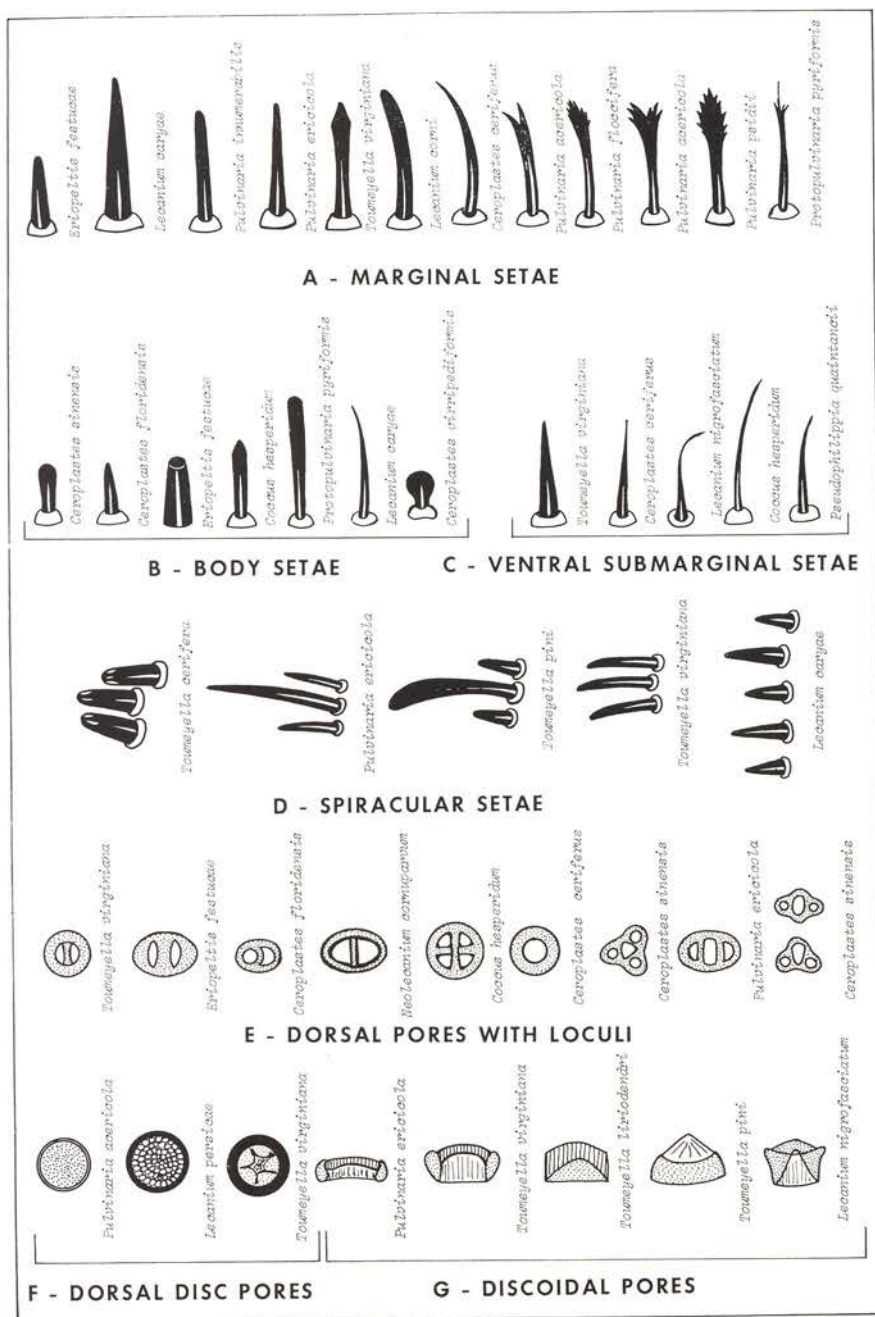


Plate 2. - Morphological details of Coccidae

cesses termed the ventral thickenings. These plates are present in all adult female Coccidae except the genus *Physokermes*.

Setae are found on various parts of the anal plates (plate 3, fig. K, L); as apical setae at, or near, the apices; subdiscal setae on the caudolateral margin away from the apex; discal setae on the middorsal surface; subapical setae on the ventral surface and ventral thickening; fringe setae along the margin of the fold made by the invagination of the anal tube; and hypopygial setae on the ventral surface of the body just anterior to this fold. Several genera have anal plates or associated setae which are distinctive. *Pseudophilippia* (plate 15) has nearly semicircular anal plates. In *Protopulvinaria* (plate 14) the anal plates are at least 4 times longer than wide. The anal plates of *Ceroplastes* are born at the apex of a sclerotized and usually elevated process (plate 4). Anal plates in the genus *Saissetia* possess a single large discal seta on each plate.

Anal ring (plate 1, fig. K): It is born at the inner end of the anal tube which is retracted into the abdomen. The anal tube is eversible and can be extended out past the anal plates for waste removal to avoid contamination of the anal area. The anal ring has 6 to 10 hairs and numerous translucent wax pores (plate 3, fig. H). The hairs may all be of the same size, or one pair may be smaller than the others. Generally there are 8 hairs, but members of *Neolecanium*, and *Toumeyella* have 10. In the genus *Ceroplastes* the second pair of anal ring setae is very near the third pair, thus it appears that there are only 6 setae on the anal ring, when there are actually 8.

The vulva is located at the 8th abdominal segment, on the ventral side of the body anterior to the anal cleft. In most species it is very difficult to detect.

VENTRAL SURFACE

Setae: Ventral submarginal setae (plate 1, fig. L), arranged in an even or irregular row around the submargin of body. Although there is some variation in shape and number (plate 2, fig. C), most of them are slender and acute; therefore, they are not important as taxonomic characters. Body setae (plate 1, fig. M), numerous in some species, sparse in others, usually resembling ventral submarginal setae, scattered randomly over the body, sometimes several are found clustered near each coxa. A varying number of setae occur between antennal bases, but are not important in clas-

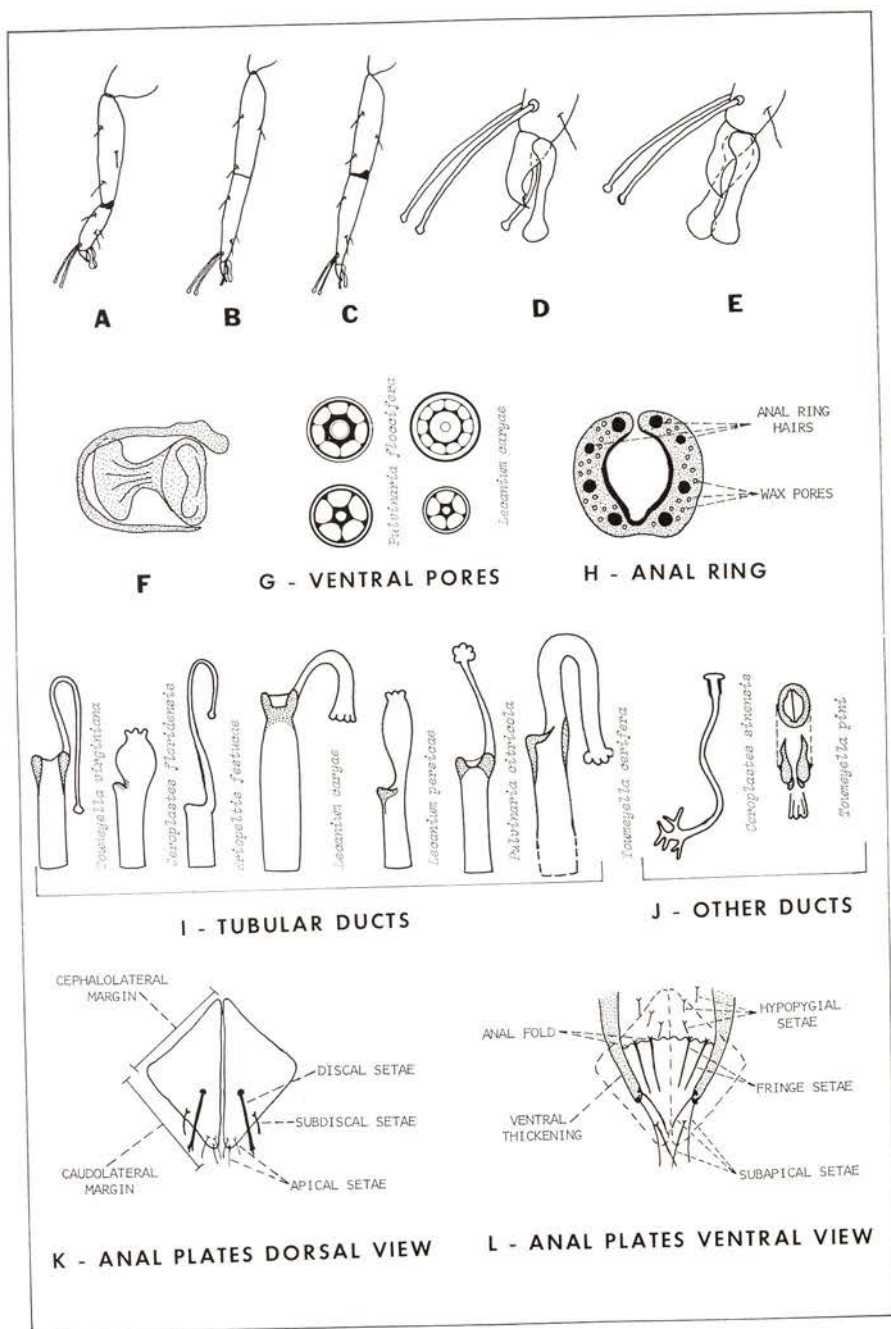


Plate 3. - Morphological details of Coccidae

sification, except in *Pulvinaria citricola* (plate 17, fig. K) which has interantennal setae that often have bulbous expansions near the apex. Interantennal setae are occasionally used as secondary characters. Usually 3 pair of large setae, termed prevulvar setae, are found anterior to the vulva on abdominal segments 6, 7, and 8; but in *Ceroplastes* and *Protopulvinaria* there are only one pair. In *Toumeyella* the prevulvar setae are variable.

Eyes: Detected in many of the species studied. They occur on or near the margin above the level of the antennae. They are apparently of no taxonomic importance.

Antennae (plate 1, fig. N): In most Coccidae the antennae are long, fairly slender, 6- to 8-segmented, with the third segment usually longest. The second segment in all species seen has a sensory pore. The terminal, or apical segment has several fleshy and several more slender, hairlike setae. The 2 subapical segments usually possess 1 fleshy sensory seta each, which extends toward the antennal apex. Occasionally specimens are found in which the 3rd and 4th antennal segments are fused, thus making them appear to have less than the expected number of segments. Antennae of the Coccidae may be well-developed (plate 19, fig. N), slightly reduced (plate 8, fig. J), or greatly reduced (plate 23, fig. K). The size and number of antennal segments is useful in separating some genera and species.

Clypeolabral shield: Located on the head, between the bases of the anterior legs. Often possessing a pair of slender setae.

Labium: Cone-shaped, appears 1-segmented, usually with 3 to 5 setae on each side.

Legs: The legs are 5-segmented and generally well-developed in most genera of Coccidae. The trochanter of all species studied had 2 sensory pores on each face, and each tarsus was fitted with a claw. Legs may be well-developed, as in *Ceroplastes floridensis* (plate 5); slightly reduced, as in *Lecanium caryae* (plate 9); or greatly reduced, as in *Toumeyella cerifera* (plate 23). The tibia and tarsus may be articulate and have an articulatory sclerosis (plate 3, fig. A); the tibia and tarsus may be fused, without a tibio-tarsal sclerosis (plate 3, fig. B); or the tibio-tarsal sclerosis may be present, without free articulation (plate 3, fig. C). The tarsus and claw of each leg possess a pair of digitules. The tarsal digitules are equal, but the claw digitules may be unequal in shape

(plate 3, fig. D) or equal in shape (plate 3, fig. E). The claw may have a denticle (plate 3, fig. D), or may be simple, without a denticle (plate 3, fig. E). The reduction of legs, the presence or absence of tibio-tarsal sclerosis, and free articulation and shape of the claw digitules are useful taxonomic characters.

Spiracles: The two pair of spiracles are located on the thorax; the anterior pair believed to be on the borderline between the prothorax and mesothorax; the posterior pair between the mesothorax and metathorax. The posterior pair is normally larger. In most species studied the spiracles are similar in structure and do not appear to be of use in classification. However, in *Pulvinaria psidii*, each spiracle is surrounded by a sclerotic plate (plate 3, fig. F); a character which immediately separates it from other members of the genus. In the genus *Toumeyella* the spiracles are larger in proportion to body size than in most other genera.

Pores: Quinquelocular pores (plate 1, fig. O) are found in the spiracular pore bands and around the spiracles in most species. In the genera *Toumeyella*, *Pseudophilippia* and *Neolecanium*, they are also found in the abdominal region (plate 24, fig. K) where they replace the multilocular pores found in most species. In *Lecanium caryae* quinquelocular pores are also located on the inner margin of the anal cleft (plate 9, fig. F). Multilocular pores, most of which are 10-loculed (plate 1, fig. P), occur in the anal area, in transverse bands on the abdomen, occasionally on the thorax near the coxae and sometimes a few in the spiracular furrows of some species, but numerous in the genus *Physokermes* and in *Toumeyella cerifera* (plate 23, fig. M). In *Pulvinaria floccifera* (plate 19, fig. P) the multilocular pores in the anal area are mostly 7-loculed, and in *P. citricola* (plate 17, fig. N), most are 8-loculed. Various types of ventral pores are illustrated in plate 3, fig. G. The type, position and number of pores are useful taxonomic characters.

Ducts: Microducts (plate 1, fig. Q) were detected in all species studied except *Eriopeltis festucae*. They are scattered over the entire ventral surface but are most numerous in the submarginal area of the body. The ducts open to the surface through round, oval, square-shaped, or cruciform orifices. Filamentous ducts (plate 4, fig. K) are found in *Ceroplastes ceriferus* in a dorsal and ventral marginal row, and in *C. sinensis* in a ventral marginal row around the body. Tubular ducts (plate 1, fig. R) were found in all species studied except *Lecanium nigrofasciatum*. Many types of tu-

bular ducts occur in the Coccidae. Three main types can be recognized: tubular ducts with slender knobbed inner filaments (plate 4, fig. T); tubular ducts with flowery tipped inner filaments which are about $\frac{1}{4}$ to $\frac{1}{2}$ as wide as the duct itself (plate 16, fig. R); and tubular ducts with expanded inner filaments which are as wide as the ducts themselves (plate 5, fig. S, and plate 17, fig. P). Various types of ducts are illustrated in plate 3, fig. I and J. The position or arrangement of the tubular ducts also varies between genera. The genus *Coccus* possesses tubular ducts only near the coxae (plate 7, fig. Q). In the genus *Lecanium* there is usually a dense pattern of tubular ducts in a submarginal band around the body, with few ducts elsewhere (plate 9, fig. P); and in *Pulvinaria* the ducts are scattered over the entire venter, with a dense pattern in the abdominal region (plate 19, fig. T). The shape and position of the tubular ducts are important taxonomic characters.

Microspines (plate 1, fig. S): Small spinelike projections of the derm occur in all species of Coccidae studied. They are in various patterns on the thorax, abdomen, and along the margin of the anal cleft.

KEY TO GENERA OF COCCIDAE IN VIRGINIA

It is difficult to prepare a generic key for Coccidae that will clearly delineate all species assigned to the included genera. Because of the extreme variability of the group, and the fact that many genera are not well defined, some genera include species which do not conform strictly to the limits of the genus to which they have been assigned. Such exceptions are mentioned in this generic key and are marked by an asterisk(*). Notes on each of these species are included at the end of the key.

1. Adult females without anal plates ----- *Physokermes*, p. 105
 Adult females with anal plates -----2
2. Anal plates at least 4 times longer than wide; anal cleft
 extending to center of body ----- *Protopulvinaria*, p. 106
 Anal plates variable, but never 4 times longer than
 wide; anal cleft not extending to center of body -----3

3. Dorsal setae numerous, stout, truncate ----- *Eriopeltis*, p. 62
Dorsal setae variable but not truncate -----4
4. Anal plates with a large discal seta; entire dorsal derm
with small oval clear areas or polygonal reticulations
----- *Saissetia*, p. 157
Anal plates without a discal seta; dorsal derm variable-----5
5. Spiracular setae numerous, stout, conical, hemispheri-
cal, or bullet-shaped; anal plates born at the apex of
a strongly sclerotic and usually elevated process---
----- *Ceroplastes*, p. 35
Spiracular setae variable, but not more than 3 in each
group; anal plates not born at the apex of an elevated
process -----6
6. Ventral tubular ducts, if present, confined to thorax;
very few pores in anal area or on abdomen --- *Coccus*, p. 54
Ventral tubular ducts not confined to thorax (*except
Lecanium nigrofasciatum, where they are entirely ab-
sent); numerous pores in anal area and on abdomen-----7
7. Dorsum with a dense pattern of invaginated 8-shaped
tubercles; spiracular setae absent -- *Pseudophilippia*, p. 112
Dorsum without invaginated 8-shaped tubercles; spi-
racular setae present (*except *Toumeyella parvicornis*) -----8
8. Dorsum covered with a dense pattern of small 8-shaped
pores; legs and antennae reduced ----- *Neolecanium*, p. 99
Dorsum without a dense pattern of small 8-shaped pores;
legs and antennae variable -----9
9. With quinquelocular pores on abdomen and in a band
extending from anal area to posterior spiracle (*ex-
cept *T. cerifera*); tubular ducts confined to anal area,
rarely on abdomen; legs greatly reduced - *Toumeyella*, p. 158
With multilocular pores (with 7-10 locules), on abdomen,
pore band from anal area to posterior spiracle absent;
tubular ducts not confined to abdomen, occurring on
thorax, and usually on head; legs usually well-devel-
oped, rarely reduced -----10

10. Legs with tibio-tarsal sclerotization and free articulation (*except *P. ericicola*); tubular ducts scattered over entire venter, most numerous on abdomen; multilocular pores in transverse bands on abdomen and sometimes a few near each coxa; produces an ovisac ----- *Pulvinaria*, p. 118

Legs without tibio-tarsal sclerotization or free articulation (*except *L. persicae*); tubular ducts most numerous in a submarginal band around body (*except *L. nigrofasciatum*), only a few scattered elsewhere; multilocular pores usually extending up to rostrum on mid-venter; no ovisac is produced ---- *Lecanium*, p. 68

* EXCEPTIONS MENTIONED IN GENERIC KEY

Lecanium nigrofasciatum Pergande—Although this species does not have ventral tubular ducts, it can easily be separated from members in the genus *Coccus* because of the mid-dorsal row of crown-shaped discoidal pores.

Toumeyella parvicornis (Cockerell)—This species does not have spiracular setae, but can be separated from the genus *Pseudophilippia* by the lack of the dense pattern of invaginated 8-shaped tubercles.

T. cerifera Ferris—The multilocular pores in the abdominal region and a large number of them in the spiracular pore band are with 10 locules. This species also possesses numerous tubular ducts on the abdomen. It is easily separated from species of *Lecanium* and *Pulvinaria* by its greatly reduced legs and short, blunt spiracular setae.

Pulvinaria ericicola McConnell—Even though this species lacks tibio-tarsal sclerosis and free articulation, it produces an ovisac and definitely belongs to *Pulvinaria*. It can be separated from *Lecanium* because the large number of tubular ducts scattered on the venter and thorax does not form a submarginal band.

Lecanium persicae (Faricius)—Although this species has a tibio-tarsal sclerosis, there is no free articulation. It can easily be separated from members of the genus *Pulvinaria* because of the dense ventral submarginal band of tubular ducts and the large number (12-34) of submarginal tubercles on the dorsum.

GENERIC DISCUSSION, KEYS TO SPECIES AND DESCRIPTIONS

Genus CEROPLASTES Gray, 1828

TYPE SPECIES

Coccus (*Ceroplastes*) *janeirensis* Gray, 1828.

DESCRIPTION

Body round, oval or irregular in outline, usually convex. Live females are covered with a dense amorphous wax which is usually white, and may or may not be divided into plates. Derm of adult female heavily sclerotized and with numerous trilocular pores. Legs and 6- to 8-segmented antennae usually well-developed. Tibio-tarsal sclerosis present or absent. Marginal and body setae variable. Spiracular setae numerous, conical, hemispherical or bullet-shaped. Submarginal tubercles absent. Quinquelocular pores in spiracular furrow; multilocular pores variable, evident in anal area, in transverse bands on abdomen, or both. Tubular ducts variable. Anal plates usually longer than wide, normally born at the apex of a cone-like or slightly elevated sclerotized caudal process. Anal plate setae variable. Hypopygial setae sometimes present. Anal ring with 8 hairs.

NOTES

The genus *Ceroplastes* is composed of a heterogenous group of species, and will very likely be divided into several genera once it is revised. The eggs are protected by the body of the adult female and the thick waxy covering over the female, until hatching. Dr. D. K. Pollet is completing a study on the morphology, biology, and control of the 3 species included in this study; while Mr. W. F. Gimpel, Department of Entomology, University of Maryland, is presently completing a study on the systematics of *Ceroplastes* of North America north of Mexico. Dr. Pollet found additional parasites and predators for each *Ceroplastes* species in Virginia.

Species recorded from Virginia include: *Ceroplastes ceriferus*, *C. cirripediformis*, *C. floridensis*, and *C. sinensis*. Both *C. ceriferus* and *C. sinensis* are known to overwinter in the state. All slides from Virginia labeled *C. cirripediformis* actually were verified as *C. sinensis* by Mr. Gimpel and M. L. Williams.

KEY TO THE SPECIES OF *CEROPLATES* IN VIRGINIA

1. Claw digitules unequal; with 40 to 80 spiracular setae
in each spiracular furrow ----- *ceriferus*, p. 36
- Claw digitules equal; with 20 to 35 spiracular setae in
each spiracular furrow ----- 2
2. With 9 to 15 marginal setae laterally between groups
of spiracular setae; dorsal derm without a clear area
in center ----- 3
- With 3 to 5 marginal setae laterally between groups of
spiracular setae; dorsal derm with a large clear area
in center ----- *floridensis*, p. 43
3. Multilocular pores absent on venter of first 4 abdominal
segments; spiracular setae usually rounded; filament-
ous ducts present in a ventral marginal band around
body ----- *sinensis*, p. 48
- Multilocular pores present on venter of first 4 abdomi-
nal segments; spiracular setae usually pointed or
bullet-shaped; filamentous ducts absent, photo 6 ---
----- *cirripediformis*

Ceroplastes ceriferus (Fabricius), 1798

* Japanese Wax Scale

Plate 4, Photos 1-5

Coccus ceriferus Fabricius, 1798:546; 1803:311. *C. chilensis* Gray, 1828:7. *C. (Ceroplastes) chilensis* (Gray) White, 1846:333. *Ceroplastes australiae* Walker, 1852:1087. *Columnea cerifera* (Fabr.), Targioni-Tozzetti, 1866:144. *Lacca alba* Signoret, 1869:848. *Ceroplastes ceriferus* (Fabr.), Signoret, 1869:848; Atkinson, 1890:188; Cotes, 1891:91; Maskell, 1892:216; Newstead, 1894:21; Cockerell, 1895a:7; Craw, 1896:44; Green, 1896:3; 1899:190; 1921:259; Howard, 1897:39; Kuwana, 1902:62; 1923:43; Fernald, 1903:149; Carnes, 1907:182; Essig, 1915:136; Morrison, 1920:188; Merrill and Chaffin, 1923:254; Steinweden, 1929:231; Zeck, 1932:611; Her-
rick, 1935:174; Merrill, 1953:86; Brimblecombe, 1956:1; 1962:224; Borchsenius, 1957:457; Dekle, 1963:1; De Lotto, 1971:133; Smith et al., 1971:889. *C. cerifera* (Anderson), Lindinger, 1907:4. *Gas-
cardia cerifera* (Anderson), De Lotto, 1965:198.

MATERIAL STUDIED

Buxus sp., 1, (3),* Portsmouth,** 1954, AMW; 1, (4), Hampton (Buckroe Beach), June 1957, M. L. Bobb; 1, (2), Isle of Wight Co., Windsor, June 24, 1964, H. Jones. *Camellia* sp., 1, (2), Norfolk, Sept. 25, 1942, H. G. Walker; 2, (10), Norfolk, Oct. 6, 1949, R. N. Hofmaster; 1, (4), Newport News, rec. Sept. 1958, K. L. Allen; 1, (2), King and Queen Co., March 18, 1964, C. J. Siding. *Celtis occidentalis*, 1, Echols Co., Ga., Oct. 6, 1968, R. Beshear. *Chaenomeles japonica*, 1, (3), Norfolk, Sept. 15, 1952, H. C. Barker; 1, (4), Williamsburg, Sept. 17, 1954, E. Raynes. *Crataegus* sp., 1, (3), Williamsburg, let., Dec. 24, 1953, E. Raynes. *Euonymus* sp., 1, Hawkinsville, Ga., Nov. 14, 1968, M. F. Alligood; 8, (9), Blacksburg, (greenhouse), March 3, 1968, MLW. *Gardenia* sp., 1, (2), Richmond, Oct. 6, 1963, FRF. *Ilex cornuta*, 1, (4), Isle of Wight Co., Windsor, June 24, 1964, H. Jones; 10, (24), Surry Co., April 29, 1969, E. L. Rawls. *I. cornuta* var. *burfordii*, 1, (4), Richmond, Dec. 3, 1962, FRF; 6, (6), Richmond, Dec. 10, 1968, T. E. Purvis. *I. crenata*, 10, (10), Newport News, April 12, 1968, N. Beal. *Ilex* sp., 2, (2), Norfolk, April 14, 1945, Walker; 2, (3), Farmville, Sept. 11, 1959, B. D. Burks; 1, (3), Virginia Beach, March 15, 1964, C. W. Sanders; 9, (18), Virginia Beach, Sept. 30, 1966, C. Hayes; 7, (7), Southampton Co., Franklin, April 30, 1968, W. Allen. *Podocarpus nagi*, 6, (8), Windermere, Fla., May 16, 1969, F. L. Ware. *Pyracantha coccinea*, 6, (6), Washington, D. C., July 6, 1969, unknown. *Tsuga canadensis*, 8, (8), Colonial Heights, Feb. 1967, T. M. Winfree. On "sumac-like bush", 6, (6), Seashore State Park, Aug. 18, 1969, MLW.

GENERAL APPEARANCE

Body covered with a thick, white, amorphous, waxy covering, convex, circular or irregular in outline. Body of the female with wax removed is pink or reddish-brown. Adults found on the woody portions of their hosts. Nymphs have a single dorsal spot of wax and 15 points of white wax around the margin; a submedian band of the scale body is devoid of wax and appears red.

NOTES:

* In each case, the first number indicates the number of slides, the second in parentheses the number of specimens available from the same collection. One specimen on one slide is indicated by the number 1.

** All localities refer to Virginia, unless otherwise stated.

DESCRIPTION

Body (fig. A) ovate, spiracular depressions distinct. Derm heavily sclerotized in old specimens; with numerous trilocular and quadri-locular pores except for 11 clear areas in a submedian band around body. Well-developed legs and 6-segmented antennae; 40 to 80 conical spiracular setae in each group, and a row of filamentous ducts on either side of margin. Anal plates at the apex of a sclerotized caudal process, with 4 apical and 2 subapical setae each. Anal ring with 8 hairs. Anal cleft obscured by caudal process.

DORSAL SURFACE AND MARGIN

Setae: Marginal setae (fig. B) 24.3(19.6-27.4) long, slender, curved, pointed, numbering about 12 around head. Body setae (fig. C) 7.82 (7.82) long, stout, blunt or occasionally with a slightly pointed apex, scattered over dorsum, numerous near margin; 1 each was also noted on each side of the anteriormost clear area in derm.

Spiracular setae (fig. D): Each group composed of 40 to 80 conical setae, arranged in the shape of a triangle, with the base on the margin and the apex well up on dorsum. Triangle made up of about 6 rows of conical setae; seta at apex largest in the group, 32.6(27.4-35.2) long, 21.3(15.6-23.5) wide; second row of 2 setae 25.5(23.5-27.4) long, 17.2(15.6-19.6) wide; third row of 6-7 setae, 20.8(19.6-23.5) long, 12.5(7.82-15.6) wide; remaining three rows containing about 35 setae of near equal size, 16.0(15.6-19.6) long, 8.98(7.82-11.7) wide, all conical and pointed.

Submarginal tubercles: Absent.

Pores: Trilocular pores (fig. E) diameter 7.82(7.82), scattered over entire dorsum except for clear areas, more numerous in median area. Quadri-locular pores (fig. F) 8.47(7.82-9.78) in diameter, mostly confined to mid-dorsum. Barred bilocular pores (fig. G) 7.82 (7.82) in diameter, scattered over dorsum, most numerous in submarginal area. Irregular bilocular pore (fig. H) 2.44(2.44) in diameter, in a band around body in submarginal and near marginal areas. Monolocular ring pores (fig. I) about 1.95 in diameter, sparsely scattered over dorsum. Conical disc pores (fig. J) about 3.90 in diameter, 5.85 in height, 12 to 25 located on sclerotized caudal process immediately anterior to anal plates.

Ducts: Filamentous ducts (fig. K) about 1.95 in diameter, in a marginal row on both dorsum and venter.

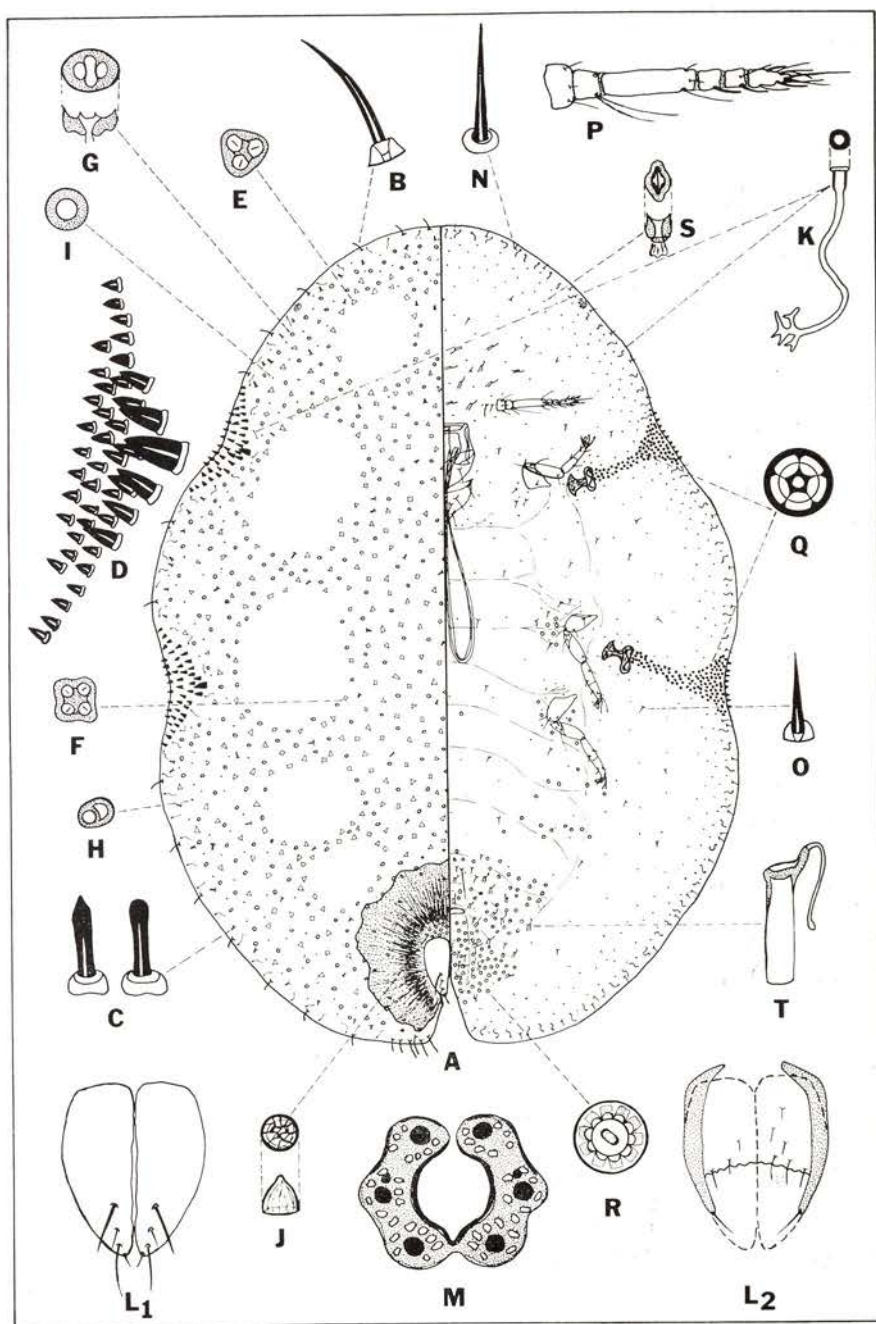


Plate 4. - *Ceroplastes ceriferus* (Fabricius)

Anal plates (fig. L₁, L₂): Elongate, 172(152-192) long, 75.1 (66.5-86.0) wide. Cephalolateral margin 80.2(54.7-106) long; caudolateral margin 141(117-149) long. Each plate with 4 apical and 1 subapical setae. Anal fold with 1 or 2 pair of fringe setae; with 1 to 6 hypopygial setae.

Anal ring (fig. M): Oval to circular, usually indentations between anal ring hairs, length not determined because of position; 86.5(66.5-97.7) in diameter, with 6 long and 2 short hairs and 2 irregular rows of translucent wax pores.

VENTRAL SURFACE

Setae: Ventral submarginal setae (fig. N) 11.7(9.76-15.6) long, slender, acute, usually straight, about 18 around head. Body setae (fig. O) 9.76 (7.82-11.7) long, similar to ventral submarginal setae but shorter and more stout. With 1 pair of large, prevulvar setae.

Eyes: Sometimes detected on margin between second and third marginal setae anterior to first spiracular setae group.

Antennae (fig. P): Well-developed, 6-segmented, 212(196-235) long. Scape 46.1(43.0-50.8) wide, 34.0(27.4-39.1) long. Length of segments II to VI: 30.1(23.5-35.2), 81.3(70.4-89.9), 18.8(15.6-23.5), 21.6(19.6-23.5), 27.0(19.6-39.1) long, respectively. Terminal segment with 2 hairlike and 8 fleshy setae. Setae on other segments: 1, 3; II, 2; III, 3; IV, 1 fleshy; V, 1 and 1 fleshy.

Legs: Well-developed, without tibio-tarsal sclerotization or free articulation. Claws without denticles. Claw digitules unequal, 25.8 (23.5-31.3) long, 1 slender, 1 broad; tarsal digitules equal, 36.8 (31.3-39.1) long, slender, knobbed.

Part of leg	Lengths prothoracic	Lengths mesothoracic	Lengths metathoracic
Coxa	50.8(35.2-78.2)	49.1(43.0-62.6)	50.8(35.2-78.2)
Trochanter	48.4(39.1-54.7)	50.8(46.9-58.7)	50.8(46.9-58.7)
Femur	80.9(78.2-89.9)	79.4(74.3-82.1)	84.4(74.3-93.8)
Tibia	59.5(50.8-66.5)	64.2(58.7-74.3)	64.9(58.7-74.3)
Tarsus	41.1(35.2-46.9)	47.7(43.0-50.8)	46.1(39.1-50.8)
Claw	14.0(11.7-15.6)	15.6(15.6)	16.0(15.6-19.6)
Entire leg	321(285-482)	306(285-328)	312(282-352)

Spiracles: Spiracular apodemes strongly constricted on both sides. Spiracular pore bands about 15 pores wide near spiracular setae, tapering to 3- or 4-pores wide near middle. Anterior spiracles 86.0(58.7-117) long, atrium 72.8(58.6-82.1) wide; posterior pair 89.6(66.5-109) long, atrium 81.7(70.4-89.9) wide.

Pores: Quinquelocular pores (fig. Q) 5.67(3.91-5.87) in diameter in spiracular pore bands, each band containing 120 to 170 pores. Multilocular pores (fig. R), most with 10 locules, 7.82(7.82) in diameter, numerous in anal area, on abdominal segments and a few near meso- and meta-coxa.

Ducts: Microducts (fig. S) about 2.93 long, opening to the surface through cruciform orifices 2.93(2.93) in diameter, scattered over venter, most numerous in a submarginal band around body. Tubular ducts (fig. T) 20.1(15.6-27.4) long, 3.54(2.60-3.91) wide with a slender inner filament about 11.7 long, located in anal area and anterior of antennae on head.

OTHER STAGES

First instar nymphs with well-developed legs and 6-segmented antennae; claw with a denticle; claw and tarsal digitules unequal; marginal setae slender, curved, acute, about 28 around body; spiracular setae in 3's, short, conical or hemispherical, median seta $1\frac{1}{2}$ times as long as laterals; anal plates with 1 long caudal, 2 apical and 1 subapical setae each; with 1 pair of fringe setae; 6 anal ring hairs. Other stages not seen. Males are known to occur, but have not been described in detail. Kuwana (1923) gives brief descriptions of the male, but his illustrations are not detailed.

BIOLOGICAL NOTES

The Japanese wax scale overwinters as an adult female. In late April or early May, a thousand or more eggs are laid and hatch in 2 or 3 weeks. The first instar nymphs settle on the stems or twigs of their hosts and the females develop through 4 growth stages. Males were not noted in any wild or greenhouse populations seen by the authors.

PARASITES AND PREDATORS

Parasites reported attacking the Japanese wax scale include: "*Cheiloneurus ceroplastis*," *Coccophagus lycimnia*, *Eusemion* sp., and *Scut-*

ellista cyanea (Borchenius, 1957). *Aphycus maculipennis* was reared at VPI.

ADDITIONAL HOSTS AND DISTRIBUTION IN VIRGINIA

(Records already given under "Material Studied" have been omitted from this, and from latter such listings.) *Artemisia abrotanum*, Virginia Beach. *Berberis julianae*, Gloucester Co., Gloucester Point; Portsmouth. *B. thunbergii*, Gloucester Co., Gloucester Point. *B. tricanthophora*, Richmond. *Betula pendula*, Virginia Beach. *Buxus sempervirens*, Richmond. *Buxus* sp., Arlington; Hampton. *Camellia japonica*, Gloucester Co., Gloucester Point; Chesapeake; Richmond. *C. sasanqua*, Norfolk; Virginia Beach. *Crataegus* sp. Norfolk. *Deutzia* sp., Virginia Beach. *Diospyros* sp., Chesapeake. *Euonymus japonicus*, Southampton Co., Franklin; Norfolk; Portsmouth. *E. japonicus* var. *microphyllus*, Gloucester Co., Gloucester Point. *Euonymus* sp., Danville. *Ilex aquifolium*, Richmond. *I. cornuta*, Accomack Co., Exmore; Norfolk; Richmond; Virginia Beach. *I. cornuta* var. *burfordii*, Colonial Heights; Southampton Co., Franklin; Alexandria. *I. crenata*, Isle of Wight Co., Colasse; Newport News; Norfolk; Richmond. *I. crenata* var. *microphylla*, Gloucester Co., Gloucester Point; Southampton Co., Franklin. *I. crenata* var. *rotundifolia*, Gloucester Co., Gloucester Point; Portsmouth; Williamsburg. *I. vomitoria*, Portsmouth; Virginia Beach. *Magnolia grandiflora*, Richmond; Virginia Beach. *Podocarpus macrophylla*, Virginia Beach. *Pyracantha coccinea*, Newport News; Norfolk. *Spiraea japonica*, Accomack Co., Wachapreague.

ADDITIONAL HOSTS AND DISTRIBUTION IN U.S.A.

The Japanese wax scale is generally distributed throughout the southeastern states. It is a polyphagous species, and the number of hosts is so extensive that it is impractical to list them in this publication.

ECONOMIC IMPORTANCE

C. ceriferus is important because of the wide variety of ornamental plants it attacks. It is a very prolific breeder and can soon cover the plant. The appearance of the plant is ruined, not only because of the presence of the scale insects in large numbers, but also because of the sooty mold which thrives on the large amount of honeydew excreted by the insects.

NOTES

The status of the Japanese wax scale has long been in a state of confusion. Its history is very intriguing as can be seen from the following paragraph taken from De Lotto (1971):

For the past hundred years the species has been credited to an author who never named it. The supposed source of his description, though cited again and again, has never been seen by anybody, and there is no agreement on the date of its publication. The plant on which the insect was actually collected has never been recorded; while that usually recorded as the type host has never been described. On the basis of the published records the species would appear widely distributed in the world; yet there are grounds for believing that the area of its natural dispersion is relatively small. Discrepancies in earlier literature indicate that at the time of discovery two species were probably involved. On top of all this no reliable diagnosis is available as yet.

Ceroplastes floridensis Comstock, 1881

Florida Wax Scale

Plate 5, Photos 7, 8

Ceroplastes floridensis Comstock, 1881:331; 1883:131; Saunders, 1883:402; Voyle, 1883:20; Riley and Howard, 1889:326; 1890:367; 1894:347; Cockerell, 1893a:80; 1895a:5; Riley, 1894:69; Howard, 1897:39; Green, 1899:191; 1909:277; Gossard, 1900:117; King, 1901d:311; Kuwana, 1902:62; 1923:34; Fernald, 1903:152; Carnes, 1907:182; Herrick, 1911:10; Berger, 1917:72; Dozier, 1920:349; Morrison, 1921:637; Merrill and Chaffin, 1923:256; Ballou, 1926:14; Compere, 1926:37; Steinweden, 1929:231; Essig, 1931:335; Ferris, 1950:75; Merrill, 1953:87; Brimblecombe, 1956:5; 1962:224; Simmonds, 1957:7; Borchsenius 1957:459; Dekle, 1963:1; Ezzat and Hussein, 1967:381; Ben-Dov, 1970a:273; 1970b:84; 1970c:1998. *Ceroplastes rusci* (L.); (misidentifications), Ashmead, 1880:252. *Cerostigia floridensis* (Comst.), De Lotto, 1969:211.

MATERIAL STUDIED

Citrus mitis: 1, (4), Baltimore, Md., Oct. 30, 1961, C. W. McComb. *Gardenia* sp.: 1, (2), Richmond, March 12, 1941, FRF. *Ilex cornuta* var. *burfordii*, 4, (8), Blacksburg (greenhouse), March 3, 1969, MLW. *I. vomitoria*, 2, (8), Baton Rouge, La., March 20, 1970, A. D. Oliver. *Ilex* sp.: Spalding Co., Ga., Oct. 21, 1966, HHT.

GENERAL APPEARANCE

Wax appears dirty white, convex and circular in outline, often with a pinkish tint in younger specimens, about 2 or 3 mm long. Usually there is a definite ledge formed by the wax in the submarginal area. Very often found on the leaves of its host.

DESCRIPTION

Body (fig. A) ovoid, with definite spiracular constrictions at margin, 2566(1845-2925) long; 2015(1300-2407) wide. Dorsal derm covered with numerous trilocular and barred bilocular pores, except for 7 clear areas in submedian area around body. Caudal process conical, short, heavily sclerotized. With 25 to 30 conical, pointed, spiracular setae arranged in 3 rows. Marginal setae numerous, slender, pointed. Legs and 6-segmented antennae well-developed, legs without tibio-tarsal sclerotization. Anal cleft obscured by caudal process.

DORSAL SURFACE AND MARGIN

Setae: Marginal setae (fig. B) 40 to 45 around head, 24.9(19.6-27.4) long, slender and pointed. Body setae (fig. C), sparsely scattered over dorsum, 6.09(3.91-7.82), stout, tapering, bluntly pointed.

Spiracular setae (fig. D): Arranged in 3 rows, all setae conical, pointed. First row composed of a single large seta, 22.6(19.6-27.4) long, 11.8(11.7-12.7) wide. Second row of 4 or 5 conical setae about 17.3 long, 8.65 wide. Third row with 20 to 25 setae, 14.7(11.7-15.6) long, 7.82(7.82) wide. Groups of spiracular setae separated by numerous (10-16) marginal setae on each side of body.

Submarginal tubercles: Absent.

Pores: Trilocular pores (fig. E) 6.30(4.91-7.82) in diameter, and quadrilocular pores (fig. F) 7.82(7.82) in diameter, numerous, scattered over dorsum with the exception of 7 clear areas submedially around body. Barred bilocular pores (fig. G), 4.35(3.91-4.91) in diameter, scattered over dorsum, most numerous in submarginal area. Irregular bilocular pores (fig. H), 2.47(2.47) in diameter, sparsely scattered around submargin. Monolocular ring pores (fig. I) about 1.95 in diameter, a few scattered over dorsum. Conical disc pores (fig. J), about 3.90 in diameter, 10 to 15 in a cluster on caudal projection immediately anterior to anal plates.

Anal plates (fig. K₁, K₂): Twice as long as wide, outer angles rounded, located at the apex of sclerotized caudal projection; length

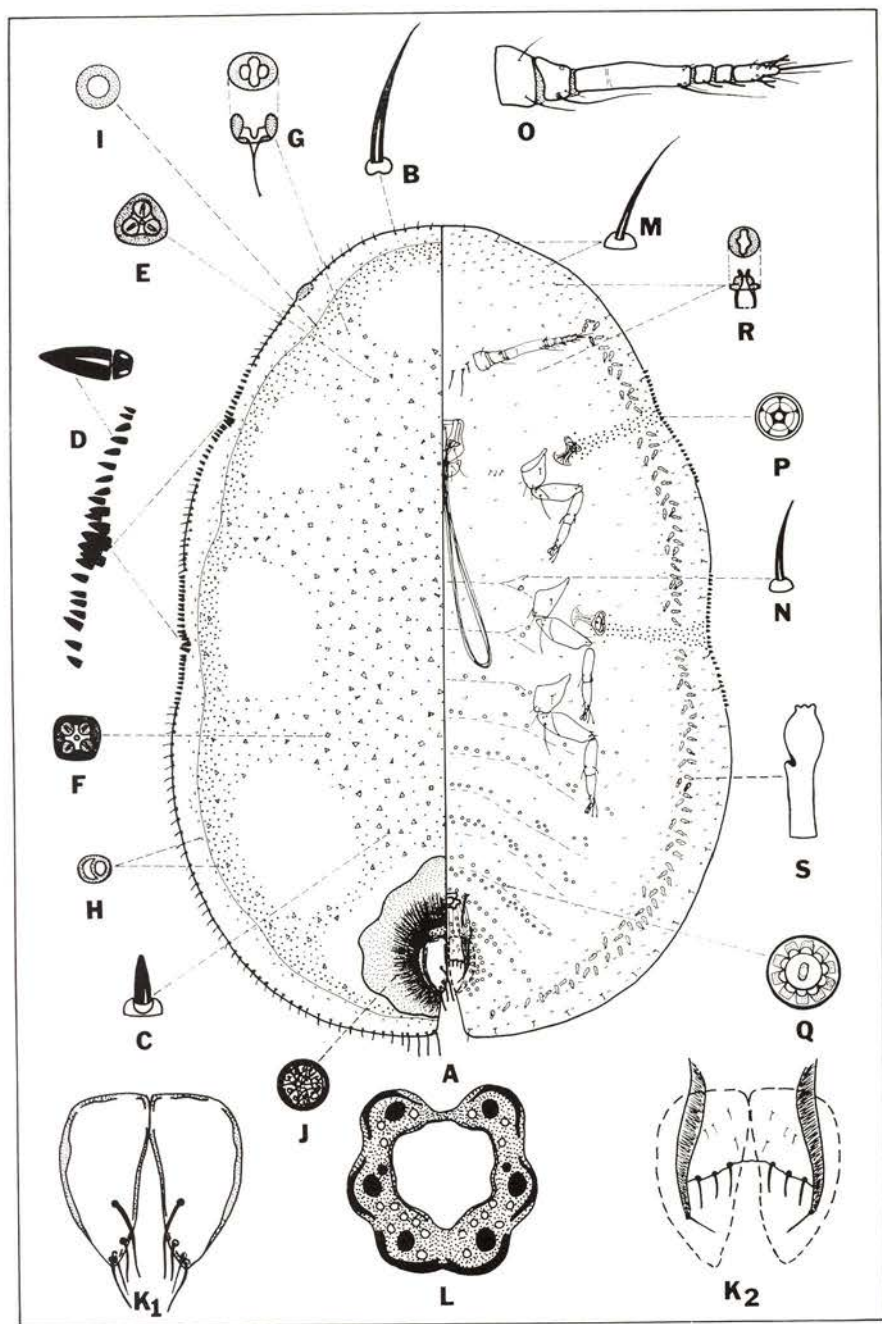


Plate 5. - *Ceroplastes floridensis* Comstock

122(113-129), width 53.8(46.9-58.6); cephalolateral margin 54.7(35.2-58.6) long, convex; caudolateral margin 97.7(89.9-106) long, also convex. Each plate with 4 apical, and 1 subapical setae. Anal fold with 3 pair of fringe setae and occasionally 2 to 4 hypopygial setae.

Anal ring (fig. L): Oval to circular, length not determined because of position in material studied, width 71.2(62.6-78.2), with 6 long and 2 short hairs and an irregular, double row of translucent wax pores.

VENTRAL SURFACE

Setae: Ventral submarginal setae (fig. M) 10.9(7.82-12.7) long, slender, pointed, 18 to 25 around head. Body setae (fig. N) 9.10(7.82-11.7) long, similar to ventral submarginal setae. With 1 pair of large prevulvar setae.

Eyes: Present, located on margin above the level of antennae.

Antennae (fig. O): Well-developed, 6- or 7-segmented but normally 6-segmented, 278(254-313) long. Scape 52.5(46.9-58.6) wide, 51.7(43.0-54.7) long. Length of segments II-VI: 42.6(35.2-54.7), 109(97.7-117), 20.0(15.6-23.5), 20.9(19.6-23.5), 36.1(31.3-39.2) long, respectively. Terminal segment with 5 hairlike and 4 fleshy setae. Setae on other segments: I,2; II,2; III,3; IV,1 fleshy; V,1 fleshy. Usually with 3 pair of setae between antennal bases.

Legs: Well-developed, without tibio-tarsal sclerotization or free articulation. Claw without a denticle. Tarsus and claw each with a pair of digitules; tarsal digitules 49.5(43.0-54.7) long, subequal, slender with knobbed tips; claw digitules 26.5(23.5-31.2) long, subequal, broad with expanded tips.

Part of leg	Lengths prothoracic	Lengths mesothoracic	Lengths metathoracic
Coxa	70.8(66.5-78.2)	78.2(62.6-89.9)	86.4(74.3-97.7)
Trochanter	65.6(62.6-70.4)	68.6(62.6-74.3)	67.4(62.6-78.2)
Femur	109(106-117)	116(109-129)	120(89.9-137)
Tibia	97.3(89.9-109)	105(97.7-121)	106(97.7-121)
Tarsus	59.1(50.8-62.6)	64.7(58.6-70.4)	66.2(62.6-74.3)
Claw	18.2(15.6-19.6)	20.0(15.6-23.5)	20.2(19.6-23.5)
Entire leg	474(399-602)	453(426-504)	456(356-520)

Spiracles: Spiracular apodemes constricted near center. Atrium and apodemal base subequal in width. Spiracular pore bands 5 to 8 pores wide near spiracular setae, 3 wide throughout most of its length; pore band extending to apodeme base. Anterior spiracles 54.7 (46.9-62.6) long, 39.9 (39.1-43.0) wide; posterior pair 56.9 (50.8-66.5) long, 43.8 (43.0-46.9) wide.

Pores: Quinquelocular pores (fig. P) 4.02 (3.91-4.91) in diameter, located in spiracular pore bands. Each band made up of 65 to 85 pores. Multilocular pores (fig. Q) most with 10 locules, 7.38 (3.91-7.82) in diameter, located in anal area and in transverse bands on abdomen.

Ducts: Microducts (fig. R) 2.93 (2.93) long, which open to the surface through a cruciform orifice 1.95 (1.95) in diameter, scattered over venter, most numerous in anterior part of head and in a submarginal band around body. Tubular ducts (fig. S) 11.4 (7.82-19.6) long, 4.02 (3.91-4.91) wide, with a bulbous inner filament 8.68 (7.82-11.7) long, 4.46 (3.91-4.91) wide, located in a submarginal band around body, except for area between eyes.

OTHER STAGES

First instar nymphs have well-developed legs and 6-segmented antennae. Spiracular setae in 3's, with median seta 2 times longer than laterals. Anal ring with 6 hairs. Second instar nymphs with well-developed legs and 6-segmented antennae. Spiracular setae in 3's, subequal in length. Anal ring with 6 hairs. Third instar nymphs not seen. Males are apparently rare, but Kuwana (1923) described all stages of the male.

BIOLOGICAL NOTES

The Florida wax scale has not been known to overwinter outdoors in Virginia, although it has been encountered several times on nursery stock which had been protected during the winter. Normally there is one generation per year. The nymphs seem to prefer settling on the leaves. The female develops through 4 instars. The authors have not seen males in any of the infestations studied, but Kuwana (1923) described their development.

PARASITES AND PREDATORS

Parasites reported attacking the Florida wax scale include: "*Microterys clauseni*," (Compere, 1926); *Aneristus youngi*, *Aphycus ceroplastis*, *Coccophagus lycimnia*, and *Scutellista cyanea* (Peck, 1963).

ADDITIONAL HOSTS AND DISTRIBUTION IN VIRGINIA

Ilex sp., Norfolk. On "ornamentals", Accomac Co.; Northampton Co.

ADDITIONAL HOSTS AND DISTRIBUTION IN U.S.A.

C. floridensis is also recorded from Alabama, California, Florida, Georgia, Louisiana, Mississippi, and North Carolina. The host list is extensive (see Merrill, 1953).

ECONOMIC IMPORTANCE

Not of economic importance in Virginia. Merrill (1953) states that it is not generally considered a serious pest in Florida because it is highly parasitized.

NOTES

De Lotto (1969) established a new genus of wax scales, *Cerostigia*, in an effort to rearrange the genus *Ceroplastes*. In this new genus he included *Ceroplastes floridensis*, *C. japonicus* Green, and *C. rufus* De Lotto. The new genus differs from *Ceroplastes* in that the inner filament of the ventral submarginal tubular ducts is short, and as wide, or wider, than the duct itself. In this study, the Florida wax scale is included in the genus *Ceroplastes*.

***Ceroplastes sinensis* Del Guercio, 1900**

*** Chinese Wax Scale**

Plate 6, Photos 9, 10

Ceroplastes sinensis Del Guercio, 1900:3; Cockerell, 1901b:469; 1905b:162; Fernald, 1903:157; Leonardi, 1920:364; Silvestri, 1920:3; Steinweden, 1929:231; Essig, 1931:335; Balachowsky, 1933:80; Cottier, 1939:422; Spiller, 1943:129; Borchsenius, 1957:451; Simmonds, 1957:7; Ben-Dov, 1970b:83; Snowball, 1970:57; De Lotto, 1971:143.

MATERIAL STUDIED

Ilex aquifolium, 1, (5), Norfolk, Sept. 14, 1948, FRF. *I. crenata* var. *rotundifolia*, 1, (5), Norfolk, Sept. 14, 1948, FRF. *I. crenata* var. *microphylla*, 4, (4), Southampton Co., Franklin, Sept. 12, 1969, DKP; 20, (20), Blacksburg (greenhouse), Oct. 27, 1970, MLW. *Ilex* sp., 1, Norfolk, April 1938, AMW; 1, (6), Norfolk, Aug. 5, 1957, RNH; 1, Menlo Park, Calif., April 9, 1964, R. P. Allen. *Syzygium* sp., 7, (7), Sydney, N. S. Wales, Oct. 19, 1970, D. P. Sands.

GENERAL APPEARANCE

Body usually circular with an irregular margin, convex, covered with a thick waxy secretion which appears pink or red in some areas and white in others. Earlier instars with 2 white, waxy, dorsal projections and 13 marginal points of wax. Nymphs are usually found on the leaves, while the adults are usually found on the stems of their hosts.

DESCRIPTION

Body (fig. A) ovate, 2849(1920-3588) long, 2244(1549-2953) wide, derm heavily sclerotized in old females. Derm with numerous bi-ocular and trilocular pores except for 7 clear areas in submedian area around body, and a large area in center of dorsum. Well-developed legs and 6- or 7-segmented antennae. Spiracular setae short, stout, and rounded, arranged in 3 rows. With a row of filamentous ducts around body near ventral margin. Anal plates at the apex of a sclerotized caudal process, with 4 apical and 2 subapical setae. Anal ring with 6 long and 2 short hairs. Anal cleft obscured by caudal process.

DORSAL SURFACE AND MARGIN

Setae: Marginal setae (fig. B) 29.4(23.5-46.9) long, slender acute, most curved near apex, with large bases, about 11 around head. Body setae (fig. C) 8.21(7.82-11.7) long, stout, rounded at apex, some may be capitate, scattered randomly over dorsum, but more numerous near margin of body.

Spiracular setae (fig. D): In 3 distinct longitudinal rows starting on margin and continuing onto dorsum. Marginal row made up of 12 to 20 setae, 11.7(11.7) long, 7.82(7.82) wide, hemispherical to short with rounded tips; 2nd row of 6 to 8 setae, larger,

more bullet-shaped, 18.8(15.6-19.6) long, 12.1(11.7-15.6) wide. Dorsal-most row containing a single large seta 32.5(23.5-39.1) long, 16.8(15.6-19.6) wide, which is usually conical with a blunt apex.

Submarginal tubercles: Absent.

Pores: Triangular trilocular pores (fig. E) 6.65(5.87-7.82) in diameter, numerous in mid-dorsal region between mid-dorsal clear area and submedian clear areas. Oval or irregular trilocular pores (fig. F) 5.87(5.87) in diameter, scattered over dorsum, most numerous in submarginal area and around submedian clear areas. Quadrilocular pores (fig. G) 7.82(7.82) in diameter, usually located in area anterior to caudal projection. Irregular bilocular pores (fig. H) about 3.42 in diameter scattered around marginal and submarginal area of body. Monolocular ring pores (fig. I) with diameter of about 1.95, sparsely scattered over body. Conical disc pores (fig. J) 3.90(3.90) in diameter, a cluster of 10 to 15 on caudal process immediately anterior to anal plates.

Anal plates (fig. K₁, K₂): Located at the apex of a sclerotized, elevated caudal process. Together longer than wide, apices bluntly pointed, lateral angles rounded. Length 154(137-172), width 72.0(58.6-78.2); cephalolateral margin 78.2(58.6-93.8) long, caudolateral margin 119(97.8-136) long. Each plate with 4 apical and 2 subapical setae. Anal fold with 4 pair of fringe setae. Hypopygial setae absent.

Anal ring (fig. L): Ovate, about 80.4(74.3-89.9) long. We were unable to make an accurate measurement of the length because of the position of the ring in the material studied; with 6 long and 2 short hairs and 2 rows of translucent wax pores.

VENTRAL SURFACE

Setae: Ventral submarginal setae (fig. M) 13.0(7.82-15.6) long, slender, slightly curved, pointed, about 15 around head. Body setae (fig. N) 10.9(7.82-11.7) long, similar to ventral submarginal setae, but more acute, scattered over venter. With 1 pair of large, prevulvar setae.

Eyes: Present, but often hard to detect in adult specimens.

Antennae (fig. O): Well-developed, usually 7-segmented, rarely 6-segmented, 335(301-374) long. Scape 61.4(50.8-66.5) wide, 52.4(35.2-66.4) long. Length of segments II to VII: 63.0(54.7-74.3),

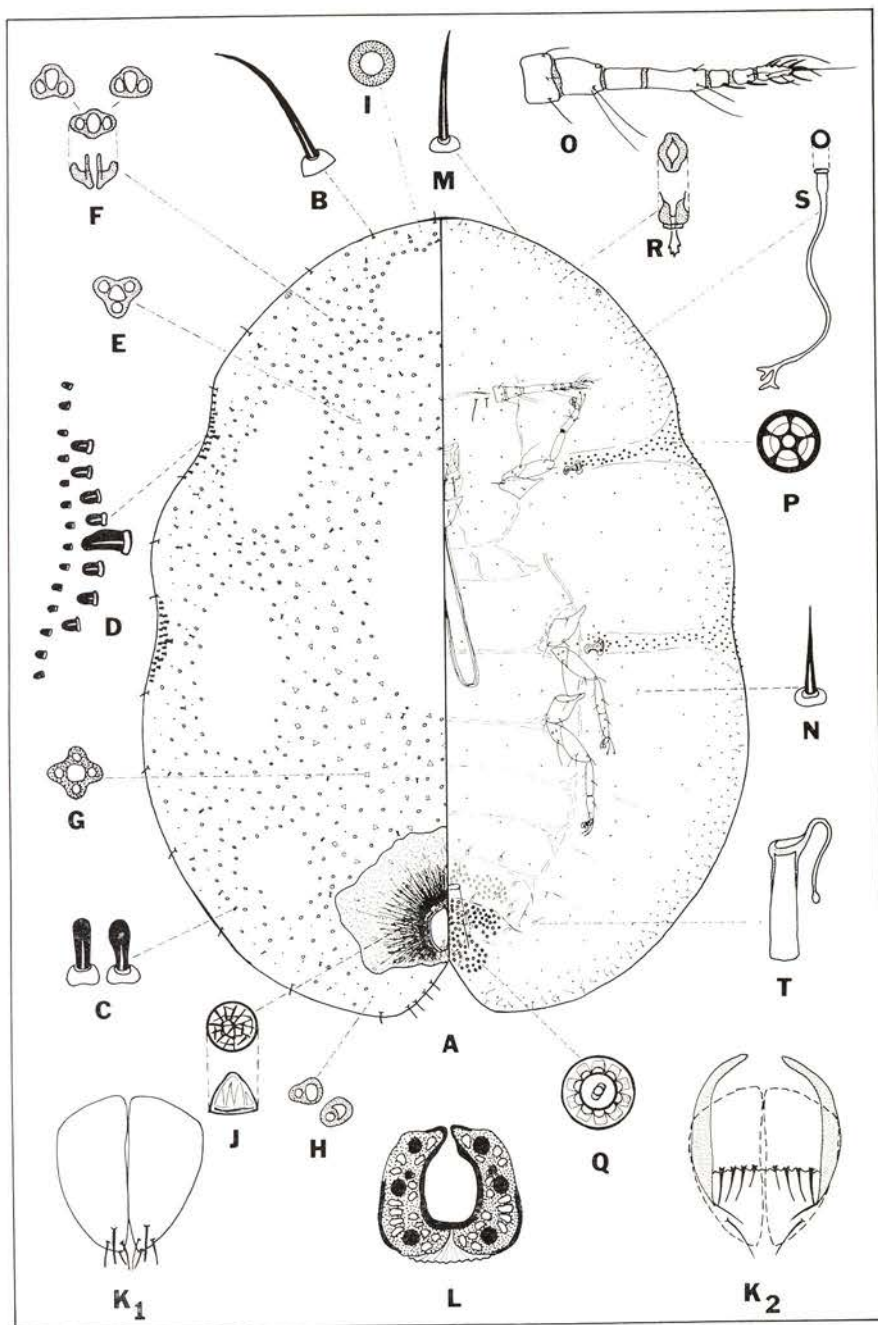


Plate 6. - *Ceroplastes sinensis* Del Guercio

49.2(39.1-58.6), 70.4(39.1-89.3), 31.3(23.5-43.0), 29.4(23.5-46.9), 39.9(27.3-43.0) long respectively. Terminal segment with 2 hair-like and 8 fleshy setae. Setae on other segments: I,3; II,2; III,0; IV,3; V,1 fleshy; VI,1 slender and 1 fleshy.

Legs: Well-developed, with tibio-tarsal sclerotization, but apparently without free articulation. Claws without a denticle. Tarsal digitules equal, 57.5(54.7-62.6) long, slender and knobbed; claw digitules equal, 35.6(31.3-39.1) long, broad, constricted in middle.

Part of leg	Lengths prothoracic	Lengths mesothoracic	Lengths metathoracic
Coxa	88.6(82.1-97.7)	92.4(74.3-101)	90.6(78.2-101)
Trochanter	81.7(78.2-93.8)	87.6(82.1-93.8)	84.4(74.3-93.8)
Femur	145(133-156)	148(133-160)	145(97.8-164)
Tibia	121(109-137)	123(109-137)	123(109-137)
Tarsus	79.4(66.5-86.0)	82.9(78.2-97.7)	81.2(74.3-93.8)
Claw	23.9(23.5-27.4)	27.0(23.5-35.2)	23.9(23.5-27.4)
Entire leg	542(512-590)	564(516-606)	545(477-602)

Spiracles: Spiracular apodeme constricted on both sides; apodemal base almost as wide as atrium. Spiracular pore band extending from margin to apodemal base; may be 7 pores wide at spiracular setae, tapering to 2 or 3 pores wide in middle and then expanding to 4 or 5 pores wide near spiracles. Anterior spiracles 73.9(58.7-89.9) long, atrium 52.0(43.0-66.5) wide; posterior pair 78.6(70.4-93.8) long, atrium 59.0(50.8-78.2) wide.

Pores: Quinquelocular pores (fig. P) 5.87(5.87) in diameter, located in spiracular pore bands, each band containing 45 to 75 pores. Multilocular pores (fig. Q) almost all 10-loculed, 7.82(7.82) in diameter, located in anal area and on posterior abdominal segments, not present on first 4 abdominal segments.

Ducts: Microducts (fig. R) about 2.44 long, which open to the surface through cruciform openings, 3.42(3.42) in diameter, scattered over entire venter, most numerous in a submarginal band around body. Filamentous ducts (fig. S) numerous, about 1.95 in diameter, forming a row around body near margin. Tubular ducts (fig. T) 16.0(15.6-19.6) long, 3.91(3.91) wide, with a slender inner filament, located in anal area, and sometimes a few are seen anterior to antennae on head.

OTHER STAGES

First instar nymphs with well-developed legs and 6-segmented antennae; claws with a denticle; claw and tarsal digitules both unequal; about 28 slender, pointed, marginal setae around body; spiracular setae in 3's, all blunt, median seta $1\frac{1}{2}$ times as long as laterals; anal plates reticulate, with 1 long caudal, 3 apical and 1 subapical setae each; 1 pair fringe setae; 6 anal ring hairs. Other stages not seen by authors. Males are known for this species, but have not been described in detail.

BIOLOGICAL NOTES

There is one generation per year in Virginia. The scale overwinters as an adult female (personal communication with Dr. D. K. Pollet) and begins laying eggs in late May. The eggs hatch in late June and the nymphs settle on the leaves of their hosts. Two nymphal stages feed on the leaves, the third instar usually migrates to the stem or twigs to complete development. Males were not seen in the Virginia populations.

PARASITES AND PREDATORS

Parasites of the Chinese wax scale include: *Aneristus ceroplastae*, *Aphobetoideus comperei*, *Cheiloneurus* sp., *Coccophagus ochraceus*, and *Aphycus helvolus* (Snowball, 1970). *Anicetus toumeyellae* was reared at VPI. Snowball (1970) also reports *Scutellista cyanea* larvae as an egg predator of this scale.

ADDITIONAL HOST AND DISTRIBUTION IN VIRGINIA

Ilex crenata var. *microphylla*, Virginia Beach.

ADDITIONAL HOSTS AND DISTRIBUTION IN U.S.A.

The Chinese wax scale is also recorded from California. Additional hosts include *Citrus* sp.

ECONOMIC IMPORTANCE

Because of past confusion between *Ceroplastes sinensis* and *C. cirripediformis* (photo 6), it is hard to determine if the scale is of much economic importance or not in the United States.

NOTES

All of the available slides of *C. cirripediformis* from Virginia were misidentified and actually represented *C. sinensis*. It is doubtful that *C. cirripediformis* occurs in Virginia. Though the Chinese wax scale was described from specimens collected in Italy, it was named *C. sinensis* because it was thought the coccid originated in China (De Lotto, 1965).

Genus COCCUS Linnaeus, 1758

TYPE SPECIES

Coccus hesperidum Linnaeus, 1758.

DESCRIPTION

Body form variable, usually flat or only slightly convex. Body of adult female naked or with a mere film of wax, derm membranous or sclerotized. Legs and 3- to 8-segmented antennae variable, but usually well-developed. Legs with or without tibio-tarsal sclerotization. Marginal and spiracular setae variable. Submarginal tubercles present or absent. Dorsal pores variable. Multilocular pores not numerous, located in anal area and a few on abdomen; quinquelocular pores in spiracular pore bands. Ventral tubular ducts entirely lacking or present in small numbers near coxae, never arranged in a distinct submarginal zone. Anal plates usually triangular with varying numbers of apical and subapical setae. Anal ring with numerous wax pores and 8 anal ring hairs.

NOTES

The genus *Coccus* is an extremely heterogeneous group and it is veritably impossible to designate generic characters which will apply for all species placed in the genus. A comprehensive generic revision is needed in order to clarify the genus and its complex of species. *Coccus hesperidum* also serves as the type species of the genus *Lecanium* Burm. Since it cannot serve as the type for both genera, and since it is almost universally accepted as the type of *Coccus*, the authors believe, as did Morrison and Morrison (1966), that it should be accepted as the type species of *Coccus*. The genus *Lecanium* should have a new type designated.

Coccus hesperidum is the only species in the genus reported from Virginia.

Coccus hesperidum Linnaeus, 1758

Brown Soft Scale

Plate 7, Photos 11, 12

Coccus hesperidum, Linnaeus, 1758:455; Fernald, 1902:232; 1903:168; Carnes, 1907:186; Sanders, 1909:436; Herrick, 1911:11; Quayle, 1911:194; 1915:291; 1917:373; 1932:46; Kell, 1912:799; Campbell, 1914:224; Dietz and Morrison, 1916:245; Lawson, 1917:196; Ferris, 1920:36; Hollinger, 1923:38; Merrill and Chaffin, 1923:258; Morrison, 1929:39; Steinweden, 1929:203; 1930:563; Watson and Berger, 1932:31; Zimmerman, 1948:294; Schmutterer, 1952a:552; 1952b:3; Merrill, 1953:90; Borchsenius, 1957:294; De Lotto, 1959:164; Reinking, 1964:70; Hart, Balock, and Ingle, 1966:70; Ezzat and Hussein, 1967:393; Hodgson, 1967a:4; 1969b:6; Hart and Meyers, 1968:617; Reed, Hart, and Ingle, 1968:1443. *Coccus* (*Lecanium*) *hesperidum* L., Cockerell, 1893b:49. *Lecanium hesperidum* (L.), Comstock, 1881:335; 1883:134; Saunders, 1883:404; Newell, 1899:170; Felt, 1901:356; Thro, 1903:206; Cockerell, 1922:309. *Lecanium* (*Coccus*) *hesperidum* (L.), Pettit and McDaniel, 1920:16.

The brown soft scale is one of the most common soft scales, occurring throughout the United States in greenhouses and in homes as well as out of doors in warmer regions. Its host list is most extensive, and it seems that there is host-induced morphological variation.

MATERIAL STUDIED

Begonia radicans, 2, (2), Dec. 4, 1881, unknown. *Begonia* sp., 1, Loudoun Co., Leesburg, Sept. 30, 1925, Mrs. B. G. Deck. *Cercis canadensis*, 1, (4), Norfolk, let., Sept. 29, 1941, FRF. *Citrus aurantium*, 1, (3), Henrico Co., Herndon, March 23, 1932, Mrs. J. T. Jones, 1, (4), Washington, D. C., July 1965, G. Mantzouranis. *C. limon*, 1, Falls Church, let., March 12, 1922, Mrs. J. T. Hiett; 1, (3), Loudon Co., Round Hill, March 3, 1926, Mrs. S. J. McMichael; 1, Nottoway Co., Blackstone, let., Oct. 4, 1921, Mrs. J. L. Hawthorne. *C. paradisi*, 1, (3), Fauquier Co., Meetze, let., July 5, 1929, S. R. Meetze. *Cryptocoryne* sp., 2, (4), Winterhaven, Fla., Dec. 5, 1968, J. C. Denmark. *Euonymus japonicus* var. *microphyllus*, 1, (2), Westmoreland Co., June, 24, 1964, Earl Thompson. *Euonymus* sp., 3, (4), Blacksburg (greenhouse) Jan. 17, 1969; 11, (19), Feb. 5, 1970, DKP. *Ficus*

sp., 1, (3), Westmoreland Co., Stratford, let., Oct. 7, 1940, FRF. *Fuchsia* sp., 1, (2), Roanoke Co., Hollins, let., March 31, 1932, I. Sitler, *Haworthia fasciata*, 1, (2), Blacksburg, May 8, 1969, JOH. *Hedera helix*, 2, (3), Washington, D. C., Oct. 1969, F. L. Campbell. *Ilex* sp., 1, (3), Richmond, let., May 11, 1939, FRF. *Laurus* sp., 1, (2), from England: at New York, Oct. 21, 1946, Shemin and Gaul. *Ma-honia aquifolium*, 1, Norfolk, let., Sept. 9, 1946, FRF. *Nephrolepis exaltata* var. *bostoniensis*, 1, Nottoway Co., Blackstone, let., Oct. 4, 1921, Mrs. J. L. Hawthorne. *Persea americana*, 1, (2), Newport News, Feb. 7, 1964, W. F. Griffin. *Plumeria acutifolia*, 1, "Rhodesia," May 30, 1968, J. R. Blowers. *Rosa* sp., 2, (7), Hampton, let., April 4, 1903, R. E. Eastman; 1, (5), Fairfax Co., Vienna, May 17, 1916, Mr. Abbott. "Bay bush," 1, (3), Charlottesville, June 23, 1923, J. Phillips. "Bay tree," 1, Edgewater, Norfolk, let., March 6, 1905, Mrs. G. I. Briggs. "Fern," 1, Norfolk, Feb. 18, 1946, Anderson. "Palms," 1, (2), Hampton, let., April 4, 1903, R. E. Eastman. Unknown host, 1, (2), Northampton Co., Franktown, let., May 21, 1921, B. B. Anderson; 1, (2), Rockingham Co., Port Republic, let., Jan. 25, 1946, M. B. Pence.

GENERAL APPEARANCE

Body rather flat, ovate, sometimes asymmetrical variable in color, but usually yellowish-brown, often with a greenish tint. Young females collected on *Euonymus* color coded as 2.5Y 8/8 mottled with spots 5YR 3/2. First instar nymphs were yellow, 2.5Y 8/6.

DESCRIPTION

Body usually ovate (fig. A), 3028(2231-3589) long, 2239(1713-2732) wide, widest near abdominal region. Dorsal derm only slightly sclerotized, with small round translucent areas surrounding a minute pore. Legs and 7-segmented antennae well-developed. Spiracular setae in 3's median seta $2\frac{1}{2}$ -3 times longer than laterals. Anal plates variable, usually triangular with pointed angles. Anal tube long, with anal ring about 2 times its diameter anterior to anal plates. Marginal setae pointed, bifid or fimbriate. With 6 to 12 submarginal tubercles. Anal cleft extending about $\frac{1}{6}$ of body length.

DORSAL SURFACE AND MARGIN

Setae: Marginal setae (fig. B) numerous, 16 to 25 around head between anterior spiracular setae, 28.2(15.6-35.2) long, pointed,

bifid or slightly fimbriate. Body setae (fig. C) stout, straight, pointed 8.98(7.82-11.7) long, about 80 scattered randomly over dorsum.

Spiracular setae (fig. D): 3 in each spiracular furrow, median seta slender, straight or curved at tip, $2\frac{1}{2}$ -3 times longer than lateral setae; median seta 65.5(43.0-97.8) long, 10.7(7.82-11.7) wide; lateral setae 20.0(11.7-27.4) long, 6.95(3.91-7.82) wide, pointed.

Submarginal tubercles (fig. E): 6 to 12 around entire body, 8.15(7.41-8.65) in diameter.

Pores: Small disc pores (fig. F) 2.41(1.86-3.09) in diameter scattered over dorsum and in an irregular row around margin. Minute cruciform pores with an inner filament (fig. G), 2.10(1.24-2.47) in diameter, scattered randomly over dorsum; each pore surrounded by a translucent area. About 15 larger simple discoidal pores (fig. H), 3.89(2.47-4.94) in diameter, in median area anterior to anal plates.

Ducts: In some specimens, an occasional tubular duct (fig. I) 16.9(16.1-18.5) long, 3.71(3.71) wide with a filament 18.5(17.3-19.8) long, 1.24(1.24) wide, was detected at the margin on head and/or posterior end of the body.

Anal plates (fig. J₁, J₂): Usually triangular, cephalolateral and caudolateral sides, slightly concave, lateral angles pointed or slightly rounded; length 165(156-188), width 81.7(78.2-90.0); length cephalolateral margin 109(102-129), length caudolateral margin 114(102-125). Each plate with 4 apical setae (3 dorsal, 1 ventral) and 2 subapical setae. Anal fold with 2 pair of fringe setae.

Anal ring (fig. K): Ovate, about 74.3 long, 58.7 wide, with 8 hairs and 2 irregular rows of translucent wax pores.

VENTRAL SURFACE

Setae: Ventral submarginal setae (fig. L) 8.59(7.82-11.7) long, slender, pointed, straight or curved, numbering 6 to 10 around anterior margin. Body setae 10.2(7.82-11.7) long, similar to ventral submarginal setae, scattered over venter; 2 pair of interantennal setae, median pair longest; 3 pair of large prevulvar setae.

Eyes: Present on margin just above level of antennal scape.

Antennae (fig. M): Well-developed, 7-segmented, 284(254-328) long, distance between bases 457(344-653). Scape 36.4(27.8-46.9) long, 48.6(35.2-66.5) wide. Length of segments II to VII: 40.3(35.2-43.0), 52.0(39.1-74.3), 60.2(39.1-70.4), 25.4(23.5-35.2), 25.5(23.5-27.8), 53.8(46.9-74.3) long, respectively. Terminal segment with 6 hairlike and 3 fleshy setae. Setae on other segments: I,3; II,2; III,0; IV,3; V,1 fleshy; VI,1 and 1 fleshy.

Legs: Well-developed, with or without tibio-tarsal sclerotization, tibio-tarsal articulation apparently absent; claws with a very small denticle near apex. Tarsus and claw each with a pair of digitules; claw digitules 26.2(23.5-31.3) long, broad, almost twice claw length; tarsal digitules 37.9(39.1-46.9) long, slender, knobbed, extending as far as claw digitules past claw.

Part of leg	Lengths prothoracic	Lengths mesothoracic	Lengths metathoracic
Coxa	67.3(58.7-78.2)	75.1(62.6-86.0)	74.8(36.0-86.0)
Trochanter	56.7(50.8-62.6)	61.4(46.9-78.2)	62.2(46.9-78.2)
Femur	107(93.8-117)	121(97.7-152)	127(113-145)
Tibia	95.4(82.1-109)	102(86.0-121)	106(89.9-125)
Tarsus	66.1(58.7-74.3)	72.7(66.5-82.1)	72.7(62.6-82.1)
Claw	17.2(15.6-19.6)	15.7(11.7-19.6)	19.2(15.6-19.6)
Entire leg	401(367-450)	449(376-515)	456(429-508)

Spiracles: Spiracular apodeme constricted on both sides, atrium about equal to width of apodemal base. Spiracular pore bands 1 or 2 pores wide. Anterior pair 52.8(43.0-58.7) long, atrium 31.7(27.4-39.1) wide; posterior pair 55.9(50.8-70.4) long, atrium 39.1(31.3-46.9) wide.

Pores: Quinquelocular pores (fig. N) 4.08(3.71-4.94) in diameter in a row 1 or 2 pores wide in each spiracular furrow, each row containing 20 to 30 pores. Multilocular pores with 7 to 10 loculi (fig. O), 6.30(6.18-7.14) in diameter, all confined to anal area.

Ducts: Microducts (fig. P) 2.44(2.44) long, which open to the ventral surface through square shaped orifices 2.44(2.44) in diameter, scattered over entire venter. Tubular ducts (fig. Q) 14.6(11.7-

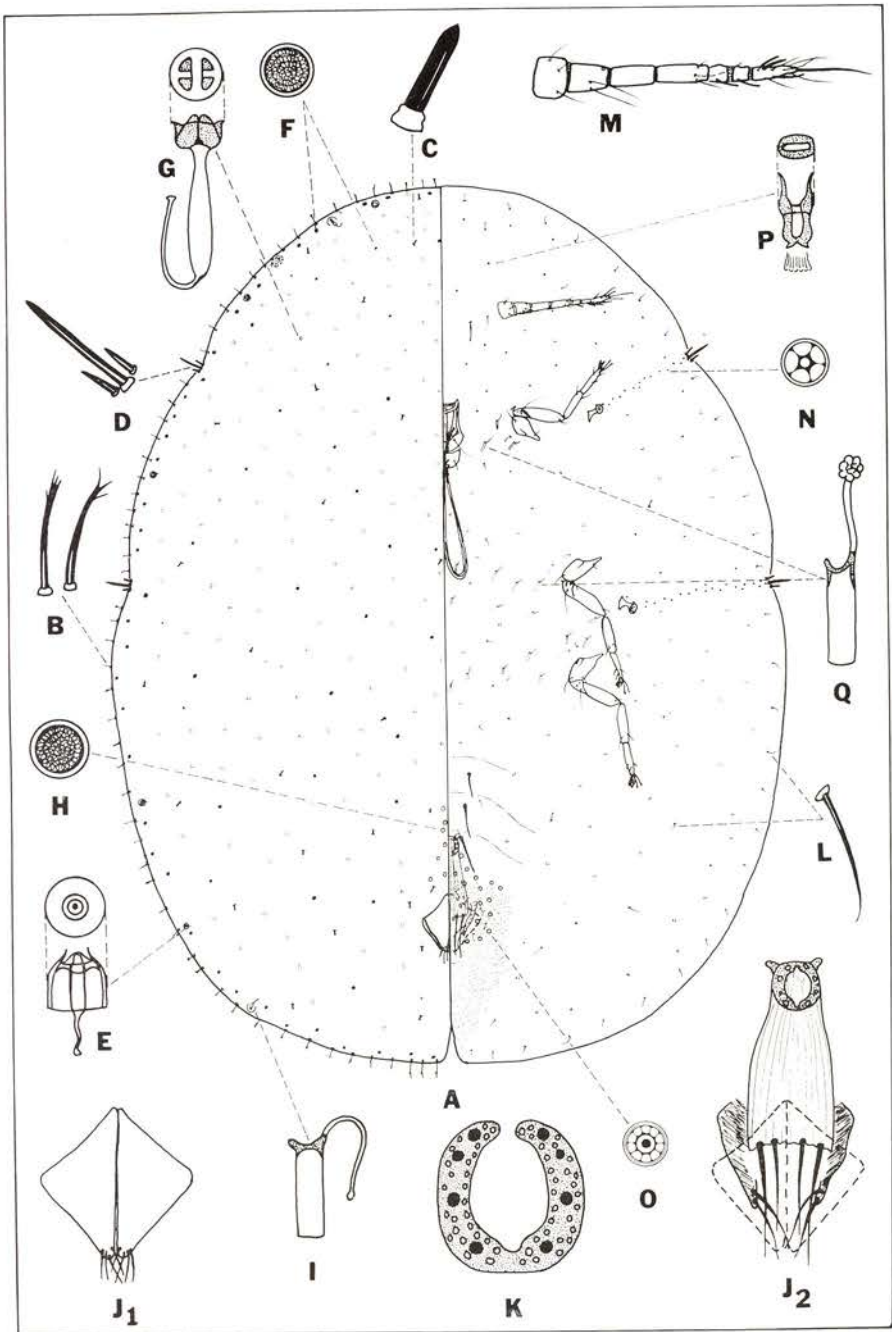


Plate 7. - *Coccus hesperidum* Linnaeus

15.6) long, 3.50 (2.16-3.91) wide, with filaments 17.6 (13.8-19.6) long, 1.80 (1.44-1.95) wide, scattered in area between meso- and metacoxae and occasionally near procoxae.

OTHER STAGES

First instar nymphs have 6-segmented antennae; well-developed legs with 2 tarsal digitules, one of these longer and about twice as thick as the other; about 26 marginal setae, slender, curved, pointed, not bifid or fringed; submarginal tubercles absent; 3 spiracular setae in each group, median seta 3 times the length of lateral setae; 3 quinquelocular pores in each anterior spiracular furrow, 4 in each posterior furrow, 6 anal ring hairs. Second instar nymphs have 6-segmented antennae; well-developed legs with tarsal digitules about equal in size; about 62 marginal setae, most bifid or fringed, slender, second marginal setae from anal cleft longest; 1 submarginal tubercle on each side, between anterior and posterior spiracular setae; 3 spiracular setae in each group, median seta $21\frac{1}{2}$ times the length of lateral setae; 6 quinquelocular pores in each anterior spiracular furrow, 10 in each posterior furrow. Males were described by Giliomee (1967).

BIOLOGICAL NOTES

The brown soft scale is ovoviviparous. The ventral region becomes concave to provide protection for the newborn crawlers. It is found indoors throughout the state and outdoors along the eastern seaboard of Virginia, overwintering in the second instar stage. In greenhouses, all stages can usually be found throughout the year.

PARASITES AND PREDATORS

If it were not for its parasites and predators, the brown soft scale would surely be the most significant soft scale pest. Normally the population is held in check by its many hymenopterous parasites. Peck (1963) lists the following species parasitizing *C. hesperidum*: *Aneristus ceroplastae*, *A. youngi*, *Anicetus annulatus*, *Aphy-cus alberti*, *A. angustifrons*, *A. eriococci*, *A. flavus*, *A. helvolus*, *A. johnsoni*, *A. luteolus*, *A. maculipes*, *A. stanleyi*, *Aspidiotiphagus citrinus citrinus* (yellow scale segregate), *Coccophagus caridei*, *C. elea-philus*, *C. fraternus*, *C. immaculatus*, *C. lycimnia*, *C. pulvinariae*, *C. scutellaris*, *C. yoshidai*, *Diversinervus elegans*, *Encyrtus bicolor*, *E. infelix*, *Eupelmus coccidis*, "*E. neococcidis*", *Eusemion californicum*,

E. longipennis, *Marietta javensis*, *M. mexicana*, *Microterys flavus*, *Moranila californica*, *Pachyneuron californicum*, *Quaylea whittieri*, *Scutellista cyanea*, *Thysanus elongatus*, *T. fasciatus*, *T. flavopalliatatus*, *T. niger*, *Trichogramma flavum*. To this listing may be added: *Aphycus pulvinariae*, *Cheiloneurus albicornis*, *Coccophagus flavifrons*, (Hart et al., 1966); *Encyrtus lecanorium*, (Reed et al., 1968); *Aphycus orientalis*, and *Coccophagus japonicus* (Thompson, 1944). Borchsenius (1957) gives a listing of parasites attacking the brown soft scale in other parts of the world.

ADDITIONAL HOSTS AND DISTRIBUTION IN VIRGINIA

On *Begonia* sp., Arlington; Rosslyn; Cumberland Co.; Harrisonburg; Port Republic. *Camellia* sp., Norfolk Botanical Gardens. *Citrus limon*, Lynchburg; Richmond. *C. paradisi*, Richmond. *Citrus* sp., Fairfax Co., Herndon; Roanoke Co., Hollins College; Norfolk. *Coleus* sp., Lexington. *Ilex cornuta* var. *burfordii*, Hampton. *Ilex crenata*, Richmond. *Ilex* sp., Norfolk; Richmond. *Laurus nobilis*, Chesterfield Co., Chester; Halifax Co., South Boston; Norfolk; Richmond. *Laurus* sp., Norfolk. *Lespedeza cuneata*, Arlington. *Nerium* sp., Albemarle Co., Rio Vista; Fairfax Co., Vienna; Fauquier Co., Warrenton; Mathews Co., North; Montgomery Co., Radford; Norfolk; Richmond; Staunton; Sussex Co., Waverly. *Persea borbonia*, Princess Anne Co., Diamond Springs. *Persea* sp., Charlottesville; Chesterfield Co., Chester; Fauquier Co., Warrenton. *Pyracantha* sp., Norfolk. *Schinus* sp., Bedford Co., Bedford. *Vitis* sp., Fauquier Co., Meetze, Richmond. "Fern," Alexandria; Alleghany Co., Covington; Falls Church; Madison Co., Madison; Nottoway Co., Blackstone. "Lily," Mathews Co., North.

ECONOMIC IMPORTANCE

The brown soft scale is a cosmopolitan species, occurring in greenhouses in less temperate regions and outdoors elsewhere. Parasites and predators play an important role in keeping the population of this pest in check, but even so, it is considered one of the more significant pest species. This is due to its ability to thrive in a diversity of habitats and on a large number of host plant species.

NOTES

Even though many papers have been written about the brown soft scale, its identity is not well established. Various morphological

variants of the species seem to occur in different localities and on different host plants. The list of synonyms for this species is very long. Our list includes only the most frequently used names in the North American literature.

Dorsal tubular ducts are not found in all specimens, and the position of these may vary from specimen to specimen, but they are always near the margin when present. Ventral tubular ducts were found on the mid-ventral region in all specimens studied. Most specimens had a tibio-tarsal sclerosis of variable size; only occasionally was this missing on the hind legs. The anal plates are always triangular in shape, although the caudolateral margin may vary from convex to concave.

Genus *ERIOPELTIS* Signoret, 1872

TYPE SPECIES

Coccus festucae Fonscolombe, 1834.

DESCRIPTION

Body of adult female elongate-oval, at maturity enclosed in a woolly or felty ovisac which is free from the body. Derm remaining membranous. Legs and 6- to 8-segmented antennae greatly reduced. Legs without tibio-tarsal sclerotization. Marginal setae small, stout, and somewhat conical. Spiracular setae absent or not differing from marginal setae. Dorsum covered with many stout, truncate setae. Submarginal tubercles absent. Quinquelocular pores in spiracular furrows; multilocular pores in anal area and on posterior abdominal segments. Tubular ducts numerous on both surfaces. Anal plates and setal arrangement variable. Hypopygial setae usually present. Anal ring with 6 to 8 hairs.

NOTES

Species of *Eriopeltis* are found on grasses. The eggs are protected by the woolly or felty ovisac until hatching. Members of this genus are not commonly encountered in the United States. The dense pattern of truncate, dorsal, body setae easily separates this genus from any other in North America.

Eriopeltis festucae is recorded from Virginia.

Eriopeltis festucae (Fonscolombe), 1834

*** Cottony Grass Scale**

Plate 8

Coccus festucae (Fonscolombe), 1834:216. *Eriopeltis festucae* (Fonsc.), Fletcher, 1896:146; King, 1091c:197; Fernald, 1903:146; Cockerell, 1905a:136; Patch, 1905:169; Schumacher, 1919:119; Steinweden, 1929:235; Schmutterer, 1952a:555; Borchsenius, 1957:154. *Rhizococcus* n. sp., King, 1901c:197.

According to King, 1901c, the cottony grass scale was introduced into Canada. It was found by Mr. A. H. McKay in large numbers on grass in Cumberland Co., Nova Scotia in 1889. King also stated that it was cited as a new species of *Rhizococcus*, and occurred in "Dakota," Indiana, and Illinois.

MATERIAL STUDIED

Agrostis perennans, 1, (3), Falls Church, Aug. 1903, N. Banks. "Grass," 1, Vienna, Aug. 21, 1938, J. C. Bridwell.

GENERAL APPEARANCE

Adult females elongate-oval, narrowed at anterior and posterior end of the body, convex (Borchsenius, 1957). Upon reaching maturity, the coccid produces a white felty covering of curly filaments over its entire body. If the secretion is removed before the female has begun to deposit eggs, the female is of a slightly pink color (Patch, 1905).

DESCRIPTION

Body (fig. A) elongate-oval, tapered at each end, narrowest at anterior end; 3885(3249-4800) long, 1787(1477-1920) wide. Derm membranous in all specimens studied; dorsum covered with stout, truncate setae (fig. B, B₁) of varying sizes which resemble those found in the family Dactylopiidae; legs and antennae reduced; antennae 6-segmented, tarsal claws straight, acute. Anal cleft extending about 1/12 of body length.

DORSAL SURFACE AND MARGIN

Setae: Marginal setae (fig. C), 14.6(11.7-15.6) long, stout, slender, conical, with blunt apices; 8 to 11 marginal setae between

spiracular furrows, most numerous anteriorly. Body setae (fig. B₁, B₂) stout, conical, truncate 23.5(15.6-31.3) long, 21.5(15.6-27.4) wide, densely covering the entire dorsum except a narrow band along the midline of the body; setae at anterior end of the body located somewhat nearer to each other and more elongate than those that are located in the middle part of the body; alongside the anal plates, the setae are longest (fig. B₂), 27.4(19.6-31.3) long, 12.7(3.90-19.6) wide, and may be slender and pointed.

Spiracular setae: Absent in specimens studied.

Submarginal tubercles: Not detected in specimens studied.

Pores: Minute simple pores (fig. D), 1.95(1.95) in diameter, and heavily sclerotized bilocular pores (fig. E), 4.40(3.91-5.87) in diameter, scattered over entire dorsum, more numerous along margin and around anal plates, and forming an irregular row around margin of body, with 2 or 3 near each marginal seta. Simple disc pores (fig. F), 6.36(5.87-7.82) in diameter, scattered in median area from anal plates nearly to anterior margin.

Ducts: Not detected.

Anal plates (fig. G₁, G₂): Triangular, all angles bluntly pointed; length 155(145-160), width 97.7(89.9-106); length cephalolateral margin 108(97.7-117); length caudolateral margin, 133(117-145). Each plate with 4 apical (3 dorsal, 1 ventral) and 2 subapical setae, also with 1 seta on the inner margin of each plate, about $\frac{1}{3}$ of anal plate length from the apex. Anal fold with 4 short fringe setae. With 8 to 10 hypopygial setae.

Anal ring (fig. H): Subcircular, 78.2(58.6-97.7) long, 84.1(78.2-89.9) wide, with 8 hairs, 2 shorter and more slender than the rest. Anal ring pores in 3 irregular rows.

VENTRAL SURFACE

Setae: Ventral submarginal setae (fig. I), 18.6(15.6-19.6) long, slender, hairlike, curved or straight, about 6 between the spiracular furrows; 1 slender hairlike seta, mesad of each antennal scape; a few slender setae scattered over venter; 6 to 10 setae 16.9(15.6-19.6) long, anterior to anal area.

Eyes: Apparently absent.

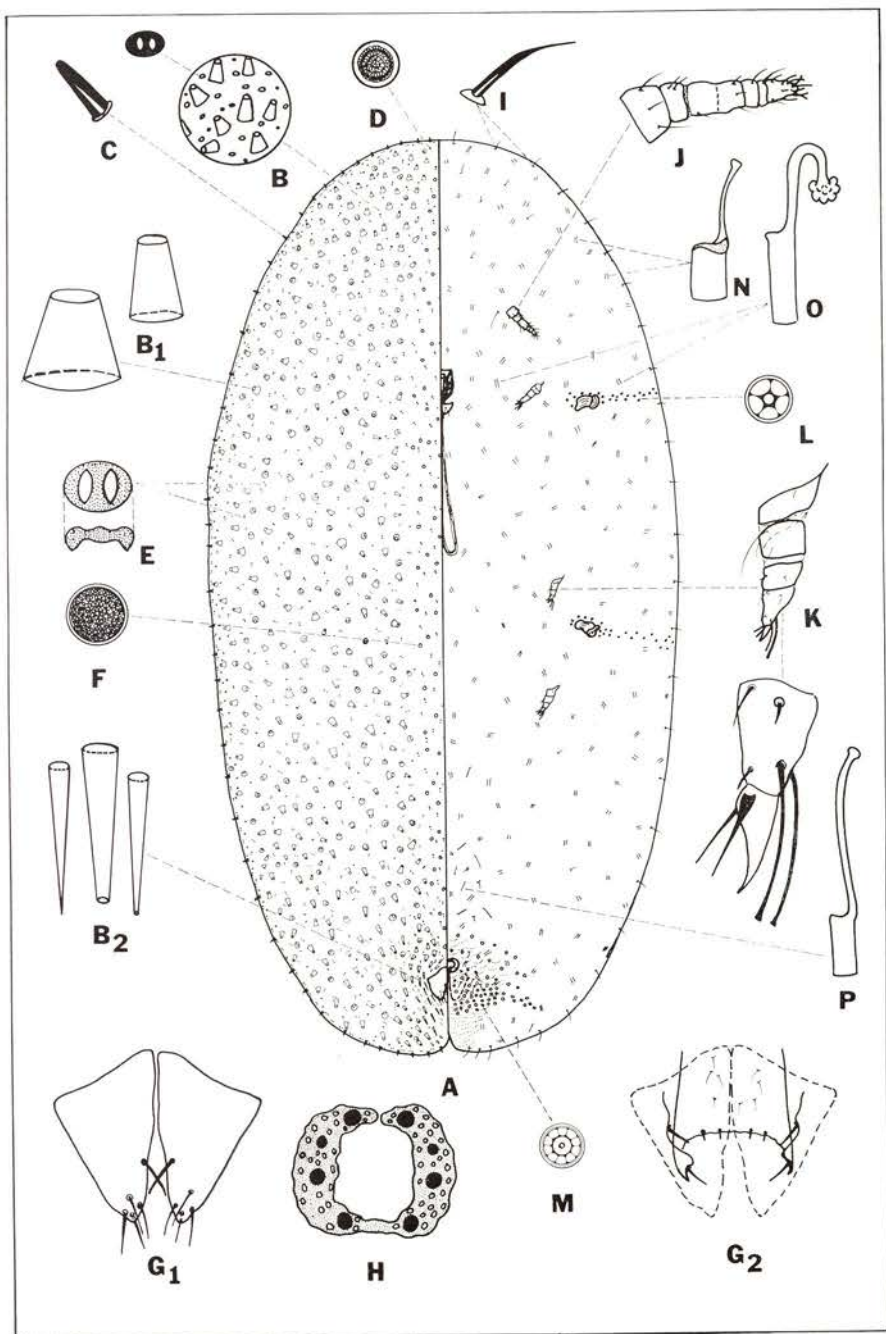


Plate 8. - *Eriopeltis festucae* (Fonscolombe)

Antennae (fig. J): Reduced, but larger than legs; 6-segmented, third segment usually as long as IV, V, and VI combined. Antennae 158(149-168) long. Scape 24.8(19.6-27.4) long, 48.2(43.0-54.7) wide. Segments II to VI, 19.6(15.6-23.5), 46.9(39.1-54.7), 12.7(11.7-15.6), 12.7(7.82-15.6), 22.5(19.6-23.5) long respectively. Terminal segment with 3 hairlike and 8 fleshy setae. Setae on segments: I,3; II,2; III,4; IV,1; V,1.

Legs (fig. K): Reduced, not much longer than spiracles, trochanter and femur apparently fused, claw simple, nearly straight with 2 slender digitules; tarsus with 2 digitules. Tarsal digitules slender, 30.0(27.4-35.2) long, knobbed. Claw digitules straight, 14.3(11.7-15.6) long, pointed.

Part of leg	Lengths prothoracic	Lengths mesothoracic	Lengths metathoracic
Coxa	23.5(-----)	27.4(23.5-35.2)	23.5(23.5)
Trochanter Femur	35.2(-----)	38.1(35.2-46.9)	29.4(27.4-31.3)
Tibia	29.4(27.4-35.2)	28.4(23.5-31.3)	25.5(23.5-27.4)
Tarsus	29.4(23.5-35.2)	31.3(23.5-43.0)	35.2(31.3-39.1)
Claw	15.6(15.6)	15.6(15.6)	16.9(15.6-19.6)
Entire leg	125(-----)	142(129-149)	137(137)

Spiracles: Apodemal base about as wide as atrium; apodeme slightly constricted on lower side, but broad throughout. Spiracular furrows short. Anterior spiracles 88.0(82.1-89.9) long, atrium 55.8(46.9-58.7) wide; posterior pair 97.7(93.8-106) long, atrium 71.7(66.5-74.3) wide. Spiracular pore bands 2 or 3 pores wide throughout, 22 to 28 pores in each band, extending from margin to past apodemal base.

Pores: Quinquelocular pores (fig. L), 5.87(5.87) in diameter, found in spiracular furrows. Numerous multilocular pores with 9 to 11 locules (fig. M), 7.82(7.82), in anal area and in transverse bands on first 2 or 3 pregenital segments.

Ducts: Of 3 types; short ducts (fig. N) about 7.32 long, 4.88 wide with slender filaments about 9.76 long, 1.95 wide, and long ducts

(fig. O), 16.6(11.7-23.5) long, 3.91(3.91) wide, with a slender filament 24.5(19.6-27.4) long, 2.44(2.44) wide, scattered over entire venter. A few ducts with filaments nearly twice the duct length (fig. P), duct 16.6(15.6-19.6) long, 3.91(3.91) wide, with filaments 24.7(23.4-27.4) long, 1.95(1.95) wide, in median area anterior to anal plates.

OTHER STAGES

Steinweden (1929), after studying *Eriopeltis coloradensis* Cockerell and *E. festucae* (Fonsc.), noted that the first instar nymphs had 6-segmented antennae; margin with short setae, anterior end of the body with 8 to 10 short, stout, conical setae; remainder of the body without setae, except near the bases of the antennae and in the ventral abdominal region; anal plates protruding beyond the end of the body, somewhat reticulated; anal ring with 6 setae. Males not seen, but Green (1917) states that the cover of the male is elongate with rounded ends, granular, semi-transparent, glossy, with slightly defined middle longitudinal keel and a posterior transverse suture; 1.75 mm. long, 0.5 mm. wide. Patch (1905) captured no adult males during a two year study on *E. festucae*, although 3 male pupae were found among 136 mounted coccids taken from grass blades in Portland, Maine, August 17, 1904.

BIOLOGICAL NOTES

According to Patch (1905), the eggs deposited by females of the fall generation overwinter in the protective egg case. The active first instar nymphs emerge during warm spring days and seek a suitable grass blade. The nymphs settle, head down, on the blade, usually on the upper surface, and reach maturity in July. The eggs of this summer generation hatch in July and August, and the coccids mature and produce overwintering eggs in the fall. Thus Patch (1905) found 2 generations in Maine.

PARASITES AND PREDATORS

King (1901c) records *Leucopis bellula* as a dipteran parasite of the cottony grass scale. Patch (1905) reports *Leucopis nigricornis*, and lists the following hymenopterous parasites: new species of *Eunotus*, *Microterys*, and one in a new genus near *Phaenodiscus*. All determined by Dr. L. O. Howard.

HOSTS AND DISTRIBUTION IN VIRGINIA

(See *Material Studied*.)

ADDITIONAL HOSTS AND DISTRIBUTION IN U.S.A.

Fernald (1903) lists "*Festuca caespitosa*" and "*F. phoenicioides*" as hosts, and records it from "Dakota," Indiana and Illinois. Patch (1905) reports it from Maine, occurring on *Agrostis alba* and *Poa pratensis*.

ECONOMIC IMPORTANCE

The cottony grass scale appears to be only a sporadic pest. Undoubtedly, natural control agents are the reason for this. When large numbers of the scale do occur, however, a substantial loss can be expected. In Deer Isle, Maine, during the summer of 1904, it was estimated that $\frac{1}{3}$ less than the usual amount of hay was harvested, and due to this insect, the hay was of inferior quality.

NOTES

Schumacher (1919) considers that specimens representing *E. festucae* from North America are similar to European representatives, but they were not identical. Borchsenius (1957) states that the antennae of the adult female in Europe is 8-segmented, while the specimens we examined appeared only 6-segmented.

Genus LECANIUM Burmeister, 1835

TYPE SPECIES

Coccus hesperidum Linnaeus, 1758.

DESCRIPTION

Body of adult female usually strongly convex, naked, with thin, flaky wax or with powdery pubescence. Derm becoming heavily sclerotized with age. Legs and 6- to 8-segmented antennae variable. Legs without tibio-tarsal sclerosis (except *L. persicae*). Marginal and body setae variable. Spiracular setae usually differing from marginal setae, but sometimes difficult to distinguish. Submarginal tubercles are present or absent even within the same species. Dorsal pores variable. Multilocular pores in anal area, in transverse bands on the abdomen, and a few usually scattered up to

rostrum. Quinquelocular pores in spiracular pore bands, and in some species found also along inner margin of anal cleft. Tubular ducts variable, scattered on abdomen and thorax, usually forming a dense submarginal band on venter. Anal plates with varying numbers of apical and subapical setae. Anal ring varies from a simple sclerotized ring without hairs to the usual case of well-developed with numerous wax pores and 8 anal ring hairs.

NOTES

Many members of this genus are extremely polyphagous, while others tend to be found on only a few plant species. The eggs are protected by the body of the old female until hatching.

The type of the genus also serves as the type for the genus *Coccus*. According to Morrison & Morrison (1966), Burmeister was the first to use the name *Lecanium* in print, crediting it to Illiger, but nothing could be found in literature to justify acceptance of Illiger as its author. No definite type designation was made by Burmeister, but detailed descriptions were given for 5 species of which *L. hesperidum* (= *Coccus hesperidum* L.) stood first. Cockerell (1893b) later designated *Coccus hesperidum* as type species. Since *C. hesperidum* definitely belongs in the genus *Coccus* and is universally accepted as the type species of that genus, we believe that a new type should be designated for the genus *Lecanium*. However, a critical study of the species presently remaining in the genus should be undertaken before any name is chosen.

Species of *Lecanium* recorded in Virginia include: *L. caryae* Fitch, *L. corni* Bouché, *L. fletcheri* Ckll., *L. nigrofasciatum* Pergande, *L. persicae* Fabricius, and *L. quercifex* Fitch. *Lecanium corni*, *L. fletcheri* and *L. quercifex* are not separable with the species key for the *Lecanium* as the authors were unable to find morphological characters which would consistently separate these 3 species.

KEY TO THE SPECIES OF *LECANIUM* IN VIRGINIA

1. With 14 to 17 pair of submarginal tubercles; inner filaments of ventral submarginal tubular ducts enlarged; legs with tibio-tarsal sclerosis ----- *persicae*, p. 91

With less than 14 pair of submarginal tubercles; inner filaments of ventral submarginal tubular ducts slender; legs without tibio-tarsal sclerosis ----- 2

2. Marginal setae slender, curved, and pointed; with a row of crown-shaped discoidal pores extending cephalad of anal plates on dorsum; ventral tubular ducts lacking ----- *nigrofasciatum*, p. 84

Marginal setae stout with blunt or rounded tips; row of crown-shaped discoidal pores cephalad of anal plates absent; ventral tubular ducts present -----3

3. Spiracular setae distinctly different in shape or size from marginal setae; tubular ducts absent from dorsum; without quinquelocular pores on inner margin of anal cleft ----- "*corni complex*," p. 76

Spiracular setae similar to marginal setae; tubular ducts numerous, scattered over dorsum; with quinquelocular pores on inner margin of anal cleft ----- *caryae*, p. 70

Lecanium caryae Fitch, 1857

*** Large Hickory Lecanium**

Plate 9, Photo 13

Lecanium caryae Fitch, 1857:443; Signoret, 1873:416; Comstock, 1881:364; 1883:133; Packard, 1881:75; 1890:298; Coquillett, 1891:383; King, 1899:141; 1901b:50; Felt, 1901:356; Sanders, 1909:442; 1910:60; Dietz and Morrison, 1916:253; Lawson, 1917:191; Richards, 1958:312; Phillips, 1965:237; Wallner, 1969:11. *L. cockerelli* Hunter, 1899:70. *Lecanium* sp., Pettit, 1902:189. *Lecanium* (*Eulecanium*) *caryae*, Cockerell, 1896a:332; Pettit and McDaniel, 1920:1; McDaniel, 1930:7. *Eulecanium caryae* (Fitch), King, 1902b:160; Fernald, 1903:183; Cockerell, 1906:83; Douglas, 1911:170.

MATERIAL STUDIED

Carya sp., 1, Charlottesville, May 9, 1946, DWC. *Castanea dentata*, 1, Craig Co., May 5, 1968, MLW; 1, Montgomery Co., May 12, 1968, MLW. *Platanus occidentalis*, 1, (20), (1st instars), Huntington, W. Va., May 22, 1908, H. B. Hagen; 1, Huntington, W. Va., May 20, 1913, R. F. Adams; 4, (4), Blacksburg, May 13, 1969, MLW; 1, same as previous data, AD. *Pyrus* sp., 2, (2), "W. Decantur," Nov. 1, 1902, G. T. Lumadul. *Quercus rubra*, 2, (2), Blacksburg,

April 24, 1968, MLW; 2, (2), Craig Co., May 7, 1968, MLW; 1, Blacksburg, May 5, 1969, MLW. *Quercus* sp., 1, Skyline Drive, May 22, 1946, DWC; 1, Blacksburg, May 13, 1969, DKP. *Ulmus americana*, 1, Britannia, Ontario, June 2, 1948, S. D. Hicks; 1, (22), Albany, N. Y., June 29, 1954, G. C. Dowell; 1, Blacksburg, April 30, 1969, MLW. *Ulmus* sp., 1, (15), Branford, Conn., June 1, 1922, A. W. Jepson; 1, Port Chester, N. Y., let. May 3, 1945, S. Bromley.

GENERAL APPEARANCE

Lecanium caryae is the largest in size, among the *Lecanium* in the United States, sometimes reaching a length of 15 mm. When on large limbs it is rather flat, but on small limbs it may be more convex and of a smaller size. The cephalic third of the coccid is usually broader than the rear two-thirds. Anal cleft conspicuous. Color usually uniformly brown (2.5Y 4/4), although sometimes an orange tint may be noticed. The derm is usually dusted with a waxy pruinose coat. Occurs on the twigs and limbs of its host.

DESCRIPTION

Body (fig. A) usually ovate, 7694(5908-12495) long, 6206(4159-11668) wide, derm becoming sclerotized after oviposition. Legs and 7-segmented antennae slightly reduced. Marginal setae very numerous and set close together, stout, almost conical. Spiracular setae hard to detect, resemble marginal setae, except shorter. Submarginal tubercles absent. Anal plates each with 4 apical setae, 3 of which are on the inner margin. Anal cleft about $1/5$ of body length.

DORSAL SURFACE AND MARGIN

Setae: Marginal setae (fig. B), about 95 around head, 48.1 (43.0-54.7) long, stout, straight, tapering and acute. Body setae (fig. C) sparse, 14.7(11.7-15.6) long, slender, curved or straight, acute, scattered over body.

Spiracular setae (fig. D): 3 in each spiracular furrow, subequal, 29.4(23.5-35.2) long, 11.0(7.82-15.6) wide, conical, shorter and stouter than marginal setae and usually separated from each other by a single marginal seta.

Submarginal tubercles: Absent.

Pores: Thick rimmed disc pores (fig. E), 6.20(5.87-7.82) in diameter, numerous, scattered over dorsum except for 2 clear spots above antennae. Quinquelocular pores (fig. F) about 6.83 in diameter, sparse, a few on inner margin of anal cleft, extending up to dorsum.

Ducts: Short tubular ducts with a heavily sclerotized cup (fig. G), 16.8(11.7-19.6) long, 5.67(3.91-5.87) wide, with a slender filament 14.8(7.82-23.5) long, numerous, scattered evenly over dorsum, except for 2 spots in cephalic region and area around anal plates, where they are absent entirely.

Anal plates (fig. H₁, H₂): Each plate trapezoid in outline, 231(211-270) long, 117(97.8-137) wide, lateral and caudal angles rounded; cephalolateral margin concave, 130(106-164) long, caudolateral margin convex and uneven, 176(168-219) long. Each plate with 4 apical setae, 3 of which are on the inner margin, and 3 or 4 subapical setae. Anal fold with 3 pair of fringe setae, subequal in length. There is a distinct V-shaped notch formed by the cephalic angles of the anal plates.

Anal ring (fig. I): Ovate, about 97.8 long, 86.0 wide. With 8 hairs and 2 irregular rows of translucent wax pores.

VENTRAL SURFACE

Setae: Ventral submarginal setae (fig. J) slender, acute, straight, or slightly curved near tip, 23.9(19.6-31.3) long, about 32 around head. Body setae (fig. K) slender, straight, acute and with a large base, 22.9(15.6-31.3) long, scattered over venter. With 3 pair of large prevulvar setae.

Eyes: Not detected in adult specimens studied.

Antennae (fig. L): Slightly reduced, 7-segmented, 302(242-344) long. Scape 44.6(35.2-58.7) long, 76.5(62.6-97.8) wide. Length of segments II to VII: 37.5(35.2-43.0); 119(74.3-179), 41.5(31.3-54.7), 29.4(23.5-39.1), 27.0(23.5-31.3), 34.4(31.3-39.1) long, respectively. Terminal segment with 1 hairlike, 1 short conical and 8 fleshy setae, one of which is often forked. Setae on other segments: I,3; II,2; III,0; IV,2; V,1 fleshy; VI,1 and 1 fleshy setae. Usually with 3 pair of setae between antennal bases.

Legs: Slightly reduced, without tibio-tarsal sclerotization or free articulation. Claws with a denticle. Tarsus and claw each

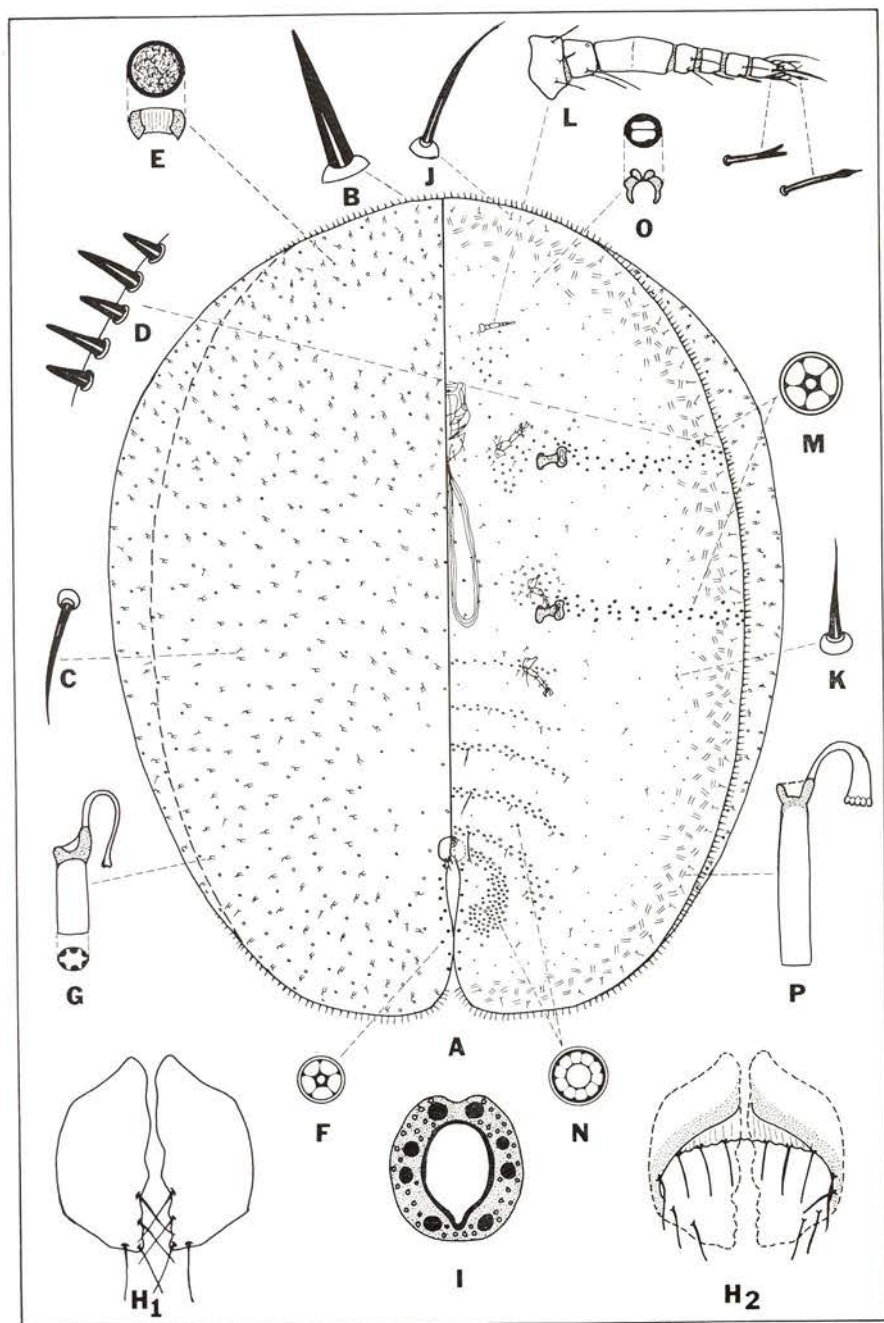


Plate 9. - *Lecanium caryae* Fitch

with a pair of digitules; claw digitules 32.2(27.4-39.1) long, unequal, expanded at apex, slender and 1 slightly broader than the other; tarsal digitules subequal, slender, knobbed, 46.0(35.2-58.7) long.

Part of leg	Lengths prothoracic	Lengths mesothoracic	Lengths metathoracic
Coxa	86.1(78.2-106)	113(106-121)	125(113-145)
Trochanter	59.6(46.9-82.1)	68.8(54.7-78.2)	65.5(46.9-82.1)
Femur	131(109-156)	140(117-160)	144(117-164)
Tibia	105(74.3-121)	110(102-117)	112(89.9-129)
Tarsus	56.7(43.0-74.3)	85.5(62.6-109)	85.6(74.3-97.6)
Claw	23.5(15.6-27.4)	25.8(23.5-27.4)	27.8(19.6-35.2)
Entire leg	455(426-489)	549(519-571)	562(515-606)

Spiracles: Spiracular apodeme constricted on both sides, atrium usually wider than apodemal base. Spiracular pore bands variable, pores usually separated quite a distance, extending from margin to apodemal base. Anterior spiracles 156(137-176) long, atrium 126(117-145) wide; posterior pair 156(145-184) long; atrium 145(129-164) wide.

Pores: Quinquelocular pores (fig. M) 6.85(5.87-7.82) in diameter, 30 to 40 in each spiracular pore band. Multilocular pores of 10 locules (fig. N), 10.5(7.82-11.7) in diameter, in anal area, in transverse bands on the abdomen, a few scattered near each coxa and elsewhere on thorax.

Ducts: Microducts (fig. O) about 3.94 long, which open to the surface through an oval or subcircular opening about 3.94 in diameter, scattered over entire venter, most prominent in a submarginal band around body. Tubular ducts (fig. P) 31.7(27.4-35.2) long, 6.07(5.87-7.82) wide, with deep sclerotized cups and filaments 18.4(15.6-19.6) long, which begin narrow at the cup and expand to a width of about 4.88 near apex, scattered around marginal and submarginal areas.

OTHER STAGES

First instar nymph with well-developed legs and 6-segmented antennae; claws with a slight denticle; 40 to 45 long, slender, pointed, marginal setae around body; spiracular setae in 3's, subequal, stouter

than marginal setae, usually slightly curved and blunt; 6 pair of mid-ventral setae on abdomen; upper 2/3 of anal plates reticulated; each plate with 4 apical setae (1 long caudal, 2 short apical, and 1 on inner margin) and 1 subapical seta; anal fold with 1 pair of fringe setae; anal ring with 6 hairs. Second instar nymphs have well-developed legs and 6-segmented antennae; claws with a denticle; many marginal setae which are stout and blunt, set close together around body; spiracular setae difficult to distinguish from marginal setae, but stouter and slightly longer; anal plates not reticulated; each plate with 4 apical setae (3 on inner margin) and 1 subapical seta; and anal fold with 2 pair of fringe setae; anal ring with 6 hairs; numerous thick rimmed disc pores are scattered over the dorsum. Males are known but have not been described.

BIOLOGICAL NOTES

Immature insects pass the winter on twigs or branches and mature during the spring. In May, each female lays 100 or more eggs beneath its body. By late June the eggs hatch; the nymphs migrate from beneath the mother to the underside of the plant leaves, where they settle and feed. Late in August, they move back to the twigs, completing their growth the following spring. There is one generation per year (Wallner, 1969).

PARASITES AND PREDATORS

Blastothrix longipennis was reported by Pettit (1902), and Comstock (1881) reared *Cheiloneurus albicornis* from *L. caryae*. Normally the coccid is kept under control by natural enemies.

ADDITIONAL HOSTS AND DISTRIBUTION IN VIRGINIA

Carya sp., Blacksburg. *Ulmus* sp., Richmond.

ADDITIONAL HOSTS AND DISTRIBUTION IN U.S.A.

L. caryae also is reported from Connecticut, Indiana, Kansas, Maine, Maryland, Massachusetts, Michigan, New York, Ohio, and West Virginia. Additional hosts include: *Betula* sp., *Fagus* sp., *Salix nigra*, (Pettit and McDaniel, 1920); *Prunus persica*, (Pettit, 1902); *Carya glabra*, *Celtis* sp., *Gleditsia* sp., *Juglans nigra*, *Malus* sp., *Morus* sp., and *Prunus* sp., (Lawson, 1917).

ECONOMIC IMPORTANCE

Apparently not of economic importance, since parasites normally keep it under control.

NOTES

Pettit and McDaniel (1920) reported that the antennae of *L. caryae* were 6- or 7-segmented, but all specimens in this study had 7-segmented antennae. Specimens collected on *Platanus occidentalis* had at least one of the fleshy setae on the terminal segment forked.

Lecanium corni Bouché, 1844

European Fruit Lecanium

Plate 10, Photos 14, 15

Lecanium corni Bouché, 1844:298; Marchal, 1908a:264; Sanders, 1909:443, 1910:60; Lindinger, 1912:121; Dietz and Morrison, 1916:256; Lawson, 1917:194; Fenton, 1917:309; Essig, 1920:1; Merrill and Chaffin, 1923:261; Gillette and Langford, 1925:12; Steinweden, 1929:225, 1930:570; McDaniel, 1930:4; Green, 1930:12; Herrick, 1935:236; Ebeling, 1938:613; Brimley, 1938:109; Craighead, 1950:145; Kawecki, 1954:9, 1958:135, 1961:65; Merrill, 1953:96; Wallner, 1969:11. *L. corylifex* Fitch, Comstock, 1883:133; Felt, 1901:356. *L. cynosbati* Fitch, Comstock, 1883:133; Felt, 1901:356. *L. fitchii* Signoret, Comstock, 1883:133; Felt, 1901:356. *L. juglandifex* Fitch, Comstock, 1883:134. *L. corni* var. *robiniarum*, Marchal, 1908b:3. *L. coryli* (Linnaeus), Richards, 1958:306; Phillips, 1965:232. *L. (Eulecanium) corni* (Bouché), Pettit and McDaniel, 1920:12. *Eulecanium corni* (Bouché), Fernald, 1903:185; MacGillivray, 1921:179; Savescu, 1943:213; Schmutterer, 1954:63; Balachowsky, 1939:228. *Parthenolecanium corni* (Bouché), Borchsenius, 1957:356; Giliomee, 1967:108. *P. coryli* (L.), Sulc, 1908:36.

MATERIAL STUDIED

Acer negundo, 4, (4), Blacksburg, May 13, 1969, MLW. *A. nigrum*, 1, Blacksburg, April 30, 1969, MLW. *A. rubrum*, 2, (2), Craig Co., April 25, 1968, MLW; 4, (9), Craig Co., April 25, 1969, MLW; 1, Montgomery Co., May 9, 1970, MLW. *A. saccharinum*, 2, (2), Blacksburg, May 2, 1969, MLW. *A. saccharum*, 1, Augusta Co.,

June 19, 1969, DPI. *Acer* sp., 2, (2), Blacksburg, May 6, 1969, JOH. *Carpinus caroliniana*, 3, (3), Claytor Lake State Park, May 22, 1969, W. Allen. *Carya ovata*, 2, (2), Montgomery Co., May 22, 1968, MLW. *Carya* sp., 3, (3), Blacksburg, May 13, 1969, MLW. *Castanea dentata*, 1, Montgomery Co., May 9, 1970, MLW. *Celtis* sp., 1, (2), Blacksburg, Sept. 3, 1968, MLW. *Cephalanthus occidentalis*, 2, (2), Wakefield, May 15, 1969, DKP. *Cornus florida*, 2, (2), Blacksburg, May 1, 1969, MLW. *Fraxinus* sp., 5, (5), Blacksburg, May 13, 1969, MLW. *Liriodendron tulipifera* 1, Blacksburg, April 24, 1970, JOH. *Myrica pensylvanica*, 1, (8), Seashore State Park, May 3, 1971, S. Nakahara. *Nyssa sylvatica*, 1, Giles Co., June 8, 1967, MK. *Platanus occidentalis*, 3, (3), Blacksburg, May 11, 1969, MLW. *Prunus* sp., 2, (3), Blacksburg, May 12, 1969, MLW. *Quercus alba*, 1, Montgomery Co., May 22, 1968, MLW. *Q. phellos*, 2, (2), Blacksburg, April 30, 1969, MLW. *Q. rubra*, 12, (12), VPI, Blacksburg, May 5, 1969, MLW. *Q. velutina*, 1, Montgomery Co., May 11, 1968, MLW. *Ribes* sp., 2, (3), Cranberry Glades, W. Va., May 18, 1968, F. Benfield. *Robinia pseudo-acacia*, 4, (4), Blacksburg, May 13, 1969, MLW. *Salix nigra*, 2, (2), Blacksburg, Aug. 6, 1970, MLW. *Sassafras albidum*, 2, (2), Montgomery Co., Aug. 4, 1970, Greg and M. Williams. *Tilia* sp., 2, (2), Blacksburg, Aug. 17, 1970, MLW. *Ulmus* sp., 1, Blacksburg, May 12, 1969, MLW.

GENERAL APPEARANCE

The appearance of *L. corni* varies extremely from host to host; however, as it becomes older, it turns a uniform brown and becomes very convex. Young females collected from *Robinia pseudo-acacia* were tan (10YR 7/8) mottled with radiating lines of black blotches. The eggs were white and were protected by the body of the old female until hatching.

DESCRIPTION

Body (fig. A) usually ovoid, 4553 (3323-5509) long, 3756 (2806-4741) wide, older specimens quite convex and heavily sclerotized. Legs and 6- or 7-segmented antennae well developed. Marginal setae short and blunt, sometimes forming an irregular double row, especially around head. Spiracular setae in 3's, median seta always longer than laterals. Submarginal tubercles present or absent. Anal plates with 4 apical and 2 subapical setae each. Anal fold with 2 pair fringe setae. Anal cleft about 1/6 of body length.

DORSAL SURFACE AND MARGIN

Setae: Marginal setae (fig. B), about 50 around head, 21.5 (15.6-23.5) long, straight or slightly curved, blunt tipped, some thicker than others. Occasionally specimens are found with a single long, slender seta on each anal lobe. Body setae of two types, those scattered randomly over dorsum (fig. C), 11.3(9.76-11.7) long, stout, straight, blunt, and those (fig. D) in an irregular double row in mid-dorsal region anterior to anal plates, these about 18.6 long, stout, tapering, blunt apices.

Spiracular setae (fig. E): 3 in each spiracular furrow; median seta 52.1(43.0-63.6) long, 10.8(9.78-11.7) wide, slender, curved, blunt tipped, usually about $1\frac{1}{2}$ times length of laterals; lateral setae 35.2 (23.5-46.9) long, 8.02(7.82-9.78) wide, usually almost straight, blunt.

Submarginal tubercles (fig. F): Present or absent in specimens collected together on the same host at the same time. As many as 12 have been seen in specimens studied, about 18.6 in diameter, located around submarginal area on dorsum.

Pores: Bilocular pores with a slender inner filament (fig. G), 2.44(2.44) in diameter, numerous, usually in irregular radiating lines extending from mid-dorsum to margin. Simple disc pores (fig. H), 2.93(2.93) in diameter, sparsely scattered over dorsum. Thick rimmed disc pores (fig. I), 8.47(7.82-11.7) in diameter, in a group of 15 to 30 pores, anterior to anal plates.

Ducts: Tubular ducts (fig. J) about 11.7 long, 3.91 wide with inner filaments about 15.6 long, 1.96 wide, sparsely scattered over dorsum, difficult to detect in most specimens.

Anal plates (fig. K₁, K₂): Each plate usually triangular with caudal angle rounded, 153(141-168) long, 92.1(78.2-113) wide; cephalolateral margin usually concave, 106(93.8-113) long; caudolateral margin convex, 113(97.8-129) long. Each plate with 4 apical and 2 subapical setae. Anal fold with 2 pair of fringe setae, the outer pair often extending past apex of anal plates.

Anal ring (fig. L): Ovate to rectangular, about 86.0 long, 74.3 wide, with 8 hairs and 2 irregular rows of translucent wax pores.

VENTRAL SURFACE

Setae: Ventral submarginal setae (fig. M) 16.4(11.7-19.6) long, slender, acute, curved or straight, about 20 around head. Body

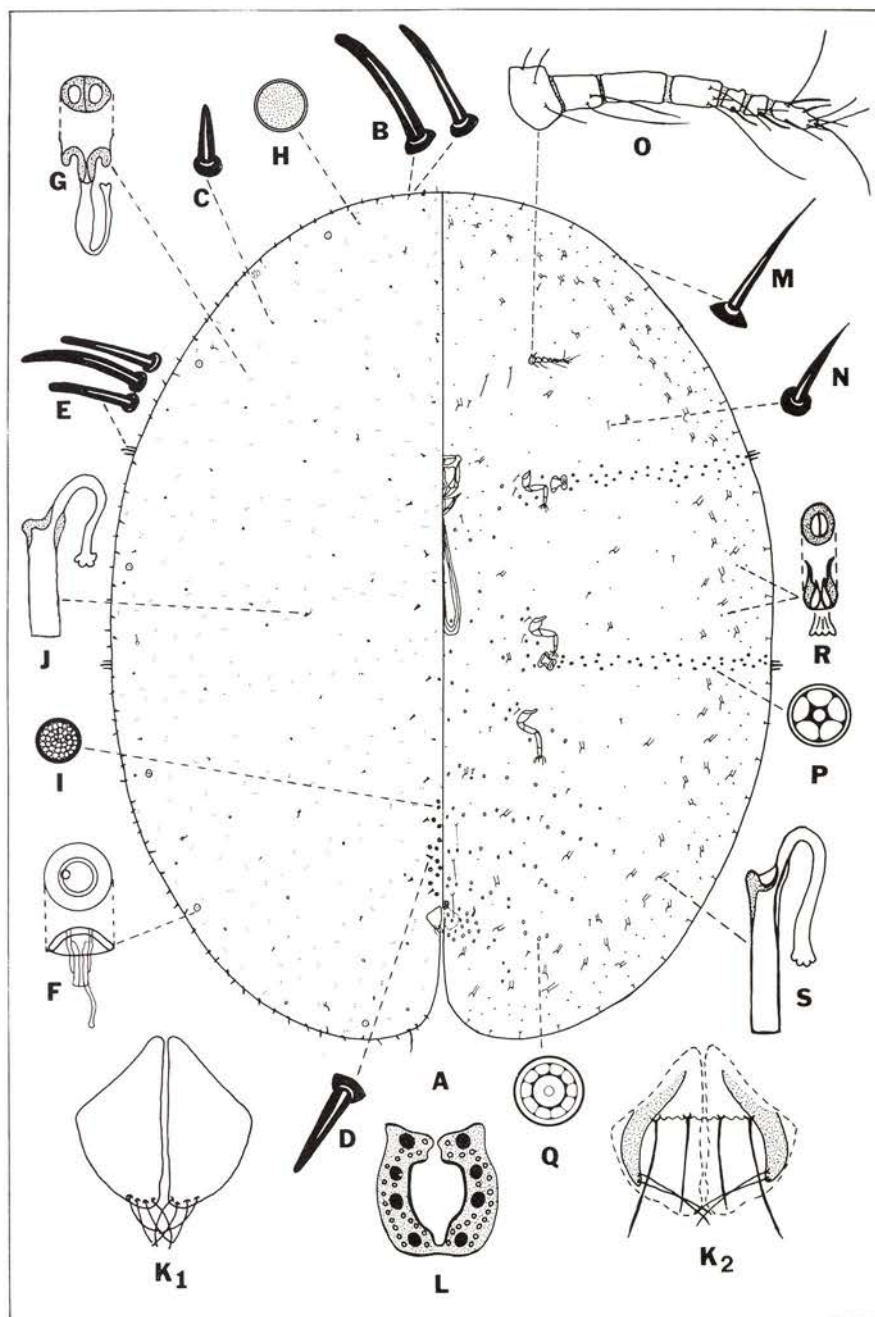


Plate 10. - *Lecanium corni* Bouché

setae (fig. N), 10.8(9.78-11.7) long, similar to ventral submarginal setae but stouter, scattered randomly over venter. With 3 pair of large prevulvar setae.

Eyes: Present in some specimens, but very obscure.

Antennae (fig. O): Well-developed, 6- or 7-segmented, 298(274-332) long. Scape 42.6(39.1-50.8) long, 61.8(50.8-70.4) wide. Length of segment II to VII: 45.3(43.0-50.8), 71.5(35.2-121), 47.5(27.4-62.6), 27.0(23.5-35.2), 24.7(19.6-27.4), 45.3(43.0-46.9) long, respectively. Terminal segment with 3 hairlike and 6 fleshy setae. Setae on other segments: I,3; II,2; III,0; IV,3; V,1 fleshy; VI,1 and 1 fleshy setae.

Legs: Well-developed, without tibio-tarsal sclerotization or free articulation. Claws with a denticle. Tarsus and claw each with a pair of digitules; claw digitules unequal, one slender, one broad, expanded at apex, 30.9(27.4-35.2) long; tarsal digitules equal, slender, knobbed, 46.9(43.0-54.7) long.

Part of leg	Lengths prothoracic	Lengths mesothoracic	Lengths metathoracic
Coxa	95.3(78.2-106)	113(97.8-121)	116(102-137)
Trochanter	65.6(58.7-74.3)	65.7(54.7-78.2)	65.7(54.7-78.2)
Femur	130(117-145)	143(125-160)	145(129-156)
Tibia	111(89.9-121)	113(89.9-129)	110(93.8-125)
Tarsus	77.3(62.6-86.0)	81.3(74.3-86.0)	84.8(66.5-113)
Claw	22.2(19.6-23.5)	22.7(19.6-27.4)	24.3(19.6-27.4)
Entire leg	502(442-540)	539(489-598)	546(493-586)

Spiracles: Spiracular apodeme usually constricted on both sides. Spiracular pore bands 2 or 3 pores wide, pores widely spaced. Anterior spiracles 95.8(82.1-117) long, atrium 59.5(43.0-78.2) wide; posterior pair 101(82.1-117) long, atrium 73.1(46.9-89.9) wide.

Pores: Quinquelocular pores (fig. P) 6.53(5.89-7.82) in diameter, located in spiracular pore band. Multilocular pores (fig. Q), 7.82(7.82) in diameter, located in transverse bands on abdomen and some in central portion of thorax, usually extending to rostrum, most with 10 loculi.

Ducts: Microducts (fig. R), about 4.39 long, which open through oval shaped orifices about 2.93 in diameter, scattered over entire

venter, most numerous in submarginal area. Tubular ducts (fig. S), 21.2(19.6-23.5) long, 3.91(3.91) wide, with inner filaments 19.2(15.6-23.5) long, 1.96(1.96) wide, numerous in a submarginal band around body, sparsely scattered elsewhere.

OTHER STAGES

First instar nymphs with well-developed legs and 6-segmented antennae; about 34 marginal setae around body; spiracular setae in 3's, stout, median seta slightly longer than laterals; a single trilocular pore near each antennal base; usually with 2 longitudinal rows of 8-shaped pores on mid-dorsum; each anal plate with 1 long caudal, 2 apical and 1 subapical seta; anal fold with 1 pair fringed setae; anal ring with 6 hairs. Second instar nymphs not seen. Males were described by Giliomee (1967).

BIOLOGICAL NOTES

European fruit lecaniums overwinter in the second nymphal stage on the twigs or branches of their host and mature during the early spring. In mid-May each female lays a large number of white eggs beneath her body. In June the eggs hatch, and the immature insects migrate from beneath the mother to the underside of the leaves to settle and feed. In August they move back to the twigs, completing their growth in the spring. There is one generation per year.

PARASITES AND PREDATORS

The following parasites are reported by Kawecki (1958): *Anagrus armatus*, *Aphycus albiceps*, *A. annulipes*, *A. flavus*, *A. maculipes*, *A. rileyi*, *Blastothrix longipennis*, *Cerapterocerus mirabilis*, *Chiloneurus formosus*, *Coccophagus cinguliventris*, *C. lycimnia*, "*C. notatus*," *C. perflavus*, *C. scutellaris*, *Encyrtus bicolor*, *E. californicus*, *E. (=Comys) fuscus*, *E. scutellatus*, *E. swederi*, *Ericydnus longicornis*, *Euderus (=Chrysocharis) lividus*, *Eusemion longipennis*, *Metaphycus mayri*, *M. punctipes*, "*Microterys aeneus*," "*M. chalcostomas*," *M. claripennis*, "*M. coccophagus*," "*M. duplicatus*," *M. flavus*, *M. lunatus*, *M. sylvis*, *M. xanthopsis*, "*Phaenodiscus aeneus*," "*Syrphophagus aeroginosus*." Reared at VPI&SU *Aphycus lounsburyi*, *Microterys fuscicornis*, and *Tetrastichus minutus*. Predators include: *Adalia bipunctata*, *Chilocorus bipustulatus*, and *Hyperaspis campestris* (Kawecki, 1958).

ADDITIONAL HOSTS AND DISTRIBUTION IN VIRGINIA

L. corni is found throughout Virginia on a large number of hosts. See Material Studied. Additional records include: *Fagus* sp., Blacksburg. *Quercus palustris*, Blacksburg. *Q. virginiana*, Norfolk. *Quercus* sp., Blacksburg. *Sassafras* sp., Blacksburg. *Taxodium distichum*, Henrico Co.

ADDITIONAL HOSTS AND DISTRIBUTION IN U.S.A.

The European Fruit Lecanium is a cosmopolitan species found throughout the United States, occurring on a wide variety of hosts too numerous to include in this study.

ECONOMIC IMPORTANCE

Because of its cosmopolitan distribution and its polyphagous habit, *L. corni* is economically important in ornamental plantings. It has a high reproductive potential and can build up heavy infestations in a short time. Once the female matures, control is difficult.

NOTES

Lecanium corni is a species which exhibits extreme morphological variation from host to host. Many of its host-induced forms have been described as separate species. Variation occurs in most morphological characters which are normally used in classification. We were unable to consistently separate *L. corni*, *L. fletcheri* and *L. quercifex*. Therefore, they are placed in a group called the "corni complex." We do not choose to synonymize *L. fletcheri* and *L. quercifex* until there is supportive evidence that they are the same as *L. corni*. Further study on the other stages and host transfer work is needed before the problems of the "corni complex" can be solved. The specimens collected on *Robinia pseudo-acacia* in Virginia seem to agree with the descriptions of *L. corni* as it occurs in Europe. Measurements of the morphological characters used in this description were mostly from specimens collected on that host.

Lecanium fletcheri Cockerell, 1893

Fletcher Scale

Photo 16

Lecanium fletcheri Cockerell, 1893c:221; Fletcher, 1895:6; King, 1899:141, 1901c:194; Felt, 1901:356; Dietz and Morrison, 1916:256;

Lawson, 1917:195; Kawecki, 1961:66; Phillips, 1965:237; Wray, 1967:33; Dziedzicka, 1968:125; Wallner, 1969:35. *Eulecanium fletcheri* (Ckll.), King, 1902b:159; Fernald, 1903:187; Douglas, 1911:173.

MATERIAL STUDIED

Cupressus sp., 1, Cape Henry, July 22, 1927, A. Busck. *Juniperus* sp., 1, (3), Tazewell, June 15, 1957, Mr. Luxtin. *Taxus* sp., 2, (3), Elm Grove, W. Va., Sept. 11, 1942, F. Craig; 1, (6), Camp Deitrick, Md., May, 1953, Capt. Pippin; 1, (4), Bristol, July 25, 1953, FRF; 2, (3), Blacksburg, May 1, 1967, S. Afifi.

PARASITES

The following parasites attack *L. fletcheri* according to Peck (1963) : *Aphyecus jarvisi* (nomen nudum), *A. pulvinariae*, *Blastothrix longipennis*, *Cheiloneurus albicornis*, *Coccophagus fletcheri*, *C. lycimnia*, *Encyrtus bicolor*, and *Microterys flavus*.

ADDITIONAL HOSTS AND DISTRIBUTION IN VIRGINIA

Cupressus sp., Virginia Beach. *Juniperus* sp., Clark Co., Berryville. *Thuja occidentalis*, Arlington. *Thuja* sp., Giles Co.; Winchester.

ADDITIONAL HOSTS AND DISTRIBUTION IN U.S.A.

Reported from Alabama, Arkansas, Colorado, Connecticut, Idaho, Illinois, Indiana, Iowa, Kansas, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Missouri, New Jersey, New York, North Carolina, Ohio, Oklahoma, Oregon, Rhode Island, South Carolina, Texas, Washington, West Virginia, and Wisconsin. An additional host is *Juniperus virginiana* (Lawson, 1917).

NOTES

We were unable to separate this species from *Lecanium corni* Bouché, therefore, both are represented by the same couplet in the species key of *Lecanium*. Since it appears distinctly different in appearance in the natural state and has been treated as a distinct species by several workers, we will not synonymize it with *L. corni* until a more comprehensive study can be made. Phillips (1965) concluded that *L. fletcheri* was a synonym of *L. corni*. Dziedzicka (1968)

felt that *L. fletcheri* and *L. corni* were separate species, but stated that many of the morphological characters she used to separate the species could not be taken as absolutely valid in all cases because of the great variation of the four species she studied. Identification cannot be based on just one character or on the examination of only a few specimens, for the morphological characters of two different species may then appear to be similar.

Lecanium nigrofasciatum Pergande, 1898

Terrapin Scale

Plate 11, Photos 17, 18, 19

Lecanium nigrofasciatum, Pergande, 1898:26; Chambliss, 1898:149; Johnson, 1899a:66; 1899b:87; Fernald, 1899:21; King, 1899:141; 1901c:195; Lugger, 1900:218; Felt, 1901:357; Banks, 1902:11; Pettit, 1902:187; 1904:53; Thro, 1903:211; Hood, 1907:2; Gahan, 1907:153; Sanders, 1909:446; 1910:60; Symons and Cory, 1910:83; Smith, 1911:28; Close and Ballard, 1911:189; Dietz and Morrison, 1916:251; Houser, 1918:299; Merrill and Chaffin, 1923:262; Hollinger, 1923:46; Gillette and Langford, 1925:11; Trimble, 1925:7; Cox, 1942:698; Craighead, 1950:146; Merrill, 1953:97; Richards, 1958:312. *L. persicae* (Fabr.) misidentifications, Murtfeldt, 1893:186; 1894a:44; 1894b:131; Howard, 1894:270; Cockerell, 1895e:256; Bethune, 1907:23. *L. (Eulecanium) nigrofasciatum*, Pergande, Cockerell and Parrott, 1899:234; Pettit and McDaniel, 1920:14; McDaniel, 1930:6. *Eulecanium nigrofasciatum* (Pergande), King, 1902b:160; 1903:192; Fernald, 1903:191; Sanders, 1907:1; Girault, 1909:75; Douglas, 1911:175; Herrick, 1911:12; 1935:190; Britton, 1915:8; Simanton, 1916:1.

The terrapin scale is a native species which was observed as early as 1872 by Mr. Theodore Pergande. It was then believed to be the European peach scale *Lecanium persicae* (Fabr.) an insect of similar habits. Pergande (1898) realized the terrapin scale was a distinct species and described it as such. The publications prior to 1898, for the most part, refer to it as *L. persicae*.

MATERIAL STUDIED

Acer platanoides, 1, (2), Bristol, let., Aug. 7, 1925, M. H. Cophaver. *A. rubrum*, 1, Giles Co., June 8, 1967, MK; 2, (4), Montgomery Co., May 4, 1968, MLW; 13, (13), Astor, Fla., March 23, 1970,

MLW. *A. saccharinum*, 9, (15), Smyth Co., Aug. 1, 1969, MLW. *Lindera benzoin*, 1, Greenwood, Sept. 12, 1945, DWC; 10, (10), Newport, May 19, 1968, MLW; 2, (4), Montgomery Co., April 5, 1969, MLW. *Phoradendron* sp., 10, (10), Salisbury, Md., Dec. 12, 1969, S. Joseph. *Platanus occidentalis*, 1, Whitehall, May 6, 1946, DWC; 4, (6), Louisville, Ky., Oct. 25, 1968, C. V. Covell. *Prunus cerasifera* var. *atropurpurea*, 1, (4), Pittsylvania Co., Aug. 25, 1965, H. Miller, Jr.

GENERAL APPEARANCE

The terrapin scale appears as a reddish (10R 5/12) hemispherical insect 2 mm. in length, mottled with about 24 radiating streaks of black which are especially conspicuous near the margin. Sometimes the streaks coalesce, forming a subdorsal dark band surrounding a central red area. Sometimes, entirely red or black individuals are found.

DESCRIPTION

Body (fig. A) subcircular, 2397(1255-4136) long, 2391(1196-4136) wide, derm becoming heavily sclerotized at maturity. Legs and 6-segmented antennae well developed. Marginal setae acute and sharply bent near tip. Submarginal tubercles absent. With a row of crown-shaped discoidal pores in mid-dorsum, extending from anal plates to anterior of rostrum. Tubular ducts lacking. Anal cleft about 1/6 of body length.

DORSAL SURFACE AND MARGIN

Setae: Marginal setae (fig. B), 14 to 18 around head, 22.7(19.6-31.2) long, slender, straight at base but curved from midway to apex. Body setae (fig. C), about 35 over entire body, primarily in submarginal areas, 9.11(7.82-11.7) long, slender, slightly curved, pointed.

Spiracular setae (fig. D): 3 in each spiracular furrow; median seta 45.4(31.3-70.4) long, 6.27(3.91-7.82) wide, slender, slightly curved, blunt tipped, $2\frac{1}{2}$ or 3 times length of laterals; lateral setae 21.2(11.7-27.4) long, 5.08(3.91-7.82) wide, straight, tapering, bluntly pointed.

Submarginal tubercles: Absent.

Pores: Bilocular pores with a slender inner filament (fig. E) about 2.44 in diameter, numerous, scattered over dorsum. Monolocular ring pores (fig. F) about 1.95 in diameter, also numerous and scattered randomly over dorsum. Crown-shaped discoidal pores (fig. G) 5.90(3.91-7.82) in diameter, arranged in a median row of about 15 to 30 pores anterior to anal plates, extending anteriorly to, and sometimes past, rostrum.

Anal plates (fig. H₁, H₂): Triangular, outer angles rounded, 130(113-141) long, 77.0(66.5-86.0) wide; cephalolateral margin straight or concave, 104(113-141) long; caudolateral margin convex, with a sclerotized thickening around margin, 90.7(82.1-101) long. Derm around anal plates usually heavily sclerotized. Each plate with 3 apical and 2 subapical setae. Anal fold with 2 pair of fringe setae, the outer pair largest.

Anal ring (fig. I): Ovate to subcircular, about 47.0 long, 43.0 wide, with 8 hairs and 2 rows of translucent wax pores.

VENTRAL SURFACE

Setae: Ventral submarginal setae (fig. J) slender, acute, curved and with a large base, 10.6(7.82-16.0) long, about 25 around head. Body setae (fig. K) similar to ventral submarginal setae, 10.5(7.82-15.6) long, numerous, scattered over venter. With 3 pair of prevulvar setae, posterior pair largest.

Eyes: Present, small circular spots surrounded by a more sclerotized area, above the level of antennal scape on margin.

Antennae (fig. L): Well-developed, 6-segmented, 264(231-316) long. Scape 34.0(19.6-46.9) long, 46.1(43.0-55.0) wide. Length of segments II to VI: 47.0(35.1-66.5), 78.7(50.8-102), 31.3(23.1-47.0), 23.1(15.6-39.1), 43.0(31.3-66.5) long, respectively. Terminal segment with 4 hairlike and 5 fleshy setae. Setae on other segments: I,3; II,2; III,3; IV,1 fleshy; V,1 normal and 1 fleshy seta.

Legs: Well-developed, without tibio-tarsal sclerotization or free articulation; claws with a denticle. Tarsus and claw each with a pair of digitules; claw digitules unequal, 1 slender, 1 broad, expanded at apex, 24.9(15.6-31.2) long; tarsal digitules equal, slender, knobbed, 39.5(31.3-50.8) long.

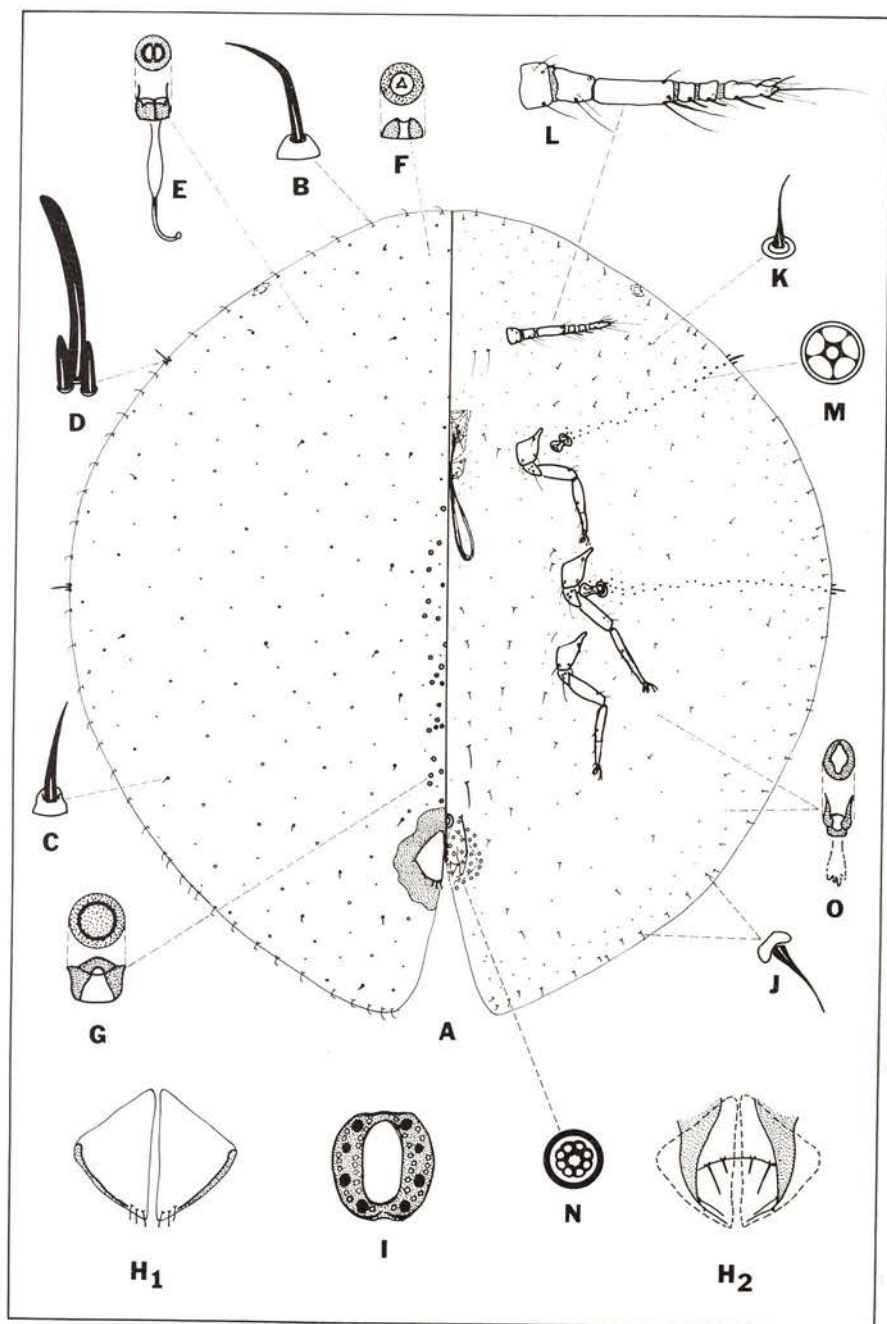


Plate 11. - *Lecanium nigrofasciatum* Pergande

Part of leg	Lengths prothoracic	Lengths mesothoracic	Lengths metathoracic
Coxa	52.4(31.3-66.5)	62.2(50.8-78.2)	61.0(46.9-74.3)
Trochanter	46.5(31.3-62.6)	51.3(43.0-70.4)	44.5(27.4-58.6)
Femur	96.5(78.2-121)	106(78.2-137)	103(86.0-136)
Tibia	83.3(70.4-113)	96.5(70.4-117)	91.9(70.4-117)
Tarsus	63.4(46.9-82.1)	69.6(55.0-97.7)	72.7(50.8-93.8)
Claw	18.7(15.6-19.6)	20.4(11.7-23.5)	18.7(15.6-19.6)
Entire leg	356(297-473)	404(317-524)	393(313-500)

Spiracles: Spiracular apodeme constricted on both sides, atrium wider than apodemal base. Spiracular pore bands 1 or 2 pores wide except near spiracle where it may be 3 or 4 pores wide. Anterior spiracles 62.2(46.9-82.1) long, atrium 32.1(27.4-39.1) wide; posterior pair 61.0(46.9-78.2) long, atrium 38.3(23.5-46.9) wide.

Pores: Quinquelocular pores (fig. M) 9.40(3.91-15.6) in diameter, forming spiracular pore bands, each band of 30 to 45 pores. Multilocular pores (fig. N) 7.82(7.82) in diameter, located in anal area only, most with 8 locules.

Ducts: Tubular ducts absent. Microducts (fig. O), about 3.90 long, which open through oval shaped orifices about 2.44 in diameter, scattered over entire venter, but most numerous in submarginal area.

OTHER STAGES

First instar nymphs with 6-segmented antennae; claws with a denticle; 30 marginal setae around body; spiracular setae in 3's with the median seta 3 times the length of laterals; anal plates with 1 long and 2 short apical setae, and 1 subapical seta; anal fold with 1 pair of fringe setae. Second instar nymphs with 6-segmented antennae, claws with a denticle; 36 marginal setae around body; spiracular setae in 3's with the median seta $2\frac{1}{2}$ or 3 times the length of laterals; anal plates with 3 apical and 1 subapical setae; anal fold with 2 pair of fringe setae. Males are known but have not been described in detail.

BIOLOGICAL NOTES

The female of the terrapin scale reaches maturity in early spring and is viviparous. The 1st instar nymphs remain under the female for 1 to 3 days, then migrate to the undersides of leaves to settle and feed. After about 18 days they molt into a second instar and 18 days later molt into the adult female. The females soon move to the twigs and pass through a period of rapid growth. During this period, the male develops through 5 stages. After emergence, it migrates directly to the twigs, copulates, and dies. The male develops in about 50 days. The fertilized female continues to develop until cold weather forces it into hibernation. In the spring growth is resumed.

PARASITES AND PREDATORS

The following parasites are reported to attack the terrapin scale: *Aphycus annulipes*, *A. californicus*, *A. johnsoni*, *A. stomachosus*, *Blastothrix sericea*, *Cheiloneurus albicornis*, *Coccidoxenus* (= *Anagyrus*) *nubilipennis*, *Coccophagus cinguliventris*, *C. fraternus*, *C. longifasciatus*, *C. lycimnia*, *Encyrtus* (= *Comys*) *fuscus*, *Eunotus lividus*, *Pachyneuron altiscuta*, *Prospaltella aurantii* (Thompson, 1944); *Aphycus pulvinariae*, *A. rileyi*, *Anagrus armatus*, *Apterencyrtus microphagus*, *Homalotylus albitarsus*, *Marietta mexicana*, *Physcus varicornis*, *Tetrastichus minutus*, *Thysanus pulcher*, (Peck, 1963); Predators of the terrapin scale include: *Camptobrochis nebulosus*, *Chilocorus bivulnerus*, *Chrysopa nigricornis*, *Hemerobius stigmaterus*, *Hyperaspis binotata*, *H. signata*, and *Laetilia coccidivora*, (Simanton, 1916).

ADDITIONAL HOSTS AND DISTRIBUTION IN VIRGINIA

Acer rubrum, Albemarle Co., Crozet; Augusta Co., Mt. Elliot; *A. saccharinum*, Blacksburg. *Acer* sp., Charlottesville; Appomattox Co., Appomattox; Augusta Co., College Park; Fairfax Co., Herndon; Wise Co., Blackwood. *Lindera benzoin*, Loudoun Co., Purcellville. *Mimosa* sp., Warren Co., Bentonville. *Platanus occidentalis*, Blacksburg. *Prunus* sp., Staunton; Fairfax Co., Herndon, Oakton; Blacksburg; Prince William Co., Manassas, Nokesville; Roanoke Co.; Lexington; Warwick Co., Morrison. *Sassafras albidum*, Virginia Beach. On "hedge," Fauquier Co., Warrenton. Unknown host, Winchester; Rappahannock Co.

ADDITIONAL HOSTS AND DISTRIBUTION IN U.S.A.

There are no indications that the terrapin scale occurs outside of North America. It is recorded from every state east of the Mississippi River except Maine, New Hampshire and Vermont. It is also recorded from Arkansas, Iowa, Louisiana, Minnesota, Missouri, New Mexico, and Texas. Additional hosts include: *Acer pseudo-platanus*, *A. saccharum*, *Amygdalus persica*, *Betula* sp., *Bumelia angustifolia*, *Castanea dentata*, *Cercis canadensis*, *Chaenomeles japonica*, *Clematis* sp., *Crataegus oxyacantha*, *Cydonia oblonga*, *Elaeagnus angustifolia*, *Euonymus atropurpureus*, *Fraxinus* sp., *Ilex opaca*, *Magnolia virginiana*, *Melia azedarach*, *Morus* sp., *Nerium oleander*, *Olea* sp., *Padus* sp., *Platanus orientalis*, *Populus deltoides*, *Prunus sinconii*, *Pyrus communis*, *P. malus*, *Quercus virginiana*, *Ribes* sp., *Rosa* sp., *Salix babylonica*, *Salix* sp., *Sapindus marginatus*, *Tilia* sp., *Vaccinium* sp., *Vitis vinifera*, and *Vitis* sp. (Simanton, 1916).

ECONOMIC IMPORTANCE

According to Simanton (1916) the terrapin scale, in its range and importance, ranks easily as second among the scale insect pests of the peach, and while not so prolific and not so injurious as the San Jose scale, it is a greater nuisance, because of the difficulty in controlling it. Symons and Cory (1910) stated that the loss to the orchardist from the terrapin scale is not so much through the damage to the tree as through injury to the fruit. The honeydew, which is excreted in large quantities by the scale insect, often coats both the leaves and fruit and furnishes an excellent medium for fungus that renders the fruit practically unsalable at remunerative prices.

NOTES

Simanton's work (1916) is a comprehensive study on the biology of the terrapin scale. In both Florida and Virginia, we have encountered entire populations of the terrapin scale in which about $\frac{1}{4}$ of the ventral part of the body was sclerotized and the margin of the female is elevated above the point of attachment, giving the coccid a pielike appearance.

Lecanium persicae (Fabricius), 1776

European Peach Scale

Plate 12, Photos 20, 21, 22

Chermes persicae Fabricius, 1776:304. *Eulecanium magnoliarum* (Ckll.), Fernald, 1903:190. *E. magnoliarum* var. *hortensiae* Cockerell, 1903:19; Fernald, 1903:190. *E. persicae* (Fabr.), Cockerell, 1901a:92; Fernald, 1903:191; Brimblecombe 1962:226. *Lecanium magnoliarum* Cockerell; 1898:145; Cockerell and Parrott, 1899:236; Thro, 1903:217. *Lecanium persicae* (Fabr.), Comstock, 1883:134; Saunders, 1883:195; Howard, 1894:270; Cockerell 1894b:334; Gillette, 1897:37; Starnes, 1897:28; Felt, 1901:357; Marchal, 1908a:285; Sanders, 1909:441; Merrill and Chaffin, 1923:264; Sulc, 1932:75; Merrill, 1953:97; Phillips, 1965:237; Ezzat and Hussein, 1967:408. *Parthenolecanium persicae* (Fabr.), Borchsenius, 1957:350.

MATERIAL STUDIED

Albizzia julibrissin, 5, (7), Blacksburg (Arboretum), May 22, 1969, MK. *Berberis canadensis*, 4, (9), Blacksburg, Jan. 5, 1970, MLW. *Daphne* sp., 1, Sacramento, Calif., March 21, 1963, W. G. Vettel and T. B. Gallion. *Elaeagnus* sp., 1, Norfolk, May 15, 1941, C. R. Willey. *Euonymus japonicus* var. *microphyllus*, 1, (4), Loudoun Co., May, 1953, Dr. Phillips. *Euonymus* sp., 1, (3), Virginia Beach, Sept. 8, 1948, FRF. *Ulmus thomasi*, 1, Richmond, let., May 31, 1934, O. H. Funsten. *Vitis* sp., 2, (6), Grayson Co., Independence, May 14, 1952, C. F. Simpson. "Tea," 1, (5), Norfolk, Sept. 9, 1948, FRF.

GENERAL APPEARANCE

Body shape and color varies, often the female is elongate oval, with a median dorsal keel extending longitudinally on the body. Old females uniformly reddish brown. Young females color coded on stems of *Berberis canadensis*, yellow (2.5Y 8/8), streaked with light brown (7.5YR 3/2), females from wounds of *Albizzia julibrissin*, brown-orange (2.5YR 6/8), mottled with dark brown (2.5YR 5/4) or black; both lots from Blacksburg.

DESCRIPTION

Derm slightly sclerotized; body outline elongate oval, (fig. A) with constriction of body margin near spiracular furrows. Body 4978

(1189-8567) long, 3261(892-6693) wide; with many (24 to 34) submarginal tubercles (fig. B) around margin of dorsum; well-developed legs with tibio-tarsal sclerotization and 8-segmented antennae; a dense submarginal band of ducts on venter. Anal cleft extending about 1/6 of body length.

DORSAL SURFACE AND MARGIN

Setae: Marginal setae (fig. C), 47.3(39.1-58.7) long, slender, slightly curved, and pointed, may be longer at posterior end of body; about 9 marginal setae between spiracular setae. Body setae (fig. D) of two types, both stout, conical, and pointed; about 60 larger setae, about 18.6 long, are located in the mid-dorsal area from anterior of the anal plates almost to anterior margin of body, while the smaller setae 16.4(15.6-19.6) long, are scattered randomly over the dorsum.

Spiracular setae (fig. E): In groups of 3, subequal in length, nearly equal in length to marginal setae. Median spiracular setae 64.1(50.8-82.1) long, 14.5(11.7-19.6) wide, usually slightly longer than lateral setae which are 45.0(35.2-54.7) long, 12.5(11.7-15.6) wide. All 3 setae in each group, stout, tapering and usually pointed.

Submarginal tubercles (fig. B): About 24 to 34 submarginal tubercles 24.7(19.6-31.3) in diameter, in a submarginal row around body. This is a distinguishing characteristic of *L. persicae*, and will immediately separate it from other related species found in the United States.

Pores: Numerous bilocular pores (fig. F) scattered over dorsum, 3.71(3.71) in diameter, each with a long inner filament. Disc pores, of two sizes. Small disc pores (fig. G), 3.34(3.09-3.71) in diameter, scattered over dorsum, not as numerous as the bilocular pores. About 24 large disc pores (fig. H), 6.67(4.94-7.41) in diameter, confined to the median area anterior of anal plates.

Ducts: Dorsal ducts not detected in specimens studied.

Anal plates (fig. I₁, I₂): Triangular in shape, anterior and lateral angles bluntly pointed, caudal angles rounded, caudolateral margin usually convex, cephalolateral margin slightly concave. Length 180(160-188), width 107(78.2-137); cephalolateral margin 127(89.9-156) long, caudolateral margin 142(133-156). Each plate with 4 apical and 3 or 4 subapical setae. Anal fold with 4 fringe setae and no hypopygial setae.

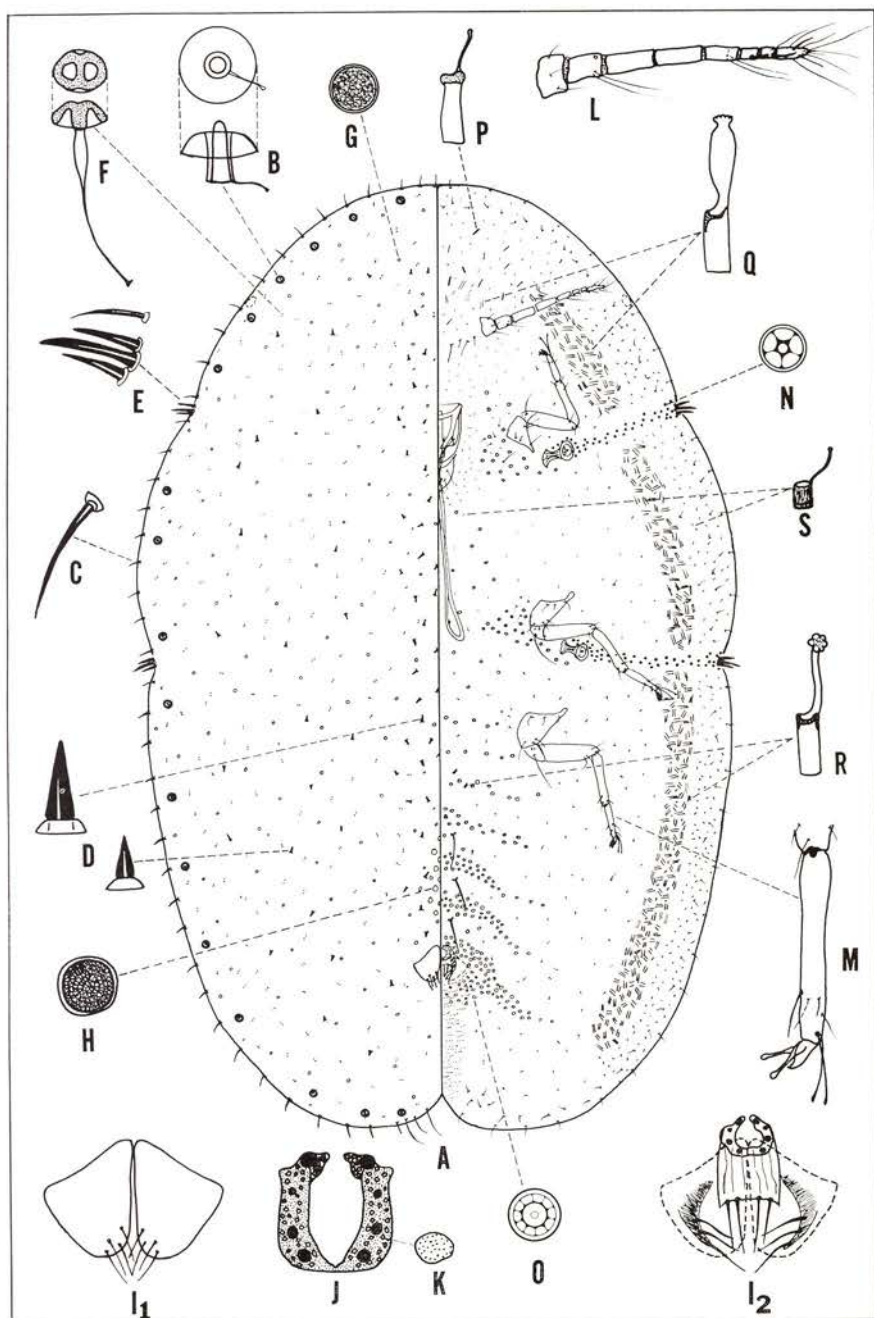


Plate 12. - *Lecanium persicae* (Fabricius)

Anal ring (fig. J): Horseshoe-shaped, about 54.7 long, 74.3 in diameter, with 6 large and 2 smaller anal ring hairs, and 2 irregular rows of translucent wax pores, each with a granulate surface (fig. K).

VENTRAL SURFACE

Setae: A double row of ventral submarginal setae, with the row nearest margin longest, outer row numbering about 6 setae between spiracular furrows, 20.8(15.6-23.5) long, slender, pointed, some curved, some straight; usually 4 pair of setae between antennae; 3 to 5 setae mesad of each coxa; 3 pair of prevulvar setae; a group of 4 to 7 setae near posterior end of anal cleft on each side; numerous small, 11.7(11.7) long, hairlike setae scattered over venter.

Eyes: Present, near margin just anterior of antennal bases.

Antennae (fig. L): Well-developed, 8- or 9-segmented, most 8-segmented, some with 8 segments on one side and 9 on the other. Segments 3 and 4 subequal, longer than any other. Antennae 464 (411-504) long. Scape 50.9(31.3-58.7) long, 72.7(54.7-93.8) wide. Segment II to VIII: 71.0(58.7-113), 90.3(74.3-109), 83.4(62.6-109), 60.8(39.1-74.3), 35.6(31.3-46.9), 27.8(19.6-31.3), 49.5(39.1-58.7) long respectively. Terminal segment with 7 hairlike and 4 stout sensory setae. Setae on other segments: I,3; II,2; III,0; IV,0; V,2; VI,1 fleshy; VII,1 and 1 fleshy setae.

Legs (fig. M): Well-developed, with tibio-tarsal sclerotization and free articulation; 2 tarsal digitules and 2 claw digitules, all extending past claw; claw digitules broader than tarsal digitules. Claw with denticle near apex. Tarsal digitules slender, knobbed, 47.7(43.0-54.7) long; claw digitules slightly broader, knobbed, 32.9(27.4-43.0) long.

Part of leg	Lengths prothoracic	Lengths mesothoracic	Lengths metathoracic
Coxa	86.1(74.3-102)	98.1(82.1-129)	98.6(86.0-117)
Trochanter	92.7(74.3-102)	99.7(89.9-117)	99.4(78.2-109)
Femur	189(168-227)	204(176-235)	208(188-235)
Tibia	187(156-211)	201(176-223)	203(176-223)
Tarsus	119(106-133)	132(117-141)	133(113-156)
Claw	24.3(19.6-27.4)	26.6(23.5-31.3)	25.1(23.5-27.4)
Entire leg	698(606-758)	761(676-832)	767(669-830)

Spiracles: Apodeme constricted on each side, base not areolate; posterior pair broader. Anterior spiracles 104(89.9-121) long, atrium 74.7(62.6-89.9) wide, positioned laterad of prothoracic coxae; atrium wider than apodemal base. Spiracular pore band extending to base of apodeme, 3 or 4 pores wide throughout, containing about 57 to 78 pores. Posterior spiracles 109(78.2-125) long, atrium 91.9(78.2-101) wide, located just posterior of mesothoracic legs; atrium and apodemal base about equal in width. Spiracular pore band containing about 66 to 76 pores, 3 or 4 pores wide at each end, uniting with multilocular pore band between mesothoracic coxae.

Pores: Quinquelocular pores (fig. N), 6.32(5.94-7.82) in diameter, in spiracular furrows. Multilocular (10 to 12 locular) pores (fig. O), 7.82(7.82) in diameter, numerous around anal area; in transverse bands on abdomen and continuing anteriorly to and even a few anterior of rostrum.

Ducts: Four types of ducts are found on the venter of *L. persicae*. Anterior of antennae are ducts of the first type (fig. P) with a heavily sclerotized rim, and a slender filament which is not expanded at the end; duct 7.82(7.82) long, 3.91(3.91) wide; filament 7.82(7.82) long, slender. The second type (fig. Q) with a broad inner filament; duct 15.2(11.7-15.6) long, 3.91(3.91) wide; filament 17.2(15.6-19.6) long, 5.13(3.91-5.94) wide, these arranged in a broad submarginal band on thorax and abdomen, interrupted in area of spiracular furrows, and forming a short median arch between the antennae. The third type, (fig. R), duct 9.76(7.82-11.7) long, 3.91(3.91) wide, with filament 16.8(11.7-19.6) long, 1.96(1.96) wide and expanded at tip, is in median and submedian areas of the body and mixed with the second type in the broad submarginal band. The fourth type, (fig. S) very small and heavily sclerotized, duct 3.91(3.91) long, 1.95(1.95) wide, with a short slender filament, scattered over entire venter, but decreasing in number near the second type.

OTHER STAGES

First instar nymphs with 6-segmented antennae and 8 submarginal tubercles around body margin. Second instar nymphs with 7-segmented antennae and 16 submarginal tubercles around the body. Males or male covers have not been encountered by the authors, but Sulc (1932) states that the male has been known in Europe since 1901.

BIOLOGICAL NOTES

The European peach scale attacks many host species. Nymphs and adults may feed on trunk, branches, twigs, and leaves; often found on the new callus tissue formed around wounds. According to Marchal (1908b), both males and females are present and reproduction is sexual, or there is facultative parthenogenesis. In Montgomery County, a barberry shrub (*Berberis canadensis*), heavily infested with the European peach scale was sampled several times throughout 1968-69, and all stages were found except males or male tests; thus it is assumed that the population was parthenogenetic.

It overwinters in the second instar stage, and the females reach maturity and some begin laying eggs in early May; the nymphs soon hatch, crawl out from under the dead female, and settle on the underside of leaves and on new growth. Time of maturity and egg production varies among individuals; sometimes adults and nymphs of various stages can be observed on the same plant at the same time.

PARASITES AND PREDATORS

Parasites often play an important role in the control of the European peach scale. Kosztarab (1956) reported 87.6% parasitization from Hungary. In Montgomery County during 1968, a small apelinid wasp, *Coccophagus lycimnia*, parasitized approximately 50% of the second instar stage of an infestation on barberry. Clausen (1940) reports the larvae of *Holcocerca iceryaella* (Lepidoptera: Blastobasidae) feeding on *L. persicae*.

ADDITIONAL HOSTS AND DISTRIBUTION IN VIRGINIA

Berberis julianae, from Virginia Department of Agriculture Division of Plant Industry records. *Berberis* sp., Blacksburg; Lynchburg. *Euonymus* sp., Botetourt Co., Daleville. *Lonicera* sp., intercepted in Virginia.

ADDITIONAL HOSTS AND DISTRIBUTION IN U.S.A.

Reported from Florida, on plum (*Prunus* sp.), (Merrill and Chaffin, 1923). From California, identified as *Lecanium magnoliarum* Ckll., (Sanders, 1909), and on grape, *Vitis* sp., *Carpenteria californica*, and *Daphne* sp. (Steinweden, 1972, personal communication). In the USNM collection it is represented from: Georgia, Indiana,

Maryland, Mississippi, Missouri, New Jersey, New York, North Carolina, Ohio, Oregon, Pennsylvania, Rhode Island, South Carolina, Texas, Washington, D. C.

ECONOMIC IMPORTANCE

The European peach lecanium is primarily a pest of ornamentals in the United States and will eventually kill the host if not controlled. Borchsenius (1957) states that in the USSR this coccid is injurious to grapes, fruit crops, and ornamentals.

NOTES

Sanders (1909) lists *Lecanium subaustrale* Ckll., *L. magnoliarum* Ckll., and *L. magnoliarum* var. *hortensiae* Ckll. as synonyms of *L. persicae* (Fabr.). Borchsenius (1957) gives a more detailed coverage of parasites from around the world and also describes other stages of *L. persicae*.

Lecanium quercifex Fitch, 1859

Oak Lecanium

Lecanium quercifex Fitch, 1859:805; Signoret, 1873:425; Packard, 1881:38, 1890:98; Comstock, 1883:135; Cockerell, 1895b:35; King, 1899:140; Felt, 1901:357; Thro, 1903:213; Sanders, 1909:445, 1910:57; Dietz and Morrison, 1916:258; Merrill and Chaffin, 1923:264; Herrick, 1935:237; Brimley, 1938:109; Craighead, 1950:147; Merrill, 1953:98. *L. quercitronis* Fitch, 1859:805; Signoret, 1873:426; Packard, 1881:38, 1890:98; Comstock, 1883:135; Cockerell, 1895b:35; 1899d:257; Felt, 1901:357; Sanders, 1910:57. *L. quercitronis* var. *kermoides* Tyrell, 1896:256. *L. antennatum* Signoret, 1873:413. *L. pruinatum* var. *kermoides* Tyrell, 1896:256. *L. (Eulecanium) quercitronis* (Fitch), Cockerell and Parrott, 1899:232. *L. (Eulecanium) quercifex* (Fitch), Cockerell and Parrott, 1899:235. *Eulecanium quercifex* (Fitch), King, 1901e:314; Fernald, 1903:194. *E. quercitronis* (Fitch), King, 1901e:315. *E. quercitronis kermoides* (Tyr.), Fernald, 1903:195.

MATERIAL STUDIED

Carya sp., 1, Charlottesville, May 13, 1946, DWC. *Diospyros virginiana*, 1, Skyline Drive, May 22, 1946, DWC. *Platanus occiden-*

talis, 1, Charlottesville, May 9, 1946, DWC. *Quercus phellos*, 2, (5), Norfolk, let. Sept. 9, 1946, FRF; 2, (9), Richmond, June 8, 1953, FRF; 1, (6), Richmond, June 25, 1954, FRF; 3, (20), Richmond, let. Sept. 12, 1955, FRF; 2, (3), Petersburg, May, 1956, S. Newbill. *Quercus* sp., 4, (6), Falls Church, May 5, 1919, A. Middleton; 5, (7), Norfolk, let. May 7, 1923, G. Murran; 2, (2), Norfolk, let. June 8, 1928, G. Gould; 6, (8), Charlottesville, May 17, 1946, DWC.

PARASITES

Peck (1963) lists the following parasites of *L. quercifex*: *Aenasioidea trimblei*, *Aphycus flammeus*, *A. lecanii*, *Blastothrix longipennis*, *Coccophagus lycimnia*, and *Encyrtus californicus*.

ADDITIONAL HOSTS AND DISTRIBUTION IN VIRGINIA

Betula sp., Charlottesville. *Carya* sp., Skyline Drive. *Quercus laurifolia*, Waynesboro. *Q. phellos*, Lunenburg Co., Kenbridge; Nottaway Co.: Crewe; Virginia Beach. *Quercus* sp., Clark Co., Berryville; Fairfax Co., Falls Church; Mathews Co., Mathews; Richmond; Skyline Drive.

ADDITIONAL HOSTS AND DISTRIBUTION IN U.S.A.

Sanders (1909) states that the range of *L. quercifex* is very general, but it is of economic importance to the oaks in the South Atlantic and Gulf States. Additional hosts include *Castanea pumila*, *Quercus velutina*, *Zanthoxylum americanum*, (Fernald, 1903), and *Quercus alba* (Dietz and Morrison, 1916).

NOTES

This species belongs in the "corni complex," as we were unable to separate it from *L. corni* with the material studied. It is possible that this species is a valid one, but all the Virginia material fell within the range of variation of *L. corni*. Sanders (1909) stated that the species could be recognized by the 3 or 4 apparent scars near the outer angles of the anal plates, which otherwise are quite similar to those of *L. corni*. We were unable to detect these 4 scars in any of the material studied; therefore, we have chosen to place it in the "corni complex" until a more comprehensive study of the genus is attempted.

Genus *NEOLECANIUM* Parrott, 1901

TYPE SPECIES

Lecanium imbricatum Cockerell, 1896.

DESCRIPTION

Body of adult female convex, naked or dusted with a white powdery bloom. Derm sclerotized at maturity. Legs reduced, antennae 6-segmented. Legs without tibio-tarsal sclerotization. Marginal setae slender and non-fimbriate. Spiracular setae in 3's, short and stout, subequal. Submarginal tubercles absent. Dorsum covered with a dense pattern of bilocular pores. Large discoidal pores around anal plates on dorsum. Quinquelocular pores in spiracular furrows, in anal area, and on abdomen. Multilocular pores absent. Tubular ducts confined to anal area. Anal plates with varying number of apical, subapical and fringe setae. Hypopygial setae present. Anal ring with 10 hairs.

NOTES

The eggs are protected by the body of the adult female. The genus *Neolecanium* was first proposed as a subgenus of *Lecanium*. Steinweden (1929) concluded that *Neolecanium*, *Pseudophilippia* and *Toumeyella* constituted a single genus. The generic characters given here refer only to *N. cornuparvum* since it is the only species of the genus which occurs in the United States. The genus *Neolecanium* must be revised before its true relationship to the genus *Toumeyella* can be understood.

N. cornuparvum is the only species in the genus recorded in Virginia.

Neolecanium cornuparvum (Thro), 1903

Magnolia Scale

Plate 13, Photos 23, 24

Lecanium cornuparvum Thro 1903:216; *Neolecanium cornuparvum* (Thro), Fernald, 1903:176; Sanders, 1909:448; Dietz and Morrison, 1916:247; Houser, 1918:302; Pettit and McDaniel, 1920:9; Merrill and Chaffin, 1923:265; McDaniel, 1930:8; Herrick, 1931:302; Craighead, 1950:144; Merrill, 1953:98; Wray, 1967:34; Wallner, 1969:34.

Previous to 1903, the magnolia scale had been known but had been misidentified as *Lecanium magnoliarum* Cockerell (Herrick, 1931). In 1903, Thro recognized it as a distinct species, stating that *L. magnoliarum* had long, well-developed 8-segmented antennae while *N. cornuparvum* had reduced, 6-segmented antennae.

MATERIAL STUDIED

Magnolia stellata, 10, (10), Blacksburg, Aug. 13, 1969, MLW; all other records from *Magnolia* sp., 4, (4), Bath Co., Aug. 8, 1966, O. W. Isakson and M. L. Daulton; 3, (4), Richmond, let. Aug. 19, 1939, FRF; 1, (3), Spalding Co., Ga., Aug. 18, 1966, H. H. Tippins; 1, (3), Westernport, Md., June 20, 1928, J. A. Mullen; 1, (2), Mantua, Ohio, July 7, 1919, W. O. Hollister; 1, (2), Wheeling, W. Va., Sept. 7, 1966, N. K. Joseph.

GENERAL APPEARANCE

Mature females very large, sometimes 12.5 mm in length, elliptical and flat to convex. Body form frequently irregular due to crowding on the branches. Color ranges from a pink-orange to a dark brown; (2.5YR 6/10), darker area around margin, (2.5Y 4/2). Derm densely alveolate, older females covered with a white waxy bloom. When removed, an elliptical scar is left on the bark with four distinct white lines converging toward the center, marking the position of the spiracular grooves of the insect.

DESCRIPTION

Body oval, slightly narrower at anterior end, body outline often irregular (fig. A). Mean length of 10 specimens 8047 (4253-12406), width 6440 (3987-10043). Some segmentation apparent on mid-ventral area. Numerous small 8-shaped pores on dorsum; antennae and legs short and stout; spiracular setae in groups of three, short, stout, conical; quinquelocular pores in spiracular furrows and scattered on abdomen, numerous in anal plate region. Older females slightly sclerotized, exhibiting a light and dark dermal pattern, heavier sclerotized area often found around anal plates. Anal cleft extending about $1/5$ body length.

DORSAL SURFACE AND MARGIN

Setae: Marginal setae (fig. B), 19.8 (13.9-27.8) long, slender, pointed, straight or slightly curved at tip, about 16 between anterior

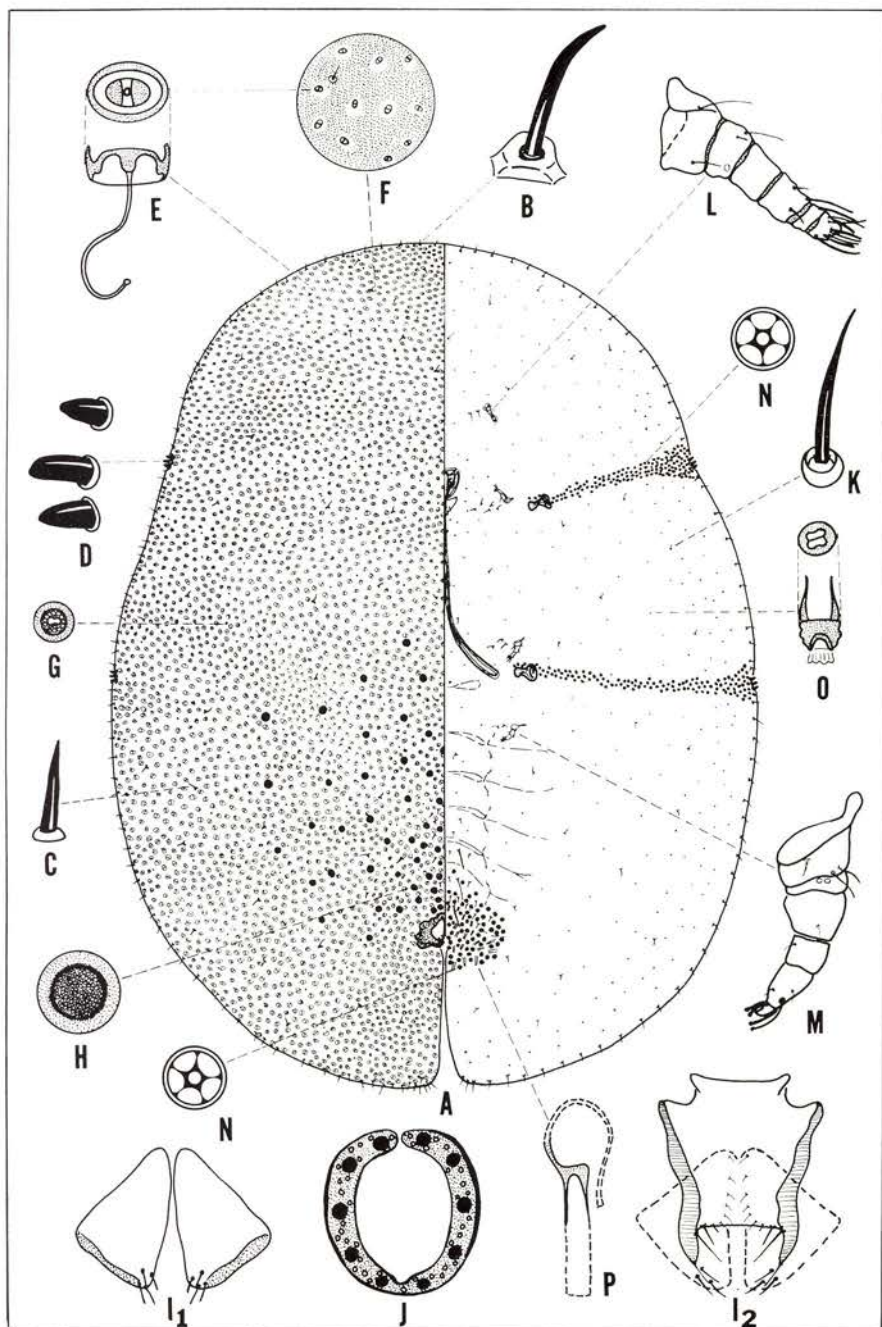


Plate 13. - *Neolecanium cornuparvum* (Thro)

and posterior spiracular setae. Body setae (fig. C), short, stout, and pointed, 16.2(12.4-20.1) long, scattered randomly over dorsum.

Spiracular setae (fig. D): 3 in each anterior and posterior group; short, stout, conical; sometimes notched at apex; median seta slightly larger than lateral setae. Median seta 38.1(26.3-47.9) long, 18.1(15.4-23.2) wide; lateral setae 36.3(20.1-47.9) long, 19.3(15.4-23.2) wide.

Submarginal tubercles: Absent.

Pores: 8-shaped pores with a slender duct (fig. E), 5.87(4.63-7.72) in diameter, very numerous, 1 pore in each light area of derm (fig. F). Many small disc pores (fig. G), 3.31(3.08-4.63) in diameter, scattered over dorsum. Large discoidal pores (fig. H), 11.4(10.8-13.9) in diameter, scattered over area anterior to anal plates and extending up to area above mouthparts; most numerous in median area just anterior to anal plates.

Ducts: Dorsal ducts not detected.

Anal plates (fig. I₁, I₂): Triangular, cephalolateral margin longer than caudolateral margin; all angles rounded. Length 234(165-257), width 315(287-333); length cephalolateral margin 197(165-224), length caudolateral margin 170(157-180). Four apical and 4 or 5 subapical setae on each plate. Two pair of fringe setae, outer pair longest, and 14 to 18 hypopygial setae.

Anal ring (fig. J): Ovate, about 122 long, 106 in diameter, with 10 hairs and 2 irregular rows of translucent wax pores.

VENTRAL SURFACE

Setae: Ventral submarginal setae (fig. K) 19.8(13.9-27.8) long, short, slender and pointed, numbering 9 setae between spiracular furrows; 2 or 3 pair of setae between antennal bases; 3 to 5 setae mesad of each coxa; 3 pair of long hairlike setae anterior to anal area; slender, pointed setae scattered over body; and numerous pointed setae, stouter than body setae, scattered in anal area.

Eyes: Not detected in specimens studied.

Antennae (fig. L): Short and stout, 6-segmented; segmentation often obscure; total length 186(149-231). Scape about 46.4 long, 84.2 wide. Segments II to VI: about 30.9, 30.9, 30.9, 15.5, 24.7 long respectively. Terminal segment with 8 or 9 stout, pointed

setae. Setae on other segments: I,3; II,2; III,0; IV,3; V,1 stout, pointed seta.

Legs (fig. M): Short, stout, 5-segmented, but segmentation sometimes indistinct. Tarsus and claw each with a pair of slender, knobbed digitules. Tarsal digitules 42.1(34.5-50.6) long, claw digitules 40.9(30.9-49.4) long. Claw simple or with a denticle.

Part of leg	Lengths prothoracic	Lengths mesothoracic	Lengths metathoracic
Coxa	57.2(49.4-61.8)	57.0(49.4-67.9)	61.3(49.4-74.1)
Trochanter	26.7(24.7-30.8)	27.0(24.7-32.1)	28.5(18.5-43.2)
Femur	65.4(61.7-67.9)	63.0(53.1-67.9)	60.8(45.7-67.9)
Tibia	54.8(46.9-61.8)	55.9(49.4-61.8)	55.6(51.9-59.2)
Tarsus	36.0(33.4-39.5)	42.6(32.1-49.4)	44.6(35.5-50.0)
Claw	18.5(17.3-21.0)	17.1(14.8-18.5)	18.6(17.3-19.8)
Entire leg	255(241-273)	262(236-283)	269(232-296)

Spiracles: Larger than legs, spiracular apodemes with strong constriction on both sides, atrium forming widest part. Anterior spiracles 192(169-203) long, atrium 151(138-165) wide. Posterior pair 216(203-234) long, atrium 191(172-199) wide. Spiracular pore band 15 to 20 pores wide near spiracular setae, becoming narrower toward spiracle; pores extending to base of apodeme.

Pores: Quinquelocular pores (fig. N), 7.41(6.20-7.70) in diameter, very numerous in spiracular pore band and in area of anal plates.

Ducts: Microducts (fig. O), 10.8(7.82-11.7) long, 3.83(3.09-3.91) wide, scattered over venter. Tubular ducts (fig. P), 17.1(15.4-20.1) long, 4.97(4.63-6.19) wide with a slender filament 22.1(15.4-29.3) long, in anal area, sometimes very numerous, 250 to 300 in anal plate area of old females. The slender filament is not always visible.

OTHER STAGES

First instar nymphs have 5-segmented antennae and well-developed 5-segmented legs; 3 spiracular setae at the margin of each furrow, the median seta 3 or 4 times as long as the lateral. In the second instar nymph there is a reduction in the size of these structures. Males are not mentioned in literature, but we have encountered male tests in a seemingly homogeneous infestation.

BIOLOGICAL NOTES

The magnolia scale is viviparous, and produces one generation a year in Virginia. First instar nymphs emerge around September 10 (Amos, 1970). The overwintering 1st instar nymphs are elliptical in outline, and dark slate-gray with a red-brown median carina. On each lateral margin of the body are two spots of white, waxy material, marking the ends of the spiracular furrows.

The overwintering nymphs are very numerous, often occupying all available space on the underside of new growth twigs. A 5 cm section of twig, about 8 mm in diameter yielded 278 overwintering nymphs.

Herrick (1931), discussing a scale infestation in Ithaca, New York during 1929, stated that the nymphs molted during the second week in May, and again in the first half of June. The nymphs grow very slowly during July; but by early August, a few females may be found which are mature and have brought forth their first young.

PARASITES AND PREDATORS

Houser (1918) reported the larvae and adults of the lady beetle *Hyperaspis signata* feeding upon the young of the magnolia scale, and the coccids had been destroyed from large infested areas.

ECONOMIC IMPORTANCE

In most cases damaging infestations of the magnolia scale are localized. Badly infested branches and twigs are weakened, growth is retarded, and repeated infestation may result in the death of branches or entire small trees. In addition, large amounts of honeydew are excreted which attract wasps, ants, and other noxious insects. The honeydew serves as a medium for sooty fungus which detracts from the ornamental value of the plant and may reduce photosynthesis.

ADDITIONAL HOSTS AND DISTRIBUTION IN VIRGINIA

Found throughout the state on twigs of magnolias. *Magnolia acuminata*, Montgomery Co.; Nottoway Co. *Magnolia* sp., Alleghany Co., Clifton Forge; Campbell Co.; Dickenson Co., Haysi; Montgomery Co., Cambria; Shenandoah Co., Woodstock; Sussex Co. Unknown host, Carroll Co.

ADDITIONAL HOSTS AND DISTRIBUTION IN U.S.A.

New York (Thro, 1903); Indiana (Dietz and Morrison, 1916); Ohio (Houser, 1918); Alabama, Connecticut, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, Pennsylvania, South Carolina, West Virginia, (Herrick, 1931); North Carolina, (Wray, 1967). Additional hosts include: *Magnolia cordata* (= *M. acuminata* var. *cordata*) (Wray, 1967); *M. grandiflora*, (Merrill and Chaffin, 1923); *M. liliiflora* and *M. soulangeana*, (Herrick, 1931).

NOTES

The magnolia scale is one of the largest scale insects occurring in the United States. The coccid is very easy to identify because of the dense pattern of small 8-shaped pores of the dorsal derm and reduced legs and antennae.

In early literature, the color of the magnolia scale is given as seal-brown. We noted that only the older females are dark brown in color.

Genus **PHYSOKERMES** Targioni—Tozzetti, 1868

Photos 25, 26

TYPE SPECIES

Coccus hemicryphus Dalman, 1825.

DESCRIPTION

Body of adult female globular and often extremely irregular, naked at maturity. Derm heavily sclerotized. Legs and antennae greatly reduced. Legs without tibio-tarsal sclerotization. Marginal and spiracular setae absent; body setae in transverse rows on venter of abdomen. A cluster of long setae near anal cleft on margin. Sub-marginal tubercles absent. Dorsal pores variable. Multilocular pores in abdominal region and in spiracular pore bands. Tubular ducts scattered on both surfaces of the body. Anal plates absent in the adult female, having been lost at the second molt. Anal ring sclerotized, with no pores and 6 hairs.

NOTES

Members of this genus have only been found on spruce and fir. The eggs are protected by the body of the old female. This genus includes the only Coccidae in which the anal plates are lacking at

maturity. *Physokermes hemicryphus* Dalm. has not been previously reported from North America although a closely related species *Physokermes piceae* Shrank was reported from the Eastern United States.

Physokermes hemicryphus is the only species in the genus recorded from Virginia. It was discovered early in 1972 on *Picea abies* and *P. pungens* in Blacksburg and Radford, MK (VPI), and it was too late to include a full description in this study. The key to genera will suffice in separating this species from other Virginia Coccidae.

Genus PROTOPULVINARIA Cockerell, 1894

TYPE SPECIES

Pulvinaria (Protopulvinaria) pyriformis Cockerell, 1894.

DESCRIPTION

Body pyriform, more or less acuminate in front; body naked or with a narrow fringe of cottony secretion. Derm becoming sclerotized at maturity. Legs and 7- or 8-segmented antennae well-developed. Legs usually with tibio-tarsal sclerotization. Marginal setae all fimbriate except for a few pointed ones near anal cleft. Spiracular setae in 3's, median seta $2\frac{1}{2}$ or 3 times the length of laterals. Submarginal tubercles present. Quinquelocular pores in spiracular furrow; multilocular pores in anal area and in transverse bands on abdomen. Tubular ducts scattered over most of venter, but most numerous in a submarginal band around body. Anal plates extremely long. Anal cleft extending to near center of the body. Hypopygial setae absent. One pair of large prevulvar setae. Anal ring with 10 hairs.

NOTES

Even though there is a waxy, fringelike ovisac produced by the adult female, the young are protected by the body of the female until emergence. Steinweden (1929) placed *Coccus acuminatus* Signoret and *C. mangiferae* Green in the genus *Protopulvinaria* because of similarities in body form.

Protopulvinaria pyriformis is recorded from Virginia; although it is not stated so in the data on the slide label, we believe this record must have come from indoors. It is primarily a tropical and subtropical species.

Protopulvinaria pyriformis (Cockerell), 1894

Pyriform Scale

Plate 14, Photo 27

Pulvinaria (*Protopulvinaria*) *pyriformis* Cockerell, 1894a:306; 1896b:307. *Pulvinaria newsteadi* Leonardi, 1898:279. *P. pyriformis* Ckll., Fernald, 1903:138; Merrill and Chaffin, 1923:268. *Protopulvinaria piriformis* (Ckll.), Lindinger, 1912:199; Brain, 1920:17. *P. pyriformis* (Ckll.), Cockerell, 1899a:311; Green, 1909:254; Ballou, 1926:30; 1945:94; Steinweden, 1929:223; Merrill, 1953:99; Simmonds, 1957:8; De Lotto, 1967:792; Hodgson, 1969b:29.

This species is the type of the genus *Protopulvinaria* Cockerell, 1894a, which was originally introduced as a subgenus of *Pulvinaria*, (Targioni-Tozzetti, 1866). It was later raised to generic rank by its original author. Fernald (1903) listed it in synonymy with *Pulvinaria* and erroneously designated *Protopulvinaria convexa* Hempel, 1900, as its type species. The genus was restored apparently by Green (1909). (De Lotto, 1967).

MATERIAL STUDIED

Bauhinia sp., 9, (16), Leesburg, Fla., June 12, 1969, A. L. Bentley; *Fatsia japonica*, 1, (2), Pacific Palisades, L. A. County, California, A. Beresford et al. *Persea borbonia*, 11, (13), Archbold Research Station, Highland Co., Fla., March 19, 1968, MLW; *Schefflera* sp., 2, (5), Richmond (Greenhouse), Feb. 1, 1965, FRF; on a "spiny rutaceous tree," 1, Cumberland Is., Camden Co., Ga., Sept. 4, 1968, R. Beshear.

GENERAL APPEARANCE

Body rather flat, pyriform, tan or reddish-brown colored, with a darker margin and radiating lines, many times body distorted because of insect's position on plant. At maturity, a thin "cottony" ovisac of curled waxy filaments projects slightly out around posterior margin.

DESCRIPTION

Body (fig. A) 2685(2112-3101) long, 2408(1653-2954) wide, usually pyriform. Dorsal derm at early stages membranous, becoming sclerotized with age. Legs and antennae well-developed. Spi-

racular setae in 3's, median seta much longer than lateral, with slight spiracular depressions. Anal plates extremely long and narrow, located near center of body. Marginal setae fimbriate except near anal cleft. With stout rod-shaped dorsal setae and 6 to 12 submarginal tubercles. Only 1 pair of prevulvar setae. Anal cleft extending about $1/3$ of body length.

DORSAL SURFACE AND MARGIN

Setae: Marginal setae (fig. B) numerous, 18 to 28 between spiracular setae, 36.2(20.6-51.8) long, all fimbriate except a few long, slender, pointed setae near anal cleft. Body setae (fig. C) 14.0(11.7-15.6) long, rod shaped, with blunt tip, scattered randomly over body.

Spiracular setae (fig. D): 3 in each spiracular furrow, median seta slender, about $2\frac{1}{2}$ or 3 times longer than lateral setae, curved near the tip; median seta 27.0(19.6-31.3) long, 4.11(3.91-5.86) wide; lateral setae 9.54(7.82-11.7) long, 3.69(1.95-3.91) wide, bluntly pointed.

Submarginal tubercles (fig. E): 6 to 12 around entire body in a submarginal row, 7.53(5.90-7.80) in diameter, location of the tubercles varies between individuals.

Pores: Minute bilocular pores with a slender filament (fig. F) 1.95(1.95) in diameter, scattered over dorsum, spaced about equidistant from each other. If derm is sclerotized, 1 of these pores occurs in each clear area of dorsum (fig. G). About 13 to 24 small disc pores (fig. H) 2.76(2.00-3.90) in diameter in median area directly anterior to anal plates. Smaller pores of this same type about 1.95 in diameter scattered over entire dorsum, not as numerous as bilocular pores.

Ducts: Dorsal ducts not detected.

Anal plates (fig. I₁, I₂): Extremely long and narrow, positioned near center of body. Cephalolateral margin straight, about 5 times as long as caudolateral margin which is slightly convex, mesal margin sometimes with a notch near center, all angles slightly rounded; length 496(461-537), width 85.0(78.2-94.8), length cephalolateral margin 453(417-505); length caudolateral margin 95.5(88.5-107). Each plate with 3 apical and 1 or 2 subapical setae. Anal fold with 4 or 5 fringe setae.

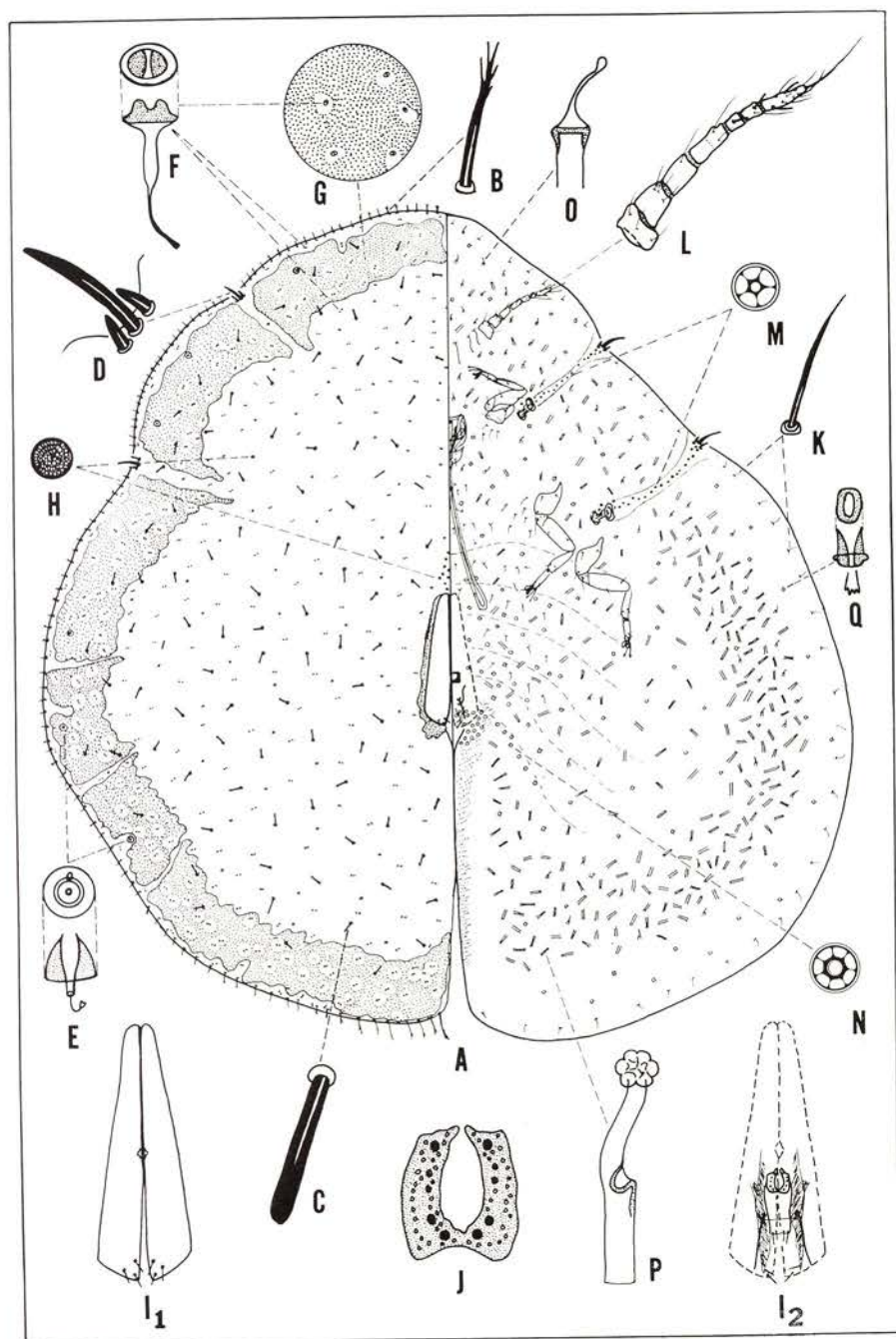


Plate 14. - *Protopulvinaria pyriformis* (Cockerell)

Anal ring (fig. J): Rectangular in outline, 68.2(58.6-88.5) long, 52.6(31.3-88.5) wide, with 10 hairs, 2 pair of these smaller and shorter than others, and 2 irregular rows of translucent wax pores.

VENTRAL SURFACE

Setae: Ventral submarginal setae (fig. K), 12.5(11.7-15.6) long, slender, slightly curved or straight, pointed, about 5 to 8 between spiracular furrows; body setae, 11.9(7.82-11.7) long, similar to ventral submarginal setae except smaller, predominately found in transverse rows on abdominal segments and in groups of 3 to 6 near each coxa; 4 to 6 long slender setae between antennal bases; 1 pair of prevulvar setae on the pregenital abdominal segment.

Eyes: Not detected.

Antennae (fig. L): Well-developed, 7- or 8-segmented (sometimes segment 4 is divided into 2 separate segments thus making 8 segments), 307(281-320) long. Scape 35.9(27.4-43.0) long, 52.6(46.9-66.5) wide. Length of segments II to VIII: 42.6(39.1-50.8), 46.9(43.0-54.7), 33.4(27.4-46.9), 30.2(27.4-39.1), 23.9(11.7-31.3), 24.8(15.6-31.3), 56.9(50.8-58.7) long respectively. Terminal segment with 7 hairlike setae. Setae on other segments: I,3; II,3; III,1 or none; IV or IV + V,3; VI, 1 fleshy; VII,2 fleshy.

Legs: Well-developed, with tibio-tarsal sclerotization and articulation in most; claws without denticle. Two claw digitules 35.2(31.3-39.1) long, broad, expanded at tips; two slender, knobbed, tarsal digitules, 56.7(50.8-58.7) long, extending past claw digitules.

Part of leg	Lengths prothoracic	Lengths mesothoracic	Lengths metathoracic
Coxa	84.1(66.5-97.8)	97.4(78.2-117)	110(86.1-137)
Trochanter	67.1(62.6-70.4)	73.0(62.6-82.1)	76.7(70.3-82.1)
Femur	133(125-140)	154(145-160)	161(136-176)
Tibia	116(105-125)	127(117-136)	133(117-140)
Tarsus	62.1(58.7-66.5)	69.3(62.6-74.3)	74.3(70.3-78.2)
Claw	21.1(19.6-23.5)	22.2(19.6-23.5)	22.7(19.6-23.5)
Entire leg	482(465-497)	529(485-559)	585(567-610)

Spiracles: Posterior spiracles largest; atrium about equal to or wider than apodemal base; apodeme constricted, narrow, widened at base. Spiracular pore bands usually with a single row, but some-

times 2 pores wide, with about 18 to 22 pores, extending from margin to base of spiracular apodeme. Anterior spiracles 44.7(43.0-46.9) long, atrium 30.1(27.4-35.2) wide; posterior pair 58.7(50.8-66.5) long, atrium 41.4(35.2-49.1) wide.

Pores: Quinquelocular pores (fig. M), 4.11(3.91-5.90) in diameter, in a row 1 or 2 pores wide in each spiracular furrow, each row containing about 18 to 35 pores. Multilocular pores, most with 7 loculi, some 6-9 loculed (fig. N) 5.26(3.90-5.90) in diameter, scattered around anal area and in transverse rows on abdomen.

Ducts: 2 types of tubular ducts scattered over entire venter; first type (fig. O), duct 7.82(7.82) long, 3.80(2.90-3.90) wide, with a slender filament 7.82(7.82) long, predominately found on anterior end near antennae, but also dispersed among larger ducts (fig. P), 13.3(7.80-19.6) long, 3.80(2.90-3.90) wide, with a broad filament 15.1(11.7-15.6) long, 2.94(2.94) wide. This second type duct predominately located in a submarginal band around body and scattered over posterior part of venter. Small ducts which open through square shaped pores (fig. Q) sparsely scattered over venter, about 2.44 long; 0.98 in diameter.

OTHER STAGES

We have not seen males or first instar nymphs, but second instar nymphs resemble adult females except for size and 6-segmented antennae.

BIOLOGICAL NOTES

To our knowledge, the pyriform scale does not occur outdoors in Virginia. It seems to prefer the lower surface of leaves when settling on its host, and many times attaches itself near the midrib or near a radiating leaf vein.

PARASITES AND PREDATORS

A cecidomyiid fly *Mycodiplosis moznettei* Felt, was reared from the pyriform scale in Florida. The larvae of this midge devour the eggs of the females, and construct small cocoons under the coccid for pupation (Felt, 1922).

ADDITIONAL HOSTS AND DISTRIBUTION IN VIRGINIA

Same as material studied.

ADDITIONAL HOSTS AND DISTRIBUTION IN U.S.A.

The following hosts and state records are from the VPI collection: On "*Brassaia actinophylla*," and *Fatsia japonica* California; *Bauhinia* sp., *Persea borbonia*, Florida, *Persea* sp., Florida, Georgia. Merrill (1953) gives an extensive host list for the pyriform scale in Florida.

ECONOMIC IMPORTANCE

This scale insect is of economic importance in Florida, especially on avocado, gardenia, guava, and some of the ornamentals (Merrill, 1953).

NOTES

Cockerell separated *Protopulvinaria* from *Coccus* by the presence of a narrow fringe of cottony secretion surrounding the body of the female after oviposition. This cottony secretion is not an ovisac, the eggs are concealed beneath the female's body.

Genus *PSEUDOPHILIPPIA* Cockerell, 1897

TYPE SPECIES

Pseudophilippia quaintancii Cockerell, 1897.

DESCRIPTION

Body of adult female convex to globular, often distorted because of crowding at needle bases; with a white cottony secretion covering the body. Derm heavily sclerotized at maturity. Antennae and legs greatly reduced. Antennae 6-segmented. Legs without tibio-tarsal sclerotization. Marginal setae short, bluntly pointed, hard to detect. Spiracular setae, if present, not differing from marginal setae. Submarginal tubercles absent. Dorsum with a dense pattern of large invaginated 8-shaped tubercles and small monolocular ring pores. Quinquelocular pores in spiracular furrows and in anal area. Multilocular pores usually absent. Tubular ducts, if present, confined to the anal area. Anal plates with 4 apical, 3 subapical, and 6 fringe setae. Hypopygial setae present. Anal ring with 10 hairs.

NOTES

The eggs and young are protected by the body of the old adult female until hatching and emergence. This genus is represented by

only one species, and has only been recorded from species of the genus *Pinus*.

Cockerell (1897b) placed this as a lecanine genus allied to *Filippia* Targioni-Tozzetti. Steinweden (1929) thought that *Neolecanium*, *Pseudophilippia*, and *Toumeyella* all constituted one genus. From this study we have concluded that there are many similarities between *Pseudophilippia* and *Toumeyella*, particularly *T. parvicornis*, but until a more comprehensive study of the three genera is made, it will be treated as a separate genus.

Pseudophilippia quaintancii is recorded from Virginia.

***Pseudophilippia quaintancii* Cockerell, 1897**

*** Woolly Pine Scale**

Plate 15, Photos 28, 29

Pseudophilippia quaintancii Cockerell, 1897b:89; Quaintance, 1897:91; Fernald, 1903:142; Felt, 1906:690; Ferris, 1922:157; Merrill and Chaffin, 1923:266; Steinweden, 1929:227; Herrick, 1935:267; Craighead, 1950:144; Merrill, 1953:101.

Described by T. D. A. Cockerell from specimens sent by A. L. Quaintance, after whom the species was named. Found at the base of leaves of "*Pinus australis* Michx." (= *P. palustris* Mill.) April 10, 1897, (Quaintance No. 2), Lake City, Florida.

MATERIAL STUDIED

Pinus taeda, 7, (19), Triplet, May 28, 1965, H. Kulman; 3, (3), Seashore State Park, Virginia Beach, March 20, 1969, MLW. *Pinus* sp., 2, (4), Henrico Co., June 23, 1967, FRF.

GENERAL APPEARANCE

Adult female oval or hemispherical and varying from 2 to 2.5 mm in diameter. Color yellowish or light-brown, body covered with a profusion of fluffy, snow-white "cottony" or fleecy-like secretion (Merrill and Chaffin, 1923).

DESCRIPTION

Mounted specimens subcircular, (fig. A) 1804(1329-2510) long, 1566(1240-2215) wide. Older females heavily sclerotized; young fe-

males with sclerotic area surrounding anal plates; antennae and legs reduced; spiracular constrictions apparently absent; dorsum densely beset with invaginated 8-shaped tubercles; spiracular pores varying from 2 to 6 loculi. Anal cleft extending $1/6$ of body length.

DORSAL SURFACE AND MARGIN

Setae: About 25 to 30 marginal setae (fig. B) around entire body, 17.2(11.7-19.6) long, stout but rather slender, straight, sharp pointed. Body setae (fig. C) scattered over dorsum; short, stout and pointed, thickest near center, 9.85(7.82-12.6) long.

Spiracular setae: Absent, occasionally 2 or 3 marginal setae tend to congregate in area of spiracular furrow.

Submarginal tubercles: Absent.

Pores: Monolocular ring pores (fig. D), 4.11(3.91-5.87) in diameter scattered over entire dorsum, fairly numerous, mixed randomly with invaginated 8-shaped tubercles (fig. E₁) these being large, 12.3(5.90-15.8) long, 10.4(7.82-12.6) wide, very numerous, scattered over dorsum with no apparent pattern.

Tubular ducts: None detected on dorsum.

Anal plates (fig. F₁, F₂): Angles of anal plates rounded, especially lateral angles, each plate may appear somewhat semi-circular; length 107(86.0-121), width 66.5(50.8-78.2), cephalolateral margin and caudolateral margin not well defined. With 4 apical and 3 subapical setae. Anal fold with 6 fringe setae and 4 to 6 hypopygial setae.

Anal ring (fig. G): Subcircular, 46.3(39.1-50.6) long, 43.1(39.1-50.8) wide, with an irregular row of translucent wax pores, and 8 hairs.

VENTRAL SURFACE

Setae: 30 to 40 ventral submarginal setae (fig. H), small rather slender and pointed, 11.2(7.80-19.0) long; 2 setae mesad of each antennal scape; body setae similar to submarginal setae, scattered over venter, numerous in anal area and near leg bases.

Eyes: Not detected in specimens studied.

Antennae (fig. I): Short and stout, 6-segmented, although often appearing 4- or 5-segmented, 79.8(66.5-89.9) long. Scape

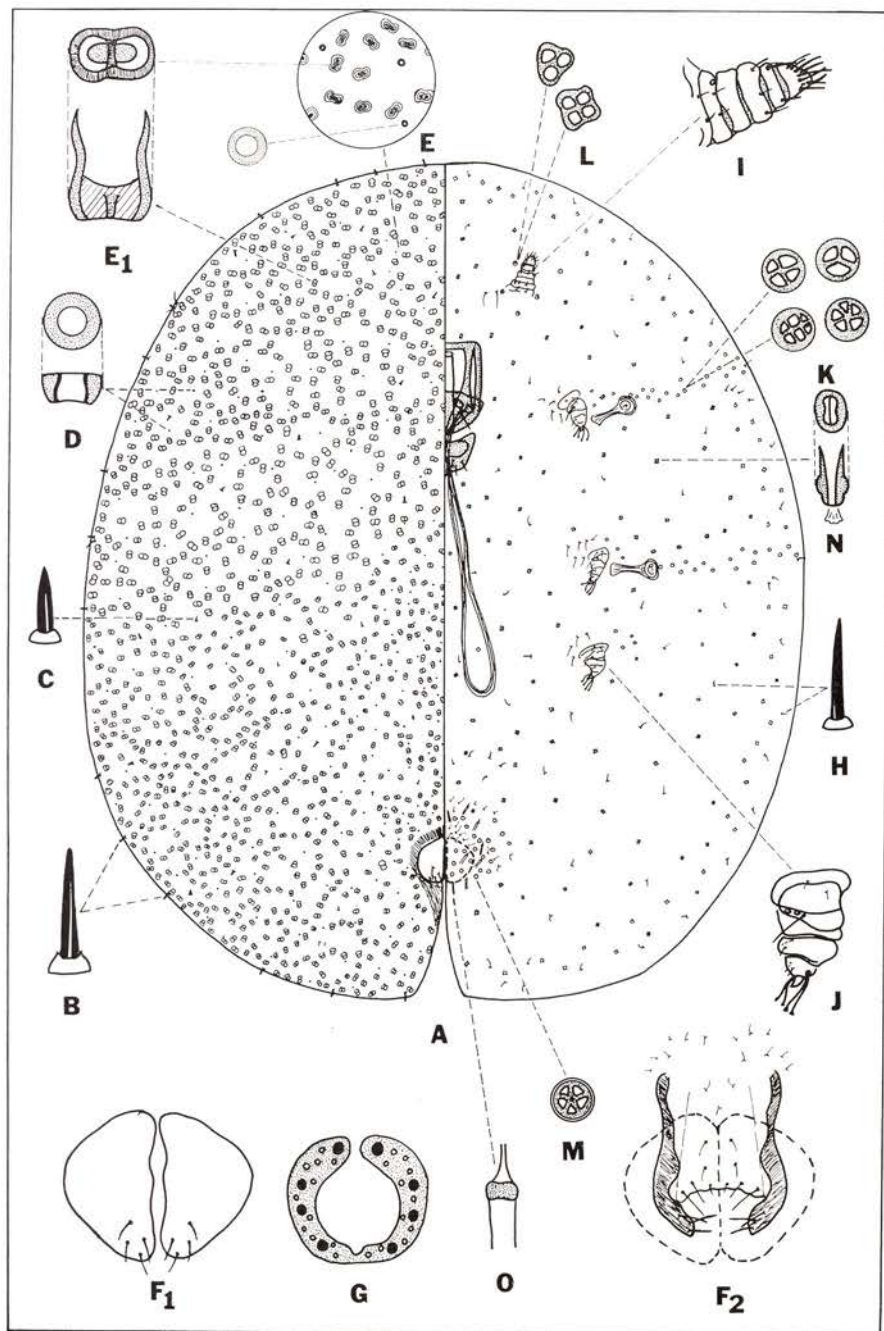


Plate 15. - *Pseudophilippia quintancii* Cockerell

12.2(7.82-19.0) long, 48.6(35.2-58.7) wide. Segments II to VI: 9.41(7.82-12.6), 10.5(7.82-19.0), 20.3(11.7-23.5), 9.64(7.82-12.6), 16.3(11.7-25.3) long respectively. Terminal segment with 10 stout sensory setae. Setae on other segments: I,2; II,2; III,0; IV,3; V,1, and 1 stout sensory seta.

Legs (fig. J): Greatly reduced, although some specimens showing normal segmentation. The entire leg length was measured because of reduction and indistinct segmental delineation. Approximate length of legs as follows: prothoracic leg, 70.4; mesothoracic leg, 82.7; metathoracic leg, 86.5 long. Tarsus and claw of each having a pair of slender, knobbed digitules, tarsal digitules longer. Claw without denticle.

Spiracles: Apodemes slender, about equal in size, not expanded greatly on inner end, atrium forming widest part. Anterior spiracles 114(82.1-145) long, atrium 67.4(35.2-86.0) wide; posterior pair 124(78.2-156) long, atrium 75.4(39.1-102) wide. Spiracular pore bands 6 or 7 pores wide, sometimes 15 pores wide, throughout their length.

Pores: About 135, 2 to 6 loculed pores in spiracular pore band (fig. K), 8.30(7.82-12.6) in diameter, locules irregularly shaped. About 5 (3 to 7), 3 or 4 loculed pores near each antenna (fig. L). A few or many quinquelocular pores (fig. M) scattered in area of anal plates on venter.

Ducts: Microducts (fig. N) 8.29(3.91-12.6) long, 4.46(3.90-6.30) wide, scattered over entire venter. A few tubular ducts (fig. O) 9.00(7.82-11.7) long, 3.91(3.91) wide, with slender filaments 11.7(11.7) long found in area of anal plates. These ducts absent in some specimens studied.

Other structures: Minute spinelike structures near anal cleft and around anal area, sometimes extending up abdominal segments.

OTHER STAGES

First instar nymphs with well-developed legs; 5-segmented antennae; and 2 or 3 setae, stouter than marginal setae, located at end of each spiracular furrow. Legs and antennae become reduced in the second instar, and the setae at the spiracular furrow appear similar to the other marginal setae.

Males or male covers have not been collected, and they are not mentioned in the literature.

BIOLOGICAL NOTES

Quaintance (1897) gave the following account on *P. quaintancii*:

I first observed this insect April 10, 1897, at Lake City, Florida. The top-most branches of a large pine ("*Pinus australis*") that had recently been cut down was found to be badly infested. The insects were crowded thickly around the more tender growth, and from their abundant excretion of cottony substance were quite conspicuous for some distance away. Abundant honey-dew is excreted, which in some cases had formed a medium for the growth of "black fungi" (*Meliola* sp.). In several of these instances the entire cottony mass of a colony of these insects was quite black.

Craighead (1950) thought that apparently only young trees under 14 feet in height are attacked, but collections have been made in Virginia from much taller mature pines. First instar nymphs appeared in mid-June in Henrico Co., Virginia, during 1967. This species is not considered of economic importance.

ADDITIONAL HOSTS AND DISTRIBUTION IN VIRGINIA

Recorded from the eastern part of Virginia, infesting pine trees. On twigs at the base of needles on *Pinus mugo*, Richmond. *P. palustris*, Mathews Co. *P. taeda*, Caroline Co., Milford; Chesterfield Co., Warwick City; Petersburg; New Kent Co.; Portsmouth. *Pinus* sp., Accomack Co., Parksley; Brunswick Co., Triplet; Chesterfield Co., Warwick City; Westmoreland Co., Oak Grove; Norfolk, Portsmouth, and Virginia Beach; Northwest Chesapeake Corporation.

ADDITIONAL HOSTS AND DISTRIBUTION IN U.S.A.

Brimley (1938) listed it from Raleigh, North Carolina, on tips of pine twigs. Craighead (1950) reported *P. quaintancii* as occurring from New York to Florida and Louisiana. Specimens were observed by the first author on *Pinus pungens*, Florida; *P. rigida*, New Jersey, North Carolina; *P. taeda*, Georgia.

NOTES

Ferris (1922) noted that the antennae were very small, but with the segmentation fairly distinct and antennae 4-segmented. In many of the specimens studied, the segmentation was indistinct, because of apparent fusion, or partial fusion, of segments. In those cases where segmentation was clearly visible, the antennae were 6-segmented.

Genus PULVINARIA Targioni—Tozzetti, 1866

TYPE SPECIES

Coccus vitis Linnaeus, 1758.

DESCRIPTION

Body of young female slightly convex, naked or with a thin coating of clear, flaky wax. Derm becoming lightly sclerotized with age. Well-developed legs and 6- to 8-segmented antennae. Legs with tibio-tarsal sclerotization and free articulation (except *Pulvinaria ericicola* McConnell). Marginal and body setae variable. Spiracular setae differing from marginal setae, usually with median seta 2 or 3 times the lateral setae. Submarginal tubercles present or absent. Dorsal pores variable. Quinquelocular pores in spiracular pore bands, multilocular pores in anal area, in transverse bands on the abdomen, and usually a few near each coxa. Tubular ducts numerous, densely scattered over abdomen, several found scattered elsewhere on venter. Anal plates with varying numbers of apical and subapical setae. Fringe setae also variable. Well-developed anal ring with numerous wax pores and 8 anal ring hairs.

NOTES

Members of this group tend to be polyphagous. The eggs are protected by a "cottony" ovisac secreted by the tubular ducts on the venter of the abdomen. The old female wrinkles up at the anterior end of the ovisac and remains there in most species, but usually falls off in *P. floccifera* (Westwood). Steinweden (1946) revised the genus *Pulvinaria* in North America.

Species of *Pulvinaria* recorded in Virginia include: *P. acericola* (Walsh and Riley), *P. citricola* Kuwana, *P. ericicola* McConnell, *P. floccifera* (Westwood), *P. hydrangeae* Steinweden, *P. innumerabilis* (Rathvon), and a species near *P. occidentalis* (Cockerell). *P. psidii* has been recorded from Arlington, on *Gardenia* sp. Although not labeled on the slide as such, it is assumed that it was found on a house plant, or intercepted by the Agricultural Quarantine Inspectors.

KEY TO THE SPECIES OF *PULVINARIA* IN VIRGINIA

1. Legs without tibio-tarsal sclerosis; dorsal derm with numerous large discoidal pores which extend from anal area up past rostrum ----- *ericicola*, p. 130
 Legs with tibio-tarsal sclerosis; dorsal derm without large discoidal pores ----- 2
2. Marginal setae stout, usually strongly expanded and dentate apically; spiracles surrounded by an oval sclerotized plate (photo 36) ----- *psidii*
 Marginal setae variable, but never strongly expanded and dentate; spiracles not surrounded by an oval sclerotized plate ----- 3
3. Marginal setae all long, stout, spikelike and thick throughout their length, with blunt apices -----
 ----- *innumerabilis* p. 146
 Marginal setae not spikelike and thick throughout their length, with apices acute or variously frayed ----- 4
4. Submarginal tubercles present ----- 5
 Submarginal tubercles absent ----- 7
5. All marginal setae acute, not frayed or bifid at apex; dorsum with 50 to 60 disc pores anterior to anal plates ----- near *occidentalis*, p. 152
 A few marginal setae close to anal cleft frayed or bifid at apex; dorsum with less than 30 disc pores anterior to anal plates ----- 6
6. Anal area of venter with predominantly 7- or 8-loculed multilocular pores; with 10 to 40 slender marginal setae frayed or bifid at apices around body; anal plate without 1 apical seta removed from apex --- *floccifera*, p. 135
 Anal area of venter with predominantly 10-loculed multilocular pores; most marginal setae acute, only a few bifid near anal plates; anal plate with 1 apical seta slightly removed from apex on caudolateral margin ----- *acericola*, p. 120
- 7(4) Anal plate with a subdiscal seta removed about $\frac{1}{3}$ from apex on caudolateral margin; interantennal setae slender, acute, without bulbous expansion near apex; some marginal setae bifid or fimbriate -- *hydrangeae*, p. 141

Anal plate without subdiscal seta; 1 or 2 interantennal
setae with bulbous expansions near apex; all marginal
setae acute ----- *citricola*, p. 125

Pulvinaria acericola (Walsh and Riley), 1868

*** Cottony Maple Leaf Scale**

Plate 16, Photos 30, 31

Lecanium acericola, Walsh and Riley, 1868:14; Putnam, 1878:318; Thomas, 1878:120; Smith, 1878b:655. *Pulvinaria acericola* (Walsh and Riley), Cockerell, 1896a:329; Howard, 1898:57, 1900:16; Scott, 1900:52; Felt, 1901:357, 1906:689, 1915:159; King, 1902a:61; Fernald, 1903:128; Sanders, 1909:435; Herrick, 1911:12, 1935:194; Dietz and Morrison, 1916:239; Houser, 1918:297; Trimble, 1925:5; McDaniel, 1930:11; Brimley, 1938:108; Langford and Cory, 1939:25; Steinweden, 1946:4; Baerg, 1947:1; Craighead, 1950:143; Merrill, 1953:101; Giliomee, 1967:104.

MATERIAL STUDIED

Acer negundo, 1, (3), Alexandria, let. June 20, 1932, Mrs. J. C. Burchfield. *A. rubrum*, 1, Great Dismal Swamp, June 1922, C. Zeimet; 3, (6), Pittsylvania Co., June 3, 1967, W. H. Matheny. *A. saccharinum*, 1, (2), Atlanta, Ga., June 1, 1900, W. M. Scott; 2, (3), Pulaski Co., let. May 27, 1921; R. E. Eastman; 4, (8), Blacksburg, May 21, 1968, MLW; 4, (10), Blacksburg, Feb. 18, 1969, MLW; 9, (9), Blacksburg, May 10, 1969, JOH. *Acer* sp., 1, (2), Winchester, let. May 31, 1921, Mr. Byrd; 1, Dyke, June 18, 1922, J. E. Walter; 1 (3), Richmond, let. June 18, 1929, Dept. Public Works; 1, (3), Alexandria, June 1931, L. Robinson; 1, Charlottesville, May 13, 1946, DWC; 1, Blacksburg, May 7, 1969, RCB. *Cornus florida*, 4, (4), Chesapeake, June 24, 1970, D. W. Craun. *Ilex cornuta*, 1, (4), Mathews Co., May 21, 1961, DPI. *I. crenata* var. *microphylla*, 1, (4), Hampton, Aug. 24, 1948, FRF. *I. opaca*, 7, (7), Saxis, May 9, 1967, N. Evans. *Ilex* sp., 2, (3), Blacksburg, May 18, 1968, MLW. *Nyssa sylvatica*, 2, (6), Purcellville, June 1961, E. J. Hambleton. *Pieris japonicus*, 2, (7), Richmond, May 17, 1954, FRF.

GENERAL APPEARANCE

Body usually oval, slightly convex. Color of adult female maroon, 5R 2/2, with a mid-dorsal keel that is yellow-brown, 2.5Y 8/6. The

body is covered with flakes of clear wax. At maturity the females produce a white, longitudinally ribbed ovisac which is 2 or 3 times the body length.

DESCRIPTION

Body (fig. A) ovate, 3541(2664-4355) long and 2864(1329-3808) wide, derm lightly sclerotized showing a pattern of large, closely set, circular or oval clear areas (fig. B), each containing a small bilocular pore. Several (10 to 30) simple disc pores in median area anterior to anal plates. Well-developed legs and 8-segmented antennae. Marginal setae slender and pointed except a few near anal cleft. Submarginal tubercles present. Anal plates together nearly quadrate, each with 3 or 4 apical setae, one of which is removed a distance from the apex. Anal cleft extending about $1/7$ of body length.

DORSAL SURFACE AND MARGIN

Setae: About 33 marginal setae (fig. C) around head, 36.6 (31.3-44.2) long, rather slender, most slightly curved, acute, bifid or fimbriate. Body setae (fig. D), 14.9(12.0-23.5) long, rather stout, bluntly pointed, scattered randomly over dorsum.

Spiracular setae (fig. E): 3 in each spiracular furrow, median seta twice as long as laterals. Median seta 106(93.8-113) long, 13.7(7.82-18.9) wide, slender, bluntly pointed; lateral setae 44.8 (39.1-50.8) long, 9.91(6.32-12.6) wide, slender, rounded at tips.

Submarginal tubercles (fig. F): Present, submarginally 1 to 10 around body.

Pores: Minute disc pores (fig. G), about 1.95 in diameter scattered over dorsum in all areas except circular clear areas. Bilocular pores (fig. H), 2.31(1.95-2.44) in diameter, numerous, scattered over dorsum, 1 in each clear area of derm. A group of 10 to 30 simple disc pores (fig. I), 4.59(3.90-5.37) in diameter, located in median area anterior to anal plates.

Anal plates (fig. J₁, J₂): Anal plates triangular, 160(152-177) long, 89.4(66.5-113) wide, all angles slightly rounded, caudolateral margin longest. Cephalolateral margin straight or slightly concave, 88.6 (54.7-107) long; caudolateral margin straight or irregular and occasionally with a slight indentation about center, 115(66.4-139) long. Each plate with 3 or 4 apical setae, 1 removed some distance

from the apex, and 2 subapical setae. Anal fold with 2 pair of fringe setae and occasionally 1 or 2 small setae occurring near the fold.

Anal ring (fig. K): Rectangular, about 60.4 long, 46.9 wide with 8 hairs and 2 rows of translucent wax pores.

VENTRAL SURFACE

Setae: Ventral submarginal setae (fig. L), 22.1(19.6-25.3) long, slender, pointed, straight or slightly curved near tip, about 24 around head. Body setae similar to ventral submarginal setae, 16.2 (15.6-29.6) long, scattered randomly over body.

Eyes: Not detected in specimens studied.

Antennae (fig. M): Well-developed, 8-segmented, 435(352-493) long. Scape 70.0(58.6-78.2) long, 81.3(63.6-97.7) wide. Length of segments II to VIII: 68.3(54.7-86.0), 93.9(82.1-117), 69.6(39.1-88.5), 50.9(39.1-58.6), 32.0(19.6-46.9), 26.2(19.6-35.2), 44.1(31.3-56.9) long respectively. Terminal segment with 8 hairlike and 1 fleshy setae. Setae on other segments: I,3; II,2-3; III,0-2; IV, 1-2; V,3; VI,1 fleshy; VII,1 fleshy.

Legs: Well-developed, 5-segmented, with tibio-tarsal sclerotization and free articulation. Claw without denticle. Tarsus and claw each with a pair of knobbed digitules; claw digitules broad, 52.2(44.2-63.2) long, equal; tarsal digitules slender, 70.0(62.2-72.2) long, equal.

Part of leg	Lengths prothoracic	Lengths mesothoracic	Lengths metathoracic
Coxa	128(117-139)	153(125-195)	160(121-189)
Trochanter	140(126-164)	153(133-177)	150(129-164)
Femur	234(208-265)	274(252-309)	266(235-290)
Tibia	239(208-272)	272(266-331)	246(207-284)
Tarsus	96.8(62.6-107)	102(94.8-114)	102(94.8-114)
Claw	30.6(19.6-39.1)	34.1(25.3-37.9)	32.9(23.5-39.1)
Entire leg	865(789-954)	987(907-1074)	958(841-1049)

Spiracles: Spiracular apodeme constricted on both sides, atrium usually wider than apodemal base. Spiracular pore band 2 or 3 pores wide, extending to apodemal base. Anterior spiracles 94.5(82.1-101) long, atrium 63.1(58.6-70.4) wide; posterior pair 108(97.8-117) long, atrium 77.3(62.6-88.5) wide.

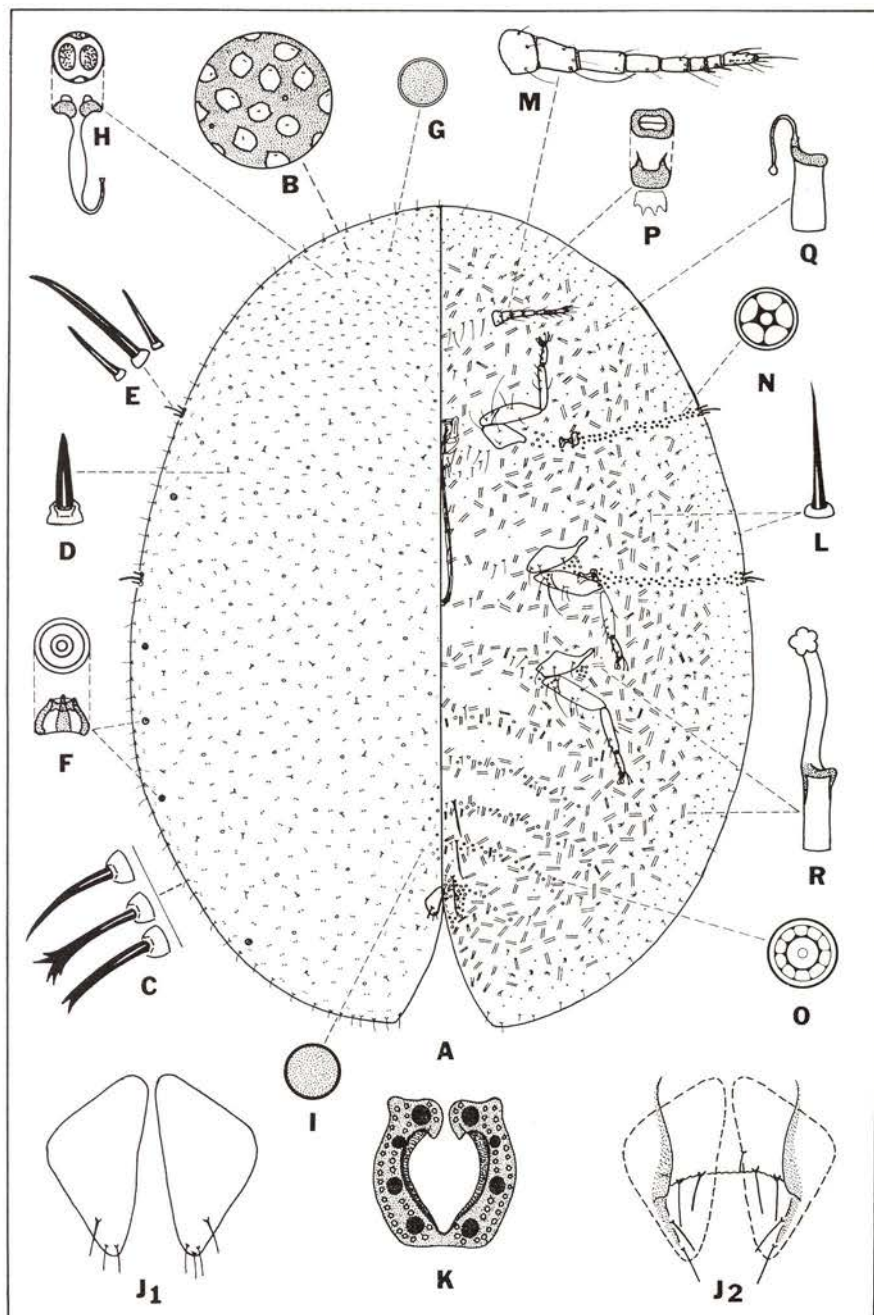


Plate 16. - *Pulvinaria acericola* (Walsh & Riley)

Pores: Quinquelocular pores (fig. N) 8.68(7.82-11.7) in diameter, 40 to 90 in each spiracular pore band. Multilocular pores (fig. O), 8.25 (7.82-11.7) in diameter, most of 10 locules, numerous in a cluster around anal area, in transverse bands on the abdomen, and several near each coxa.

Ducts: Microducts (fig. P) about 2.47 long, which open through rectangular or square shaped orifices 2.73(1.95-2.93) in diameter, numerous in a submarginal band around body, a few scattered elsewhere on venter. Tubular ducts of two types. The first type (fig. Q) 6.59(6.18-7.41) long, 4.06(3.71-4.94) wide, with a slender knobbed inner filament 7.06(6.18-7.41) long, scattered in an intermediate band around body and a few elsewhere on venter. The second type (fig. R) 10.4(7.82-11.7) long, 4.47(3.91-4.91) wide, with a broad flowery tipped filament 22.2(19.6-27.4) long, 3.60(2.93-3.91) wide, scattered over entire venter, less numerous in submarginal and intermediate areas.

OTHER STAGES

First instar nymphs with 6-segmented antennae; well-developed legs without tibio-tarsal sclerosis or free articulation; marginal setae, slender, acute, numbering about 32 around body; spiracular setae in 3's, median seta $2\frac{1}{2}$ times longer than laterals. First instar nymphs very light green, 5Y 8/2. Second instar nymphs with 7-segmented antennae; well-developed legs without tibio-tarsal sclerosis or free articulation; marginal setae similar to first instar, but numbering about 60 around body; spiracular setae in 3's, median seta 4 times longer than laterals, with a reddish spot, 2.5 YR 4/2, at each end of the mid-dorsal keel. The adult male of *P. acericola* has been described in detail by Giliomee (1967).

BIOLOGICAL NOTES

Baerg (1947) published a comprehensive paper on the biology of the cottony maple leaf scale. Our data concur with his findings. There is one generation per year. Eggs are laid on the leaves in June. The eggs hatch and the nymphs settle on the leaves. After 2 molts the nymphs migrate in the fall from the leaves to twigs and branches and overwinter there. In the spring the coccids grow rapidly. Soon the elongate males can be distinguished from the more oval females. Males emerge about the middle of May. In late May the coccids start to move toward the leaves, but it is not until mid-June that they are firmly settled on the underside of the leaves.

PARASITES AND PREDATORS

The following are reported from the cottony maple leaf scale: *Aphycus hederaceus*, *A. flavus*, *Coccophagus fraternus*, *Cheiloneurus albicornis*, *Leucopis nigricornis*, *Pachyneuron altiscuta*, (Howard, 1900) ; *Coccophagus lycimnia*, *Encyrtus* sp., (Baerg, 1947) ; and *Aphycus pulvinariae* (Peck, 1963). *Hyperaspis signata* is reported to be a predator of the coccid (Howard, 1900).

ADDITIONAL HOSTS AND DISTRIBUTION IN VIRGINIA

Acer rubrum, Blacksburg. *Cornus florida*, Blacksburg. *Ilex* sp., Newport News. *Rhus radicans*, Winchester.

ADDITIONAL HOSTS AND DISTRIBUTION IN U.S.A.

The cottony maple leaf scale is found over the eastern half of the United States. Additional hosts include *Acer pensylvanicum*, (Scott, 1900) and *Sassafras variifolium*, (Baerg, 1947).

ECONOMIC IMPORTANCE

Parasites and predators normally keep this scale under control, but occasionally heavy infestations occur, causing premature dropping of leaves and in some cases, even death of twigs and branches.

NOTES

Steinweden (1946), noticed 1 or 2 submarginal tubercles in the specimens he studied, while we found up to 10 in some specimens from Virginia. The cottony maple leaf scale and the cottony maple scale (*P. innumerabilis*) were for some time regarded as one species. Howard (1898, 1900) described the differences between the two species.

***Pulvinaria citricola* Kuwana, 1914**

*** Cottony Citrus Scale**

Plate 17

Pulvinaria citricola, Kuwana, 1914:3; Steinweden, 1946:5; Takahashi, 1955:149. *Eupulvinaria citricola*, Borchsenius, 1957:224.

This species was originally described from *Citrus* sp. at Okayama,

Shizuoka, Japan, and from *Diospyros kaki*, *Hibiscus syriacus*, *Citrus* sp. and "other plants" at Tokyo, Japan.

MATERIAL STUDIED

Pyracantha coccinea, 1, (2), Alexandria, June 12, 1965, F. Smith.
Pyracantha sp., 2 (4), Alexandria, no date, D. Baldwin. On "weed,"
2, (4), Arlington, May 24, 1965, W. Lawrence.

GENERAL APPEARANCE

Only slide mounted specimens seen. Borchsenius (1957) described the living female as elongate oval, moderately convex; light olive with a yellow band on top. Ovisac snowy white, quite long (4-7 mm), with 2 distinct deep furrows on top. The egg is oblong and white (Kuwana, 1914).

DESCRIPTION

Body (fig. A) ovate, 3115(2290-4165) long, 2785(1920-3722) wide; derm remaining membranous; with many bilocular and disc pores; numerous dorsal tubular ducts; submarginal tubercles absent. Marginal setae all pointed; always 1 or 2 setae in interantennal setae group with bulbous expansions near apex. Well-developed legs and 8-segmented antennae. Multilocular pores, most with 8 loculi, in anal area and in transverse bands on abdomen. Anal cleft about 1/6 the body length.

DORSAL SURFACE AND MARGIN

Setae: Marginal setae (fig. B), about 32 around head, 48.5 (35.2-58.7) long, slender, acute, slightly curved. Body setae (fig. C) scattered over dorsum, 7.62(5.82-7.82) long, rather stout, bluntly pointed.

Spiracular setae (fig. D): 3 in each spiracular furrow; median seta 3 or 4 times the length of laterals, 90.4(78.2-97.8) long, 11.7 (11.7) wide, slender, curved at apex, blunt; lateral setae 25.4 (15.6-31.3) long, 7.82(7.82) wide, slender, slightly curved with rounded tips.

Submarginal tubercles: Absent.

Pores: Bilocular pores (fig. E) 1.95(1.95) in diameter, numerous, scattered over dorsum. Simple disc pores (fig. F) also 1.95

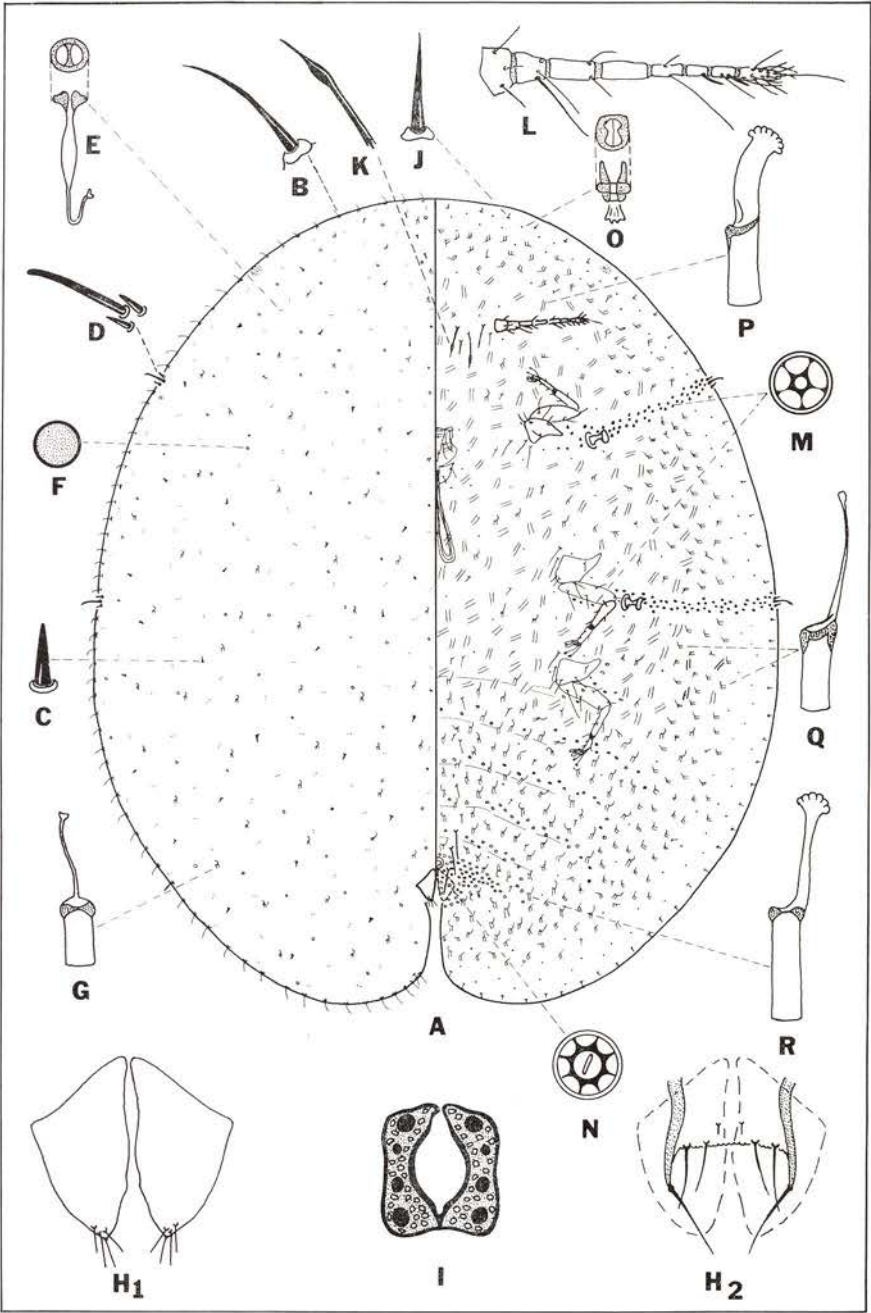


Plate 17. - *Pulvinaria citricola* Kuwana

(1.95) in diameter, mixed randomly with bilocular pores but not as numerous.

Ducts: Shallow cupped ducts (fig. G) about 7.32 long, 2.93 wide, with slender knobbed filaments about 9.76 long, scattered over entire dorsum.

Anal plates (fig. H, H₂): Triangular, lateral angles sometimes pointed, 137(125-145) long, 79.2(62.6-89.9) wide; cephalolateral margin usually concave, 98.2(78.2-113) long; caudolateral margin convex, 79.2(62.6-89.9) long. Each plate with 4 apical and 1 or 2 subapical setae. Anal fold with 2 pair of fringe setae, the outer pair longest; occasionally a small seta may be detected just off the lip of the anal fold.

Anal ring (fig. I): Rectangular, about 70.4 long, 58.7 wide, with 8 hairs and 2 irregular rows of translucent wax pores.

VENTRAL SURFACE

Setae: Ventral submarginal setae (fig. J), about 24 around head, 21.2 (19.6-23.5) long, slender, straight, acute. Body setae similar in form to ventral submarginal setae, 12.9(11.7-19.6) long, scattered randomly over venter and in a double mid-ventral row; 10 to 12 setae between antennae, some of these with bulbous expansions near apex (fig. K); 3 pair of long prevulvar setae; a few setae near each coxa. Clypeolabral shield with 1 pair of setae; labium with 4 pair.

Eyes: Present, usually located between 7th and 8th marginal setae.

Antennae (fig. L): Well-developed, 8-segmented, 393(371-434) long. Scape 42.2(35.2-50.8) long, 65.7(50.8-82.1) wide. Length of segments II to VIII: 51.3(43.0-62.6), 79.9(70.4-89.9), 63.9(46.9-74.3), 40.8 (27.4-51.3), 33.5(23.5-39.1), 27.0(23.5-31.3), 48.2(43.0-50.8) long respectively. Terminal segment with 1 short pointed, 2 hairlike, and 8 fleshy setae. Setae on other segments: I,3; II,2; III,2; IV,0; V,2; VI,1 fleshy; VII,1 and 1 fleshy.

Legs: Well-developed, with tibio-tarsal sclerotization and free articulation; claws without a denticle. Tarsus and claw each with a pair of digitules; claw digitules broad, equal, expanded at apex, 49.1(43.0-54.7) long; tarsal digitules slender, knobbed, 76.6(66.5-86.0) long.

Part of leg	Lengths prothoracic	Lengths mesothoracic	Lengths metathoracic
Coxa	102(82.1-117)	112(97.8-125)	114(102-133)
Trochanter	109(86.0-129)	122(102-149)	119(97.8-145)
Femur	182(149-215)	211(168-254)	209(133-250)
Tibia	180(152-207)	183(152-215)	178(149-211)
Tarsus	86.5(74.3-106)	90.3(78.2-109)	86.0(70.4-97.8)
Claw	31.7(27.4-35.2)	32.1(23.5-39.1)	32.6(23.5-35.2)
Entire leg	691(583-797)	751(622-872)	738(580-860)

Spiracles: Spiracular apodeme constricted more strongly on caudal side; atrium usually wider than apodemal base. Spiracular pore bands 3 or 4 pores wide, extending past spiracular apodeme to below coxa. Anterior spiracles 68.9(58.7-97.8) long, atrium 57.1(46.9-70.4) wide; posterior pair 82.9(66.5-117) long, atrium 66.9(54.7-89.9) wide.

Pores: Quinquelocular pores (fig. M) 5.45(3.91-5.86) in diameter, 40 to 75 in each spiracular pore band. Multilocular pores (fig. N) 7.62(5.82-7.82) in diameter located in anal area, in transverse bands on the abdomen, and a few near each coxa, most 8 loculed.

Ducts: Microducts (fig. O) about 2.44 long, which open through square shaped orifices about 2.44 in diameter, scattered over entire venter but most numerous in a submarginal band around body. Broad tubular ducts (fig. P), 15.6(11.7-19.6) long, 3.91(3.91) wide with an equally broad flowery tipped filament, 15.6(15.6) long, 3.91(3.91) wide, on head and extending posteriorly to abdomen. Tubular ducts (fig. Q) 7.82 (7.82) long, 3.91(3.91) wide with a slender, knobbed filament 12.9 (11.7-15.6) long, occurring around body in intermediate area, some in anal area. Tubular ducts (fig. R) 12.5(11.7-15.6) long, 3.91(3.91) wide, with a flowery tipped filament 20.0(19.6-23.5) long, 1.96(1.96) wide, in anal area and on abdomen, a few in thoracic region.

OTHER STAGES

Only slide-mounted adult females seen by the authors.

BIOLOGICAL NOTES

Very little is known about the biology of this species. In Japan there is one generation per year on citrus (Borchsenius, 1957).

PARASITES AND PREDATORS

No parasites or predators reported in the literature available to the authors.

HOSTS AND DISTRIBUTION IN VIRGINIA

Same as material studied.

ADDITIONAL HOSTS AND DISTRIBUTION IN U.S.A.

On *Diospyros kaki* in California and *Hibiscus (Althaea) syriacus* in Maryland (Steinweden, 1946).

ECONOMIC IMPORTANCE

Not of great economic importance in the United States, but according to Kuwana (1914), it is very injurious to *Citrus* spp. in Japan.

NOTES

The bulbous expansions near the apex of some of the interantennal setae will immediately separate *P. citricola* from all other *Pulvinaria*. In all specimens seen, at least one of the interantennal setae had such expansions.

***Pulvinaria ericicola* McConnell, 1949**

*** Cottony Azalea Scale**

Plate 18, Photo 32

Pulvinaria ericicola, McConnell, 1949:29; Merrill, 1953:102.

MATERIAL STUDIED

Rhododendron nudiflorum, 2, (2), (paratypes), College Park, Md., April 24, 1930, HSM; 2, (3), College Park, Md., July 15, 1931, HSM; 2, (3), (paratype nymphs), College Park, Md., June 21, 1938, HSM. *Vaccinium vacillans*, 2, (2), Blacksburg, May 19, 1967, MK; 4, (7), Broad Run, Craig Co., May 7, 1969, DKP.

GENERAL APPEARANCE

Body slightly convex, elongate oval, dark red to yellow in color. Adult females collected from roots of *Vaccinium* sp.: adult female reddish brown 7.5R 4/10; eggs light orange 2.5YR 6/8. Derm of fe-

male covered with platelets of glassy wax. Ovisac 2 to 4 times as long as female.

DESCRIPTION

Body elongate-oval to round (fig. A), widest in abdominal region, 2462(1521-3471) long, 1984(1108-2481) wide. Dorsal derm membranous or at most only slightly sclerotized at maturity. Legs and 8-segmented antennae well-developed. Spiracular setae in 3's; median seta about twice as long as laterals. Anal plates triangular, lateral angles may be slightly rounded. Marginal setae stout, straight and acute. Four to 17 submarginal tubercles. Anal cleft extending about 1/8 of body length.

DORSAL SURFACE AND MARGIN

Setae: Marginal setae (fig. B), 24.4(19.6-27.4) long, stout, straight and acute; about 23 around head. Body setae (fig. C) sparse, about 24 scattered over dorsum 9.76(7.82-11.7) long, straight, stout, bluntly pointed.

Spiracular setae (fig D): 3 in each spiracular furrow, median seta straight or curved, tapering toward tip, bluntly pointed, 63.6 (39.1-106) long, 8.93(7.82-11.7) wide; lateral setae straight or only slightly curved, bluntly pointed, 27.4(23.5-39.1) long, 6.73(3.91-7.82) wide.

Submarginal tubercles (fig. E): 4 to 17 around entire body, 16.1 (11.7-19.6) in diameter.

Pores: Oval trilocular pores with an inner filament (fig. F) about 2.44 in diameter, numerous, scattered over entire dorsum. Minute disc pores (fig. G) about 1.46 in diameter also scattered over dorsum. About 35 (28 to 39) large discoidal pores (fig. H) 13.0 (11.7-15.6) in diameter extending from anterior to anal plates past rostrum in median area of dorsum.

Ducts: Tubular ducts with a slender inner filament (fig. I) occasionally found on derm. Duct about 10.3 long, 3.42 wide; filament about 17.1 long.

Anal plates (fig. J₁, J₂): Usually triangular, lateral angles pointed or slightly rounded, length 161(156-168), width 73.9(58.7-82.1); cephalolateral margin uneven or straight, 97.4(58.7-109) long; caudolateral margin usually straight, 109(97.8-117) long. Each plate with 3 apical setae, 1 seta on inner margin and 3 subapical setae. Anal fold with 2 pair of fringe setae and 2 small hypopygial setae.

Anal ring (fig. K): Ovoid, about 66.5 long, 58.7(54.7-62.6) wide, with 8 hairs and 2 rows of translucent wax pores.

VENTRAL SURFACE

Setae: Ventral submarginal setae (fig. L) straight, slender, pointed, 10.8(7.82-15.6) long; 10 to 16 around head. Body setae similar to ventral submarginal setae 11.2(7.82-15.6), sparsely scattered over venter, 1 on each side laterad of labium; usually 3 pair of inter-antennal setae and 3 pair of long prevulvar setae.

Eyes: None detected in specimens studied.

Antennae (fig. M): Well-developed, 8-segmented 224(199-254) long. Young females occasionally had 7-segmented antennae. Scape 47.3 (43.0-54.7) long, 32.2(27.4-35.2) wide. Length of segments II to VIII: 28.7(23.5-39.1); 42.6(39.1-50.8); 35.2(27.4-46.9); 23.1(19.6-31.3); 19.6(15.6-23.5); 17.4(11.7-23.5); 23.9(15.6-31.3) long respectively. Terminal segment with 2 hairlike and 6 fleshy setae. Setae on other segments I,3; II,2; III,0; IV,0; V,3; VI,1 fleshy; VII, 1 and 1 fleshy.

Legs: Well-developed, without tibio-tarsal sclerotization or free articulation (fig. N); claws each with a slight denticle; 2 tarsal digitules of same size, slender, knobbed, 35.2(31.3-39.1) long, and 2 claw digitules 25.7(19.6-31.3) long, 1 twice as broad as the other, both knobbed.

Part of leg	Lengths prothoracic	Lengths mesothoracic	Lengths metathoracic
Coxa	42.5(31.3-58.7)	59.2(50.8-66.5)	55.7(43.0-66.5)
Trochanter	50.8(43.0-54.7)	54.1(50.8-54.7)	51.9(46.9-54.7)
Femur	92.3(82.1-125)	96.3(86.0-117)	90.5(78.2-102)
Tibia	61.6(54.7-70.4)	64.8(62.6-70.4)	65.0(58.7-74.3)
Tarsus	54.3(43.0-62.6)	64.8(58.7-70.4)	61.1(58.7-66.5)
Claw	17.1(15.6-19.6)	17.9(15.6-19.6)	18.6(15.6-23.5)
Entire leg	315(297-327)	350(336-364)	343(309-368)

Spiracles: Anterior pair 65.0(50.8-78.2) long, atrium 36.2(35.2-39.1) wide; posterior pair 76.2(58.7-109) long, atrium 44.0(39.1-46.9) wide. Spiracular apodeme constricted on each side, atrium usually wider than apodemal base. Spiracular pore bands 2 or 3 pores wide except near spiracular setae where they concentrate into a cluster 6 to 10 pores wide.

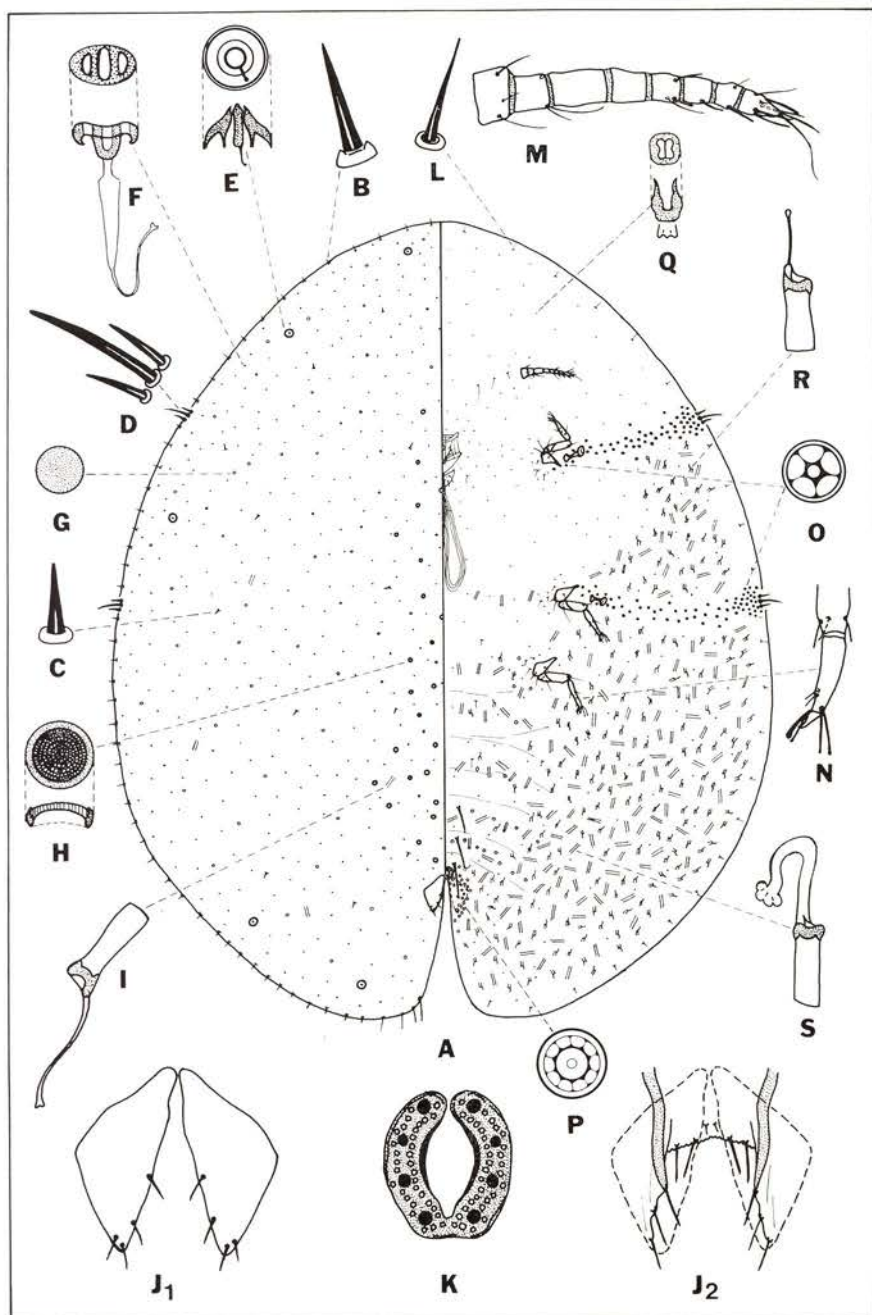


Plate 18. - *Pulvinaria ericicola* McConnell

Pores: Quinquelocular pores (fig. O) 6.60(5.86-7.82) in diameter located in pore bands of spiracular furrows, each pore band made up of 50 to 70 pores. Multilocular pores with 10 loculi (fig. P) 7.26 (5.86-7.82) in diameter in a cluster confined to anal area, and a few scattered on the anterior abdominal segments.

Ducts: Microducts (fig. Q) about 3.42 long, opening to surface through square shaped orifices about 2.44 in diameter, scattered over entire venter, most numerous around mouthparts. Tubular ducts of two types, numerous on abdomen, but tapering toward margin near anterior spiracular furrow, none detected on head. One type (fig. R) with a slender knobbed filament, duct 8.49(7.82-11.7) long, 3.91 wide, filament 10.9 (7.82-15.6) long; the other duct with a broad flowery tipped filament (fig. S), duct 10.7(7.82-15.6) long, 3.91 wide, filament 20.1(15.6-27.4) long, 2.44(1.95-3.91) wide.

OTHER STAGES

First instar nymphs with 6-segmented antennae; well-developed legs without tibio-tarsal sclerotization or free articulation; 2 tarsal digitules one larger and positioned farther back on tarsus than the other; claw slender, with an acute denticle near apex and 2 digitules subequal in length, but one broader than the other; 36 slender, acute marginal setae around body; spiracular setae in groups of 3, median seta $2\frac{1}{2}$ times laterals, all slender, slightly curved; with 3 quinquelocular pores in anterior spiracular pore bands and 3 or 4 pores in posterior pore bands; eyes present; anal ring with 6 hairs. McConnell (1949) studied both second instar males and females. According to him, the second instar male had fewer and smaller marginal setae than the adult female. Tubular ducts were also present around the margin of the head, thorax and anterior part of the abdomen. Second instar female similar to adult female except without multilocular or large discoidal pores, only a few tubular ducts on ventral surface and with 6 to 8 submarginal tubercles.

BIOLOGICAL NOTES

The coccids overwinter as fertile, but not fully grown adult females (McConnell, 1949). They are usually found near the base of the plant below the duff layer of the forest floor and occasionally on the roots. Ovisac formation and egg deposition begins in early May in Craig County, Va., about a month earlier than the colony studied by McConnell in College Park, Md. According to McConnell, the newly hatched nymphs settle along the stems both below and above

the ground cover, but those above ground cover succumb to parasites. Apparently there is only one generation.

PARASITES AND PREDATORS

Although McConnell (1949) mentioned the effect of parasites in controlling exposed females of *P. ericicola*, no identification of the parasite was made.

ADDITIONAL HOSTS AND DISTRIBUTION IN VIRGINIA

On *Vaccinium* sp., Craig Co.: Broad Run Conservation Area; Blacksburg.

ADDITIONAL HOSTS AND DISTRIBUTION IN U.S.A.

Rhododendron obtusum var. *kaempferi*, *R. molle*, and *Rhododendron* sp. in New York; and *R. nudiflorum* in District of Columbia and Maryland (McConnell, 1949). "Huckleberry" in Florida (Merrill, 1953). *Vaccinium* sp. in New Hampshire.

ECONOMIC IMPORTANCE

McConnell (1949) stated that *P. ericicola* might become an economic pest of azaleas and *Rhododendron*, but since that time no evidence of heavy damage to these plants has been noted. Apparently it is not of great economic importance.

NOTES

We were unable to locate the sclerotized pores as mentioned by McConnell (1949) in the original description. Most likely these were just sclerotized sections of the derm or might have been due to the difference in mounting procedures.

***Pulvinaria floccifera* (Westwood), 1870**

*** Cottony Camellia Scale**

Plate 19, Photo 33

Coccus flocciferus, Westwood, 1870:308. *Pulvinaria camelicola*, Signoret, 1873:32; Maskell, 1879:207, 1887:83; Douglas, 1885:159, 1886:81, 1887:243; Cockerell, 1899b:272; Green, 1900:7; Fernald, 1903:130; Carnes, 1907:180; Brimley, 1938:109. *P. brassiae*, Cock-

erell, 1895c:135; King, 1901c:197, 1901d:311. *P. phaiiae*, Lull, 1899: 237; Cockerell, 1900:596; King, 1902a:61. *P. floccosa* (West.), Newstead, 1900:26. *P. floccifera* (West.), Green, 1897:72, 1918:153; King, 1901c:197; Fernald, 1903:132; Newstead, 1903:36; Kuwana, 1909: 153; Dietz and Morrison, 1916:241; Brain, 1920:19; Froggatt, 1921: 9; Hall, 1922:20; Steinweden, 1946:6; Merrill, 1953:102; Takahashi, 1955:153; Simmonds, 1957:8; Ezzat and Hussein 1969:417. *Chloro-pulvinaria floccifera* (West.), Borchsenius, 1957:205; Canard, 1965a: 170, 1965b:411, 1965c:424.

MATERIAL STUDIED

Camellia sasanqua, 7, (7), Princess Anne Plaza, Princess Anne Co., May 15, 1970, DKP. *Camellia* sp., 5, (8), Newport News, April 17, 1967, D. J. Kelly; 3, (5), Hampton, May 5, 1967, J. Amos; 5, (8), Richmond, May 2, 1969, JAW; 1, (2), Richmond, May 5, 1969, JOH. *Ilex cornuta*, 4, (4), Surry Co., May 10, 1969, E. L. Rawls. *I. cornuta* var. *burfordii*, 4, (4), Newport News, May 19, 1969, JAW. *Ilex* sp., 1, (4), Abingdon, ref. slip June 29, 1931, W. E. Mingea. *Jasminum* sp., 1, (3), Charlottesville, let. July 7, 1925, Mrs. W. F. Long. *Rhododendron* sp., 9, (9), Cape Charles, May 16, 1968, JAW.

GENERAL APPEARANCE

Body elongate oval, slightly convex, usually widest near center. Color ranges from cream to tan (2.5Y 7/4) mottled with brown (2.5Y 3/4) and usually with a brown border around body. Adult females occur on stems and leaves of the host, and at maturity secrete an elongate ovisac which may be straight or curved. Often, after completion of the ovisac, the dried female drops to the ground leaving only the ovisac attached to the plant.

DESCRIPTION

Body (fig. A) elongate oval, 3804(3102-4579) long, 2785 (2140-3323) wide, usually with slight spiracular constrictions around body margin. Derm remaining membranous at maturity. Marginal setae long, acute, fringed, or bifid; dorsum with numerous bilocular and disc pores; submarginal tubercles present. Spiracular setae in 3's, median seta 2 or 2½ times the length of laterals. Well-developed legs and 8-segmented antennae. Most multilocular pores in abdominal area with 7 loculi. Anal cleft about 1/6 body length.

DORSAL SURFACE AND MARGIN

Setae: Marginal setae (fig. B) numerous, about 63 around head, 54.5 (44.2-75.8) long, slender, most curved; acute, bifid, or fringed. Body setae (fig. C) randomly scattered over dorsum, 8.21 (7.82-11.7) long, straight, slender, acute.

Spiracular setae (fig. D): 3 in each group, median seta 2 to $2\frac{1}{2}$ times length of lateral setae; median seta 67.6 (63.2-70.4) long, 9.66 (6.32-13.6) wide, slender, straight or curved at tip, bluntly pointed; lateral setae 28.8 (19.6-37.9) long, 7.10 (6.32-8.32) wide, slender, straight, tapering, bluntly pointed.

Submarginal tubercles (fig. E): Numbering 4 to 11 around entire body, 8.82 (7.82-9.82) in diameter.

Pores: Bilocular pores (fig. F) 1.95 (1.95) in diameter, numerous, scattered over dorsum, mixed with simple disc pores (fig. G) 1.95 (1.95) in diameter. About 25 larger disc pores (fig. H) 3.10 (2.47-3.71) in diameter, scattered in median area anterior to anal plates.

Ducts (fig. I): Tubular ducts with a sclerotized rim and a slender knobbed filament scattered over dorsum; duct about 12.4 long, 2.47 wide, with a slender filament about 11.1 long.

Anal plates (fig. J₁ J₂): Triangular, length 146 (125-234), width 75.6 (62.6-88.5); cephalolateral margin concave, 101 (86.0-158) long; caudolateral margin convex, 99.3 (82.1-158) long. Apical angles somewhat pointed, others rounded. Each plate with 4 apical and 2 subapical setae. Anal fold with 2 pair of fringe setae; the outer pair longest. Occasionally 2 small subfringe setae are seen.

Anal ring (fig. K): Rectangular, about 61.8 long, 56.8 wide, with 8 hairs and 2 rows of translucent wax pores.

VENTRAL SURFACE

Setae: About 25 to 35 ventral submarginal setae (fig. L) around head, 21.9 (18.9-31.6) long, slender, acute, straight or slightly curved near tip. Body setae (fig. M) scattered over venter, 12.0 (7.82-18.9) long, slender, acute, usually curved, with a large base. A submedian row of abdominal setae that terminates with the 3 large prevulvar setae on each side.

Eyes: Present near margin, above level of antennal scape.

Antennae (fig. N): Well-developed 8-segmented, 453 (438-474) long. Scape 53.4 (39.1-63.2) long, 79.2 (63.2-89.9) wide. Length of

segments II to VIII: 63.6(50.6-82.1), 75.4(69.5-78.2); 67.3(56.9-78.2); 48.1(31.6-56.9); 37.1(35.3-39.1), 34.0(27.4-37.9) 63.4(56.9-69.5) long respectively. Terminal segment with 2 hairlike and 8 fleshy setae. Setae on other segments: I,2; II,2; III,3; IV,0, rarely 1; V, 3; VI, 1 fleshy; VII,1 and 1 fleshy.

Legs: Well-developed, with tibio-tarsal sclerotization and free articulation; claws simple, without denticle. With 2 equal, slender knobbed tarsal digitules 68.5(56.9-70.4) long and 2 equal, broad and spatulate claw digitules 42.6(37.9-50.8) long.

Part of leg	Lengths prothoracic	Lengths mesothoracic	Lengths metathoracic
Coxa	115(94.8-152)	126(117-139)	132(117-145)
Trochanter	117(107-126)	129(120-137)	129(120-164)
Femur	202(183-215)	221(209-234)	224(215-235)
Tibia	205(190-221)	227(209-240)	227(215-242)
Tarsus	90.8(74.3-97.8)	102(94.8-109)	102(93.8-113)
Claw	28.6(23.5-31.6)	30.2(27.4-43.6)	29.0(25.3-31.6)
Entire leg	755(715-827)	833(806-884)	844(817-878)

Spiracles: Anterior spiracles 83.3(75.8-93.8) long, atrium 50.3(46.9-50.8) wide; posterior pair 98.1(93.8-101) long, atrium 58.0(50.6-66.5) wide. Spiracular apodemes constricted on both sides. Spiracular pore bands 3 or 4 pores wide, each band containing 50 to 70 pores.

Pores: Quinquelocular pores (fig. O) 5.78(4.91-7.82) in diameter, numerous in spiracular pore bands. Multilocular pores (fig. P) 7.13 (5.86-7.82) in diameter, forming a cluster around anal area and in transverse bands on the abdomen, most with 7 loculi.

Ducts: Microducts (fig. Q) about 2.47 long, which open through square-shaped orifices 1.95 in diameter, scattered over entire venter, more numerous in submarginal area around body. Tubular ducts of 3 types: On head between antennae are ducts (fig. R) 14.8(11.7-19.6) long, 3.81 (2.94-3.91) wide, with broad flowery tipped filaments 16.8(11.7-19.6) long, 3.23(1.96-3.91) wide; scattered over posterior $\frac{2}{3}$ of body are ducts (fig. S) 7.82(7.82) long, 3.92(3.92) wide, with slender knobbed filaments 13.7(11.7-15.6) long, and ducts (fig. T) 12.1(7.82-15.6) long, 4.01(2.94-5.86) wide, with flowery tipped filaments 17.6(15.6-19.6) long, 2.15(1.95-2.94) wide. The pattern of tubular ducts on the abdomen is very dense.

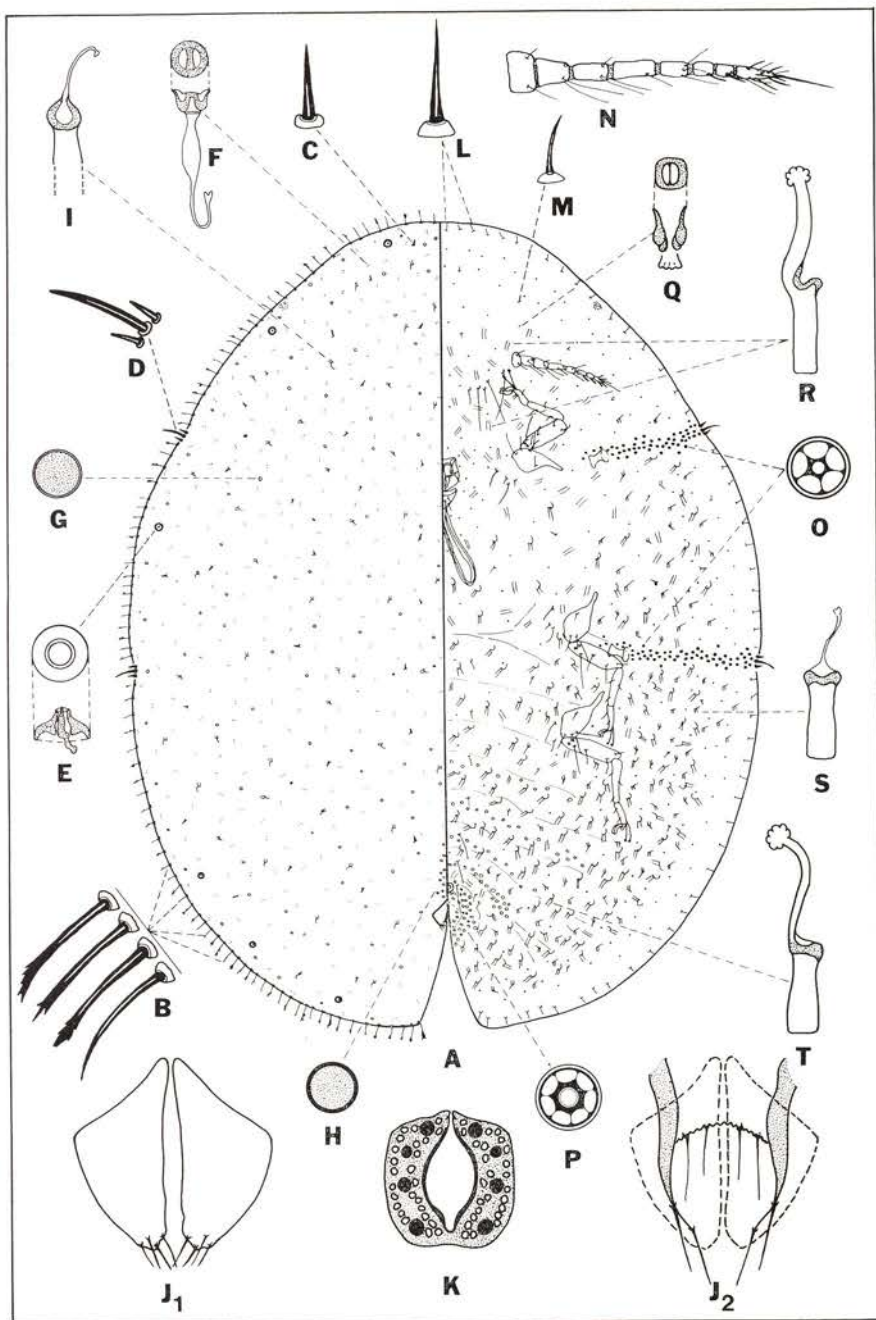


Plate 19. - *Pulvinaria floccifera* (Westwood)

OTHER STAGES

Not seen by the authors. Canard (1965c) found the stylet of the first instar nymph 191μ long.

BIOLOGICAL NOTES

P. floccifera has one generation per year. Adult females usually remain on the stems of their host plant until time for oviposition when they migrate to the leaves and produce the ovisac containing the eggs. After oviposition is completed the dried female usually falls to the ground leaving only the white cottony ovisac attached to the plant. First instar nymphs usually settle on the leaves, but during the second nymphal stage, they migrate to the twigs where they mature. Canard (1965a) noted 1100 eggs per female, also provided comparison (1965b) with *P. hydrangeae*.

PARASITES AND PREDATORS

Peck (1963) reported *Coccophagus lycimnia* as a parasite of *P. floccifera*.

HOSTS AND DISTRIBUTION IN VIRGINIA

Same as material studied.

ADDITIONAL HOSTS AND DISTRIBUTION IN U.S.A.

Reported from California and Oregon (Steinweden, 1946); Florida (Merrill, 1953); Indiana (Dietz and Morrison, 1916); Maryland (collected by Michael L. Williams); and Massachusetts (Fernald, 1903). Also present in the USNM from New York, North Carolina, Rhode Island, South Carolina, Texas, and Washington. Additional hosts include: *Acalypha* sp., *Acer palmatum*, *Ardisia* sp., *Callicarpa americana*, *Datura arborea*, *Hedera helix*, *Ilex aquifolium*, *I. opaca*, *Psidium* sp. and *Taxus baccata*.

ECONOMIC IMPORTANCE

Not considered to be of economic importance.

NOTES

A few specimens of *P. floccifera* collected from *Cornus* had 3 apical setae on each anal plate instead of 4, and often had 2 small subfringe setae. Steinweden (1946) noted considerable variation in the num-

ber of frayed or bifid marginal setae on specimens from *Camellia*, these varying from 2 to 30, even in specimens from the same collection.

Pulvinaria hydrangeae Steinweden, 1946

*** Cottony Hydrangea Scale**

Plate 20

Pulvinaria hydrangeae Steinweden, 1946:7; Brookes, 1964:17. *Eupulvinaria hydrangeae*, Canard, 1965a: 70, 1965b:411, 1965c:424, 1969:458.

MATERIAL STUDIED

Hydrangea sp., 6 (6), Suffolk, June 5, 1970, J. C. Smith; 1, Guerneville, Calif., June 22, 1970, D. Loukonen.

GENERAL APPEARANCE

Only alcohol-preserved specimens seen. Body slightly convex, elongate ovate to ovate. According to Steinweden (1946), females are yellow to light-brown in color. Females occur on the leaves and stems of their hosts and at maturity secrete a broad, white, ribbed, cottony ovisac about 3 times the body length.

DESCRIPTION

Body (fig. A) usually ovoid, 4291(2956-5020) long, 3430 (2510-4016) wide, derm remaining membranous at maturity. Legs and antennae well-developed; marginal setae almost all acute except near anal cleft where some may be bifid or fimbriate; submarginal tubercles absent; 40 to 50 simple disc pores anterior of anal plates; each plate with a subdiscal seta about $\frac{1}{3}$ up caudolateral margin from apex; multilocular pores in anal area 7-loculed. Anal cleft about $\frac{1}{8}$ of body length.

DORSAL SURFACE AND MARGIN

Setae: Marginal setae (fig. B) about 30 around head, 53.3 (44.2-63.2) long, slender, most acute, a few bifid or fimbriate, slightly or strongly curved. Body setae (fig. C) 12.6(12.6) long, straight, tapering, acute, scattered randomly over body.

Spiracular setae (fig. D): 3 in each spiracular furrow; median seta $2\frac{1}{2}$ or 3 times the length of laterals, 90.1(56.9-109) long, 12.1 (6.32-13.6) wide, slender, curved near apex, about same width throughout, and bluntly pointed; lateral setae 34.3(25.3-44.2) long, 6.89(6.32-7.32) wide, slender, slightly curved, rounded at tips.

Submarginal tubercles: Absent.

Pores: Bilocular pores (fig. E) 2.44(2.44) in diameter, numerous, scattered over entire dorsum, each pore with a slender inner filament projecting into the body. Simple disc pores (fig. F), about 1.95 in diameter, scattered over dorsum, not as numerous as bilocular pores. Simple disc pores (fig. G) 3.21(2.44-3.90) in diameter, 40 to 50 scattered in median area anterior to anal plates.

Ducts: Broad tubular ducts (fig. H) about 2.93 long, 1.46 wide, with a slender, knobbed filament about 3.90 long, randomly scattered over dorsum.

Anal plates (fig. I₁, I₂): Triangular, all angles blunt, 169(158-180) long, 92.1(82.2-94.8) wide; cephalolateral margin concave, 107 (94.8-120) long; caudolateral margin convex, 123(113-133) long. Each plate with 4 apical setae, 3 at apex and 1 subdiscal in position, about $\frac{1}{3}$ from apex on caudolateral margin, and 3 subapical setae. Anal fold with 2 pair of fringe setae, subequal in length, occasionally there may be a smaller median seta.

Anal ring (fig. J): Rectangular, 67.7(56.9-94.8) wide. Length unmeasurable due to position. With 8 hairs and 2 rows of irregular shaped, translucent wax pores.

VENTRAL SURFACE

Setae: Ventral submarginal setae (fig. K) slender, tapering, acute, straight or slightly curved, 24.4(18.9-25.3) long, about 30 around head. Body setae similar 20.7(18.9-25.3) long, scattered over venter; 10 to 12 setae between antennae; 3 pair of large prevulvar setae; a submedian row extending from the prevulvar setae anteriorly to prothorax.

Eyes: Present, usually located between 6th and 7th marginal setae anterior to spiracular setae.

Antennae (fig. L): Well-developed, 8-segmented, 562(505-730) long. Scape 77.7(69.5-82.2) long, 77.6(75.8-82.2) wide. Length of segments II to VIII: 72.2(63.2-82.2), 105(94.8-113), 76.7(63.2-94.8), 50.5 (37.9-63.2), 37.9(31.4-44.2), 34.3(31.6-37.9), 54.1(50.6-56.8) long

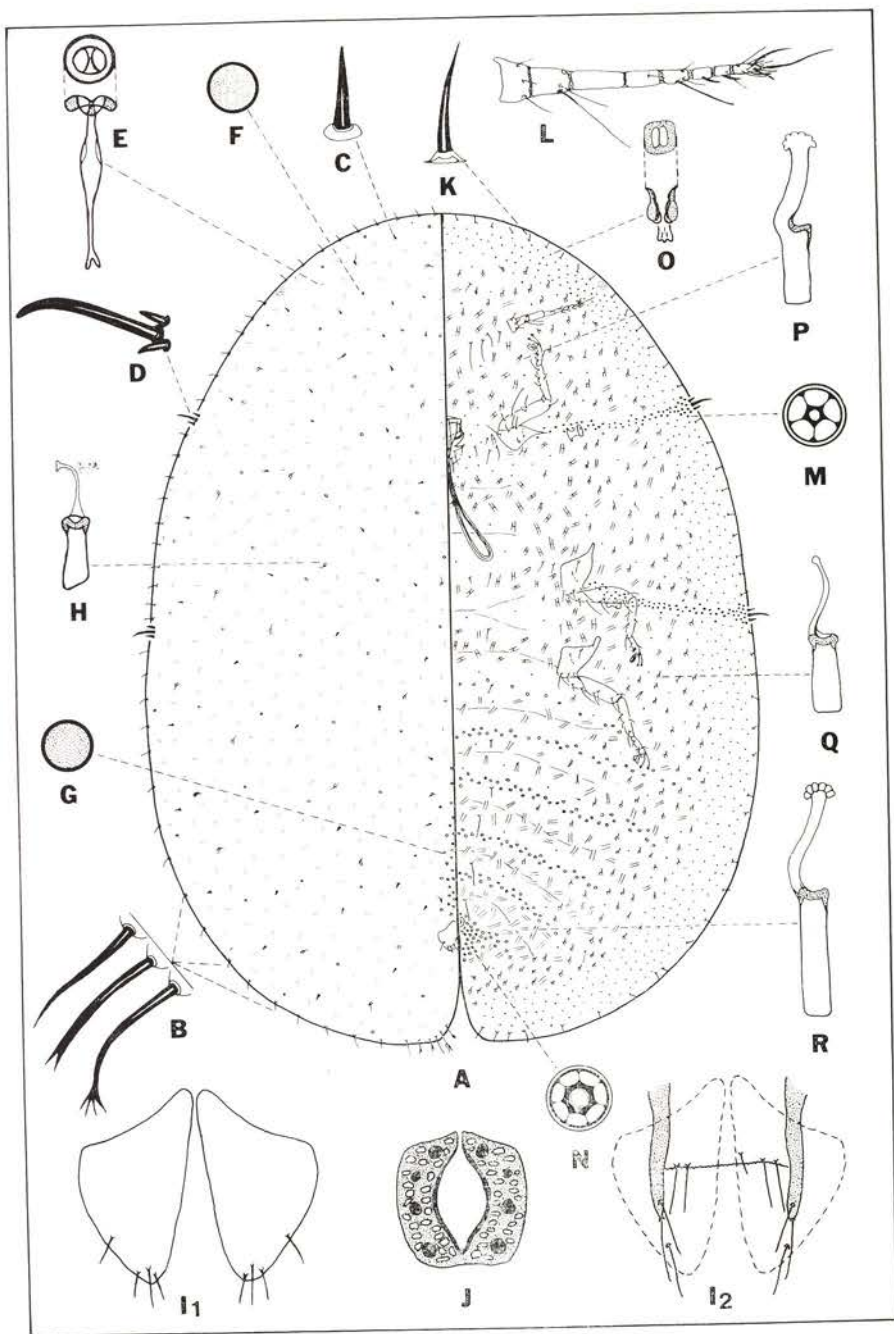


Plate 20. - *Pulvinaria hydrangeae* Steinweden

respectively. Terminal segment with 3 hairlike and 8 fleshy setae. Setae on other segments: I,3; II,2; III, 0-1; IV, usually 0, sometimes 1; V,3; VI,1 fleshy; VII,1 and 1 fleshy.

Legs: Well-developed, with tibio-tarsal sclerotization and free articulation; claws without a denticle. Tarsus and claw each with a pair of digitules; claw digitules broad, equal, expanded at apex 46.9 (37.9-56.8) long; tarsal digitules slender, knobbed, 73.1 (63.2-75.8) long.

Part of leg	Lengths prothoracic	Lengths mesothoracic	Lengths metathoracic
Coxa	140(139-145)	155(145-158)	159(152-171)
Trochanter	145(139-152)	147(145-164)	155(133-164)
Femur	250(240-253)	284(278-291)	281(272-290)
Tibia	233(215-247)	246(221-277)	225(156-246)
Tarsus	94.7(75.8-113)	103(94.8-120)	105(94.8-120)
Claw	33.4(25.3-37.9)	33.7(31.6-44.2)	34.3(25.3-37.9)
Entire leg	896(859-942)	970(896-1024)	956(839-1016)

Spiracles: Spiracular apodeme constricted on both sides, apodemal base areolate and almost as wide as atrium. Spiracular pore bands 2 or 3 pores wide throughout most of their length, but 4 or 5 pores wide near spiracular setae; pore band extends to base of coxa. Anterior spiracles 96.5 (82.2-107) long, atrium 67.7 (63.2-75.8) wide; posterior pair 109 (94.8-120) long, atrium 74.9 (69.5-75.8) wide.

Pores: Quinquelocular pores (fig. M) 6.32(6.32) in diameter, making up spiracular pore bands, each band of about 55 to 70 pores. Multilocular pores (fig. N) 9.22(7.32-12.6) in diameter, located in anal area and in transverse bands on the abdomen, most 7-loculed.

Ducts: Microducts (fig. O) about 3.42 long, which open through square shaped orifices about 2.44 in diameter, scattered over entire venter, more numerous in submarginal area and on head. Tubular ducts (fig. P) 16.2(11.7-19.6) long, 4.05(3.91-4.91) wide, with broad flowery tipped filaments 17.3(15.6-19.6) long, 3.91(3.91) wide, scattered in median areas of head and thorax. Ducts (fig. Q) 8.93 (7.82-11.7) long, 3.91 (3.91) wide, with slender, knobbed filaments 11.2(7.82-15.6) long scattered over venter, but most numerous in intermediate areas. Ducts (fig. R) 15.6(11.7-19.6) long, 3.72(2.60-

3.91) wide with flowery tipped filaments 16.9(11.7-19.6) long, 2.41 (1.95-2.60) wide, scattered over abdomen and in intermediate areas around body.

OTHER STAGES

Not seen by the authors. Canard (1965c) gives 150μ as the stylet length for the first instar nymphs. Male morphology was also described by Canard (1969).

BIOLOGICAL NOTES

The biology of this species was studied by Canard (1965b, 1969) in southern France. Females occur on the leaves and stems of their hosts, and at maturity, secrete an ovisac about 3 times the body length (Steinweden, 1946). The specimens sent to us for identification were collected on June 5, 1970, and had begun producing ovisacs and laying eggs.

PARASITES AND PREDATORS

None seen by the authors.

HOSTS AND DISTRIBUTION IN VIRGINIA

Same as material studied.

ADDITIONAL HOSTS AND DISTRIBUTION IN U.S.A.

Type from *Hydrangea macrophylla* at San Mateo, California; from same host at East Palo Alto, Hillsborough, Oakland, Pogue, Sausalito, Watsonville, and Los Angeles, Calif., and from *Prunus* sp. at Los Angeles (Steinweden, 1946). Occurs also in Massachusetts and New York (USDA records).

ECONOMIC IMPORTANCE

Apparently the cottony hydrangea scale is not of economic importance except in localized areas.

NOTES

This species needs to be studied since very little is known about its biology. Steinweden (1946) noted specimens representing *P. hydrangeae* in collections which were misidentified as *P. floccifera* (Westwood).

Pulvinaria innumerabilis (Rathvon), 1854

Cottony Maple Scale

Plate 21, Photos 34, 35

Coccus innumerabilis, Rathvon, 1854:256. *Lecanium acericulticis*, Fitch, 1859:775; Thomas, 1878:121; Smith 1878a:176, 1878b:655. *L. acericola* (Walsh and Riley), Thomas, 1878:120. *Pulvinaria tinsleyi*, King, 1900:360. *P. vitis* (L.), Sanders, 1909:443; Dietz and Morrison, 1916:240; Lawson, 1917:188; Houser, 1918:295; MacGillivray, 1921:177; Hollinger, 1923:59; Merrill and Chaffin, 1923:270; Gillette and Langford, 1925:7; Herrick, 1935:192; Brimley, 1938:109. *P. innumerabilis* (Rathv.), Putnam, 1880:339; Comstock, 1881:350, 1883:137; Saunders, 1883:241, 1884:141, 1885:27; Forbes, 1885:103; Packard, 1890:247; Newell, 1899:170; Howard 1900:7; Felt 1901:357; Sanders, 1905:1; Carnes, 1907:179; Merrill, 1953:103; Phillips, 1962:499; Wallner, 1969:20.

MATERIAL STUDIED

Acer negundo, 6, (6), New River bank, Montgomery Co., June 8, 1967, MK. *A. nigrum*, 1, Blacksburg, May 14, 1969, AD. *A. rubrum*, 1, Blacksburg, May 11, 1969, MLW; 1, Blacksburg, June 25, 1956, J. M. Grayson. *Carya ovata*, 1, Blacksburg, May 14, 1969, MLW. *Carya* sp., 1, Charlottesville, May 9, 1946, DWC. *Celtis occidentalis*, 1, Blacksburg, May 29, 1967, MK. *Cornus florida*, 3, (3), Blacksburg, May 13, 1969, MLW. *Diospyros virginiana*, 1, Blacksburg, May 29, 1967, MK et al. *Fagus grandifolia*, 1, (2), Blacksburg, May 9, 1969, JOH. *Lindera benzoin*, 1, Montgomery Co., April 5, 1969, MLW. *Quercus rubra*, 1, Blacksburg, May 5, 1969, MLW. *Robinia pseudo-acacia*, 1, Blacksburg, June 3, 1968, MLW. *Salix nigra*, 1, Blacksburg, May 13, 1969, MLW. *Tilia* sp., 1, Blacksburg, May 13, 1969, DKP. *Ulmus alata*, 4, (4), Richmond, June 6, 1957, collector unknown. *Vitis* sp., 1, (4), Harrisonburg, June 16, 1964, K. W. Peterson. "Fern locust," 1, (3), Floyd Co., May 26, 1964, Mr. Talley.

GENERAL APPEARANCE

Body only slightly convex, elongate ovate to ovate. The color of specimens tends to vary from host to host. Specimens collected from red oak, silver maple, and basswood were gray (10Y 7/2) speckled with black and light-brown (2.5Y 8/8) and 2 dark bands dorsally in area of spiracular setae; specimens from hickory and red

maple were dark red (5R 3/4) with a lighter margin (2.5YR 4/8); specimens seen from sycamore were tan with varying mahogany-colored markings. *Pulvinaria innumerabilis* occurs on twigs and small limbs of its hosts, and at maturity secretes a broad, white, convex ovisac that is 1 or 2 times the length of the coccid; many times it tilts the body of the insect up at an angle from the twig.

DESCRIPTION

Body (fig. A) usually ovate, 5083(3693-6974) long, 4028 (2171-6794) wide, derm only slightly sclerotized at maturity. Legs and 8-segmented antennae well-developed. Submarginal tubercles absent. Marginal setae stout and blunt tipped. Anal plates slender. Anal cleft about 1/7 of body length.

DORSAL SURFACE AND MARGIN

Setae: Marginal setae (fig. B) 41.1(19.6-62.6) long, straight, rather stout, blunt tipped, about 50 around head. Body setae (fig. C) 12.6(7.82-23.5) long, with a large base, straight, tapering to a sharp point, about 90 scattered randomly over the body, except for a double longitudinal row on mid-dorsum.

Spiracular setae (fig. D): 3 in each group, median seta 21½ times the length of lateral setae; median seta 104(58.7-141) long, 11.7(7.82-15.6) wide, slender, parallel sided, slightly curved and blunt; lateral setae 37.8(27.4-50.8) long, 8.03(5.87-11.7) wide, straight, tapering, blunt.

Submarginal tubercles: Absent.

Pores: Bilocular pores (fig. E), about 1.95 in diameter, numerous, scattered over entire dorsum. Simple disc pores (fig. F), about 2.44 in diameter, evenly distributed on derm, also a row around margin near bases of marginal setae which are slightly larger than those on rest of dorsum. About 20 to 30 simple disc pores (fig. G) 5.56(4.94-6.98) in diameter, located in median area anterior to anal plates.

Anal plates (fig. H₁, H₂): Each plate rather slender, 158(145-184) long, 74.9(66.5-89.9) wide, lateral angles pointed or rounded, caudolateral margin longest; cephalolateral margin usually concave, 96.0(86.0-109) long; caudolateral margin usually convex, 116(109-133) long. Each plate with 4 apical and 2 subapical setae. Anal fold with 2 pair of fringe setae, the outer pair largest.

Anal ring (fig. I): Ovate to subcircular about 58.7 long, 54.7 wide, with 8 hairs and 2 rows of translucent wax pores.

VENTRAL SURFACE

Setae: Ventral submarginal setae (fig. J) 20.4(11.7-23.5) long, slender, pointed, about 28 around head. Body setae similar to ventral submarginal setae except smaller, 12.1(11.7-15.6) long, scattered randomly over body. With 3 pair of large prevulvar setae.

Eyes: Not detected in adult specimens.

Antennae (fig. K): Well-developed, 8-segmented, 341(305-414) long, 3 setae mesad of each scape. Scape 32.5(23.5-50.8) long, 60.6(46.9-78.2) wide. Length of segments II to VIII: 40.2(23.5-58.7), 64.5(50.8-93.8), 58.7(46.9-70.4), 39.5(27.4-66.5), 26.5(23.5-31.3), 26.5(19.6-31.3), 45.2(19.6-70.4) long respectively. Terminal segment with 5 hairlike and 4 fleshy sensory setae. Setae on other segments: I,3; II,2; III,2; IV,0; V,3; VI,1 fleshy; VII,1 and 1 fleshy setae.

Legs: Moderately developed, with tibio-tarsal sclerotization and free articulation; claws with a small denticle. Tarsus and claw each with a pair of digitules; claw digitules broad, subequal, 32.5(23.5-43.0) long, expanded at apex; tarsal digitules slender, subequal, 55.5(35.2-66.5) long, knobbed.

Part of leg	Lengths prothoracic	Lengths mesothoracic	Lengths metathoracic
Coxa	74.3(62.6-97.8)	84.5(70.4-106)	87.4(74.3-109)
Trochanter	70.4(46.9-97.6)	77.4(54.7-97.8)	77.8(62.6-106)
Femur	149(125-188)	166(133-207)	172(133-227)
Tibia	147(121-199)	154(102-211)	162(102-215)
Tarsus	76.2(54.7-93.8)	84.5(74.3-97.8)	85.6(70.4-97.8)
Claw	21.9(15.6-23.5)	23.9(19.6-27.4)	23.5(19.6-27.4)
Entire leg	539(445-673)	590(470-727)	609(481-763)

Spiracles: Spiracular apodeme constricted on both sides, atrium wider than apodemal base. Anterior spiracles 79.7(62.6-97.6) long, atrium 68.2(54.7-82.1) wide; posterior pair 90.1(66.5-106) long, atrium 78.6(62.6-93.8) wide. Spiracular pore band 2 or 3 pores wide throughout most of its length, but 4 or 5 pores wide near spiracles.

Pores: Quinquelocular pores (fig. L) 6.86(5.89-7.82) in diameter, 30 to 80 pores in each spiracular pore band. Multilocular pores

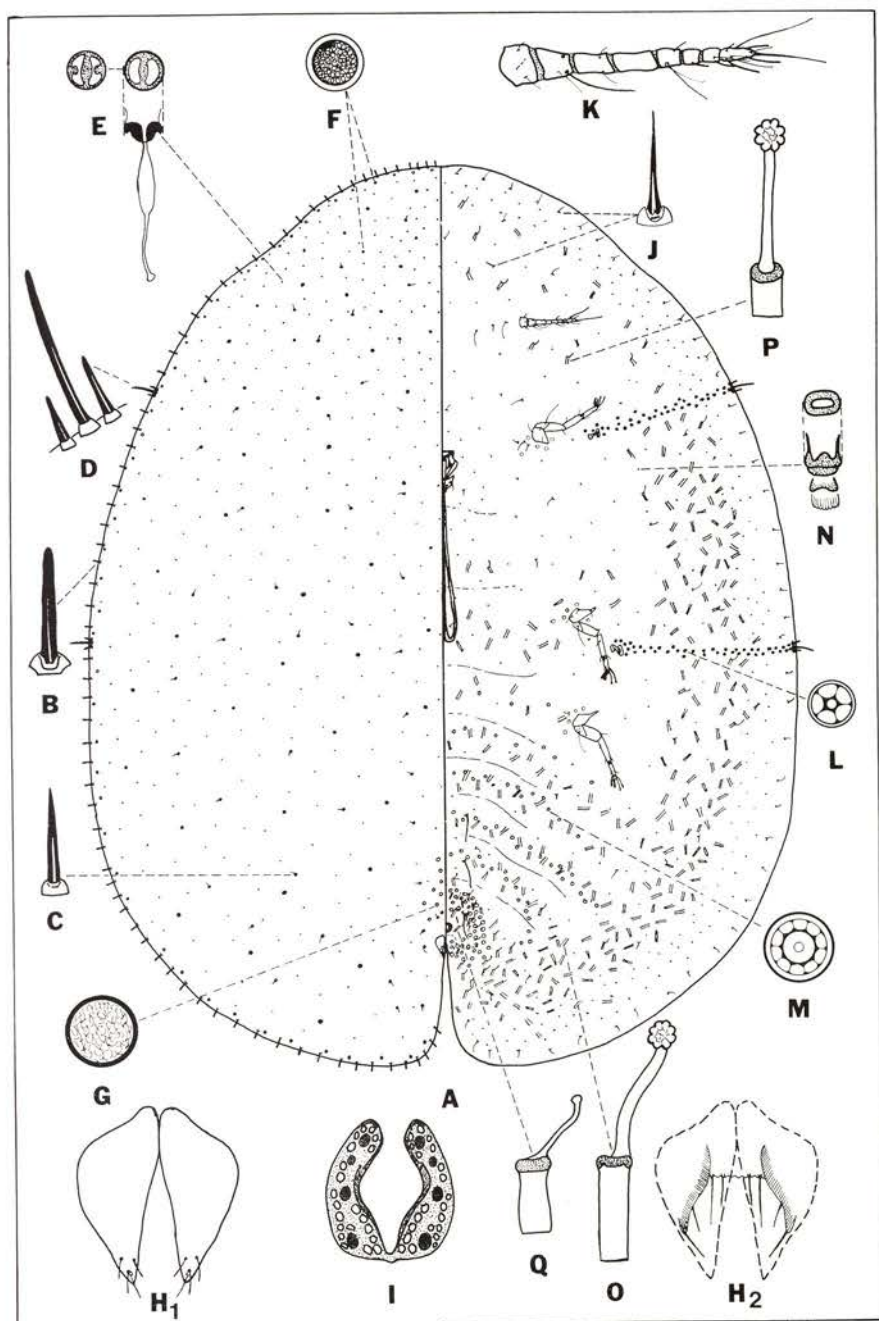


Plate 21. - *Pulvinaria innumerabilis* (Rathvon)

with 10 locules (fig. M) 7.82(7.82) in diameter, located in anal area and in transverse bands on abdomen, rarely seen elsewhere.

Ducts: Microducts (fig. N) about 3.42 long, which open through oval orifices about 3.42 in diameter, scattered over entire venter, most numerous in a submarginal band around body. Tubular ducts of 3 types: large ducts (fig. O) 14.0(11.7-15.6) long, 4.69(3.91-5.87) wide, with a flowery tipped filament 21.6(19.6-31.3) long, 2.94(1.96-3.91) wide, scattered over abdomen and in a submarginal band around body, sparse on head; short ducts (fig. P) 7.82(7.82) long, 5.00(3.91-5.87) wide, with long flowery tipped filaments 23.5(19.6-27.4) long, 3.04(1.96-3.91) wide, located in head region and in area of spiracular pore bands; ducts (fig. Q) 10.4(7.82-11.7) long, 3.91(3.91) wide, with slender knobbed filaments 13.7(11.7-15.6) long, 1.95(1.95) wide, located in anal area.

OTHER STAGES

First instar nymphs with well-developed legs and 6-segmented antennae; about 32 slender, pointed, marginal setae around body; spiracular setae in 3's, median seta $1\frac{1}{2}$ times as long as laterals, lateral setae bluntly pointed, median seta blunt; legs without tibio-tarsal sclerosis; claw denticle minute; claw and tarsal digitules unequal; anal plates smooth, with 1 long caudal seta, 3 apical and 1 subapical seta each; anal fold with 1 pair fringe setae; anal ring with 6 hairs. Second instar nymphs with well-developed legs and 7-segmented antennae; legs without tibio-tarsal sclerosis; 80 to 90 marginal setae around body, some blunt, others slightly pointed; spiracular setae in 3's, median seta $1\frac{1}{2}$ or 2 times length of laterals; anal plates with 4 apical and 1 subapical setae each; anal fold with 2 pair fringe setae; anal ring with 6 hairs. Males are known, but apparently have not been described in detail.

BIOLOGICAL NOTES

The biology of the cottony maple scale was studied in detail by Putnam (1880). The scale overwinters as a young female on the twigs of its host, and reaches full maturity in early spring. In late May or early June, the female secretes a white cottony ovisac in which she lays a large number of eggs. In late June or early July, the eggs hatch, and the nymphs migrate to, and settle on, the lower surfaces of leaves. Before the leaves fall, the nymphs migrate back to the twig. The males emerge around September and immediately mate with available females. The males soon die, and the females

continue to develop until cold weather, when they go into hibernation. There are 3 stages in the development of the females and 5 stages in the males. According to Phillips (1962), unfertilized females produce eggs, but the resulting progeny are all males.

PARASITES AND PREDATORS

Parasites and predators play an important role in keeping the cottony maple scale under control, particularly in the wild. The following parasites are recorded as attacking the coccid: *Aphycus pulvinariae*, *Atropates collinsi*, *Encyrtus* (= *Comys*) *fuscus*, *Eunotus lividus* (Howard, 1900); *Coccophagus lycimnia* (Thompson, 1944); and *Leucopis nigricornis* (Sanders, 1905). Predators of the pest include: *Chilocorus bivulnerus*, "*Dakruma coccidivora*," *Hyperaspis signata* (Howard, 1900); *Chrysopa* sp., larva (Putnam, 1880); *Hyperaspis binotata*, and *Laetilia coccidivora* (Sanders, 1905). *Microterys flavus* was reared at VPI.

ADDITIONAL HOSTS AND DISTRIBUTION IN VIRGINIA

Acer negundo, Blacksburg. *A. pensylvanicum*, Montgomery Co., Craigs Creek. *A. rubrum*, Albemarle Co., Crozet; Giles Co., Poverty Hollow. *A. saccharinum*, Blacksburg. *Acer* sp., Blacksburg; Richmond. *Carya illinoensis*, Norfolk, *Carya* sp., Blacksburg. *Cornus florida*, Falls Church. *Cornus* sp., Blacksburg. *Fraxinus* sp., Blacksburg. *Platanus occidentalis*, Blacksburg. *Populus deltoides*, Albemarle Co., Whitehall. *Pyrus malus*, Arlington Co. *Quercus palustris*, Waynesboro. *Q. virginiana*, Virginia Beach. *Quercus* sp., Pulaski Co., Claytor Lake. *Rhus* sp., Albemarle Co., Crozet. *Salix* sp., Pulaski Co., New River bank. *Ulmus americana*, Blacksburg. *Vitis* sp., Arlington; Blacksburg; Winchester.

ADDITIONAL HOSTS AND DISTRIBUTION IN U.S.A.

The cottony maple scale is recorded from practically every state. It feeds on many types of hosts other than those listed from Virginia. Sanders (1905) reported it from 47 different species of plants.

ECONOMIC IMPORTANCE

Sporadic outbreaks of this scale insect are reported from time to time in various parts of the United States, but in each case, natural enemies have subsequently increased with sufficient rapidity to effectively check its progress. Sanders (1905) noted that most of the reports of serious injury by the cottony maple scale come from states

or portions of states north of the fortieth parallel, where it seems to be attacked by fewer parasites than in the southern regions.

NOTES

Although *Pulvinaria innumerabilis* is quite different from *P. acericola* morphologically, these two were often confused until Howard (1898) separated the two species by their differences in life history. *P. innumerabilis* has also long been confused with *P. vitis*, but can easily be separated from *P. vitis* by its stout, blunt, marginal setae. In *P. vitis* the marginal setae are slender and acute.

Pulvinaria sp., near *occidentalis* Cockerell, 1897

Plate 22

Pulvinaria innumerabilis var. *occidentalis*, Cockerell, 1897a:13. *P. ehrhorni*, King, 1901a:145. *P. coulteri*, Cockerell, 1905c:514. *P. vitis*, Sanders, 1909:433, (in part; possible misidentification). *P. occidentalis subalpina*, Cockerell, 1910:428. *P. occidentalis*, King, 1901c:197, 1901e:315; Fernald, 1903:136; Steinweden, 1946:9.

MATERIAL STUDIED

Alnus sp., 2, (4), Tillamook Co., Oregon, let. June 17, 1944, H. Scullen. *Betula glandulosa*, 1, Tolland, Colorado, 1910, E. Bethel. *Crataegus* sp., 3, (3), Buxton, Oregon, April 27, 1926, A. P. Bailey. *Ilex cassine*, 17, (21), Richmond, Va., June 4, 1968, collector unknown. *Ribes* sp., 2, (2), Missoula, Montana, R. A. Cooley; 3, (4), Montana, Cooley Coll. 667. *Rosa* sp., 2, (2), Coulter, Middle Park, Colorado, Aug. 1904, E. Bethel.

GENERAL APPEARANCE

Living specimens not seen, but according to Steinweden (1946) mature females are ovate, dark brown and wrinkled, with the derm heavily sclerotized and with little or no dorsal secretion. Females occur on the twigs of their host, and at maturity secrete a broad, rather convex, white cottony ovisac, which is about twice the length of their bodies.

DESCRIPTION

Body (fig. A) usually ovate, 4763 (3754-5332) long, 4131 (3365-4652) wide. Derm sometimes moderately sclerotized. Marginal setae

rather stout but pointed. Submarginal tubercles present. Anal plates usually rather narrow, caudolateral margins longest. Fifty to 60 small disc pores anterior to anal plates. Antennae 8-segmented. Legs well-developed with tibio-tarsal sclerotization and free articulation. Anal cleft about $1/8$ body length.

DORSAL SURFACE AND MARGIN

Setae: Marginal setae (fig. B) numerous, about 40 around head, 34.8 (27.4-43.0) long, rather stout, usually slightly curved, pointed, nonfimbriate. Body setae (fig. C) scattered over dorsum, 11.7 (7.82-15.6) long, straight, parallel-sided to near apex where they quickly taper to a point.

Spiracular setae (fig. D): 3 at apex of each spiracular furrow; median seta $2\frac{1}{2}$ or 3 times the length of laterals, straight or curved, bluntly pointed, 99.3 (94.0-102) long, 9.10 (7.82-11.7) wide; lateral setae straight, also bluntly pointed, 42.0 (39.1-50.8) long, 7.82 (7.82) wide.

Submarginal tubercles (fig. E): 3 to 6 present in the specimens studied; 8.76 (6.83-10.7) in diameter, usually on submargin of anterior $\frac{2}{3}$ of body. Steinweden (1946) found specimens among those he studied with submarginal tubercles entirely absent.

Pores: Minute bilocular pores (fig. F) about 2.44 in diameter, numerous scattered over entire dorsum. Simple disc pores (fig. G) about 1.44 in diameter, randomly mixed with bilocular pores but only about $\frac{1}{3}$ as numerous. Fifty to 60 simple disc pores (fig. H) 4.30 (3.90-4.88) in diameter located in median area anterior to anal plates.

Anal plates (fig. I₁, I₂): Varying in shape, usually elongate, caudolateral margin longest, angles usually somewhat rounded though not always. Length 147 (133-156), width 80.4 (70.4-89.9); cephalolateral margin slightly concave, 90.3 (74.3-117) long; caudolateral margin convex or irregular, 115 (97.8-129) long. Each plate with 3 or 4 apical and 3 subapical setae. Anal fold with 3 pair of fringe setae.

Anal ring (fig. J): Rectangular, about 66.5 long, 62.6 wide, with 8 hairs and 2 irregular rows of translucent pores.

VENTRAL SURFACE

Setae: Ventral submarginal setae (fig. K) 21.5 (15.6-27.4) long,

slender, straight and pointed, about 22 around head. Body setae similar, 15.2(11.7-23.5) long, scattered randomly over body.

Eyes: Not detected in specimens studied.

Antennae (fig. L): Well-developed, 8-segmented, 424(360-474) long. Scape 73.1(47.0-86.0) wide, 61.0(43.0-74.3) long. Length of segments II to VIII: 61.4(46.9-70.4); 90.3(78.2-109); 61.8(50.8-78.2); 44.6(39.1-50.8); 29.0(23.5-35.2); 27.0(23.5-31.3); 48.1(43.0-54.7) long respectively. Terminal segment with 2 hairlike, 1 spike-like, and 7 fleshy setae. Setae on other segments: I,3; II,2; III,0; IV,1; V,3; VI,1 fleshy; VII,1 and 1 fleshy.

Legs: Well-developed, with tibio-tarsal sclerotization and free articulation; claw without denticle. Tarsus and claw each with a pair of knobbed digitules; claw digitules equal, broad, 50.2(43.0-56.9) long; tarsal digitules also equal, slender, 72.1(63.2-82.1) long.

Part of leg	Lengths prothoracic	Lengths mesothoracic	Lengths metathoracic
Coxa	123(106-137)	137(121-158)	138(129-158)
Trochanter	139(117-158)	152(141-160)	142(126-156)
Femur	231(203-274)	265(242-285)	255(235-266)
Tibia	213(188-227)	227(207-250)	219(207-235)
Tarsus	93.7(74.3-106)	104(86.0-114)	97.8(94.8-101)
Claw	32.7(27.4-39.1)	33.6(31.3-38.0)	33.2(31.3-38.0)
Entire leg	820(716-900)	919(828-999)	884(837-912)

Spiracles: Spiracular apodeme narrow, constricted on both sides, atrium wider than apodemal base. Spiracular pore bands 3 or 4 pores wide. Anterior spiracles 88.8(74.3-97.8) long, atrium 55.9(43.0-66.5) wide; posterior spiracles 99.3(93.8-109) long, atrium 68.8(58.7-78.2) wide.

Pores: Quinquelocular pores (fig. M) 6.10(5.87-7.82) in diameter, located in spiracular pore bands. Each band containing 50 to 75 pores. Multilocular pores with 10 locules (fig. N) 8.00(7.82-9.52) in diameter in a cluster around anal area, in transverse bands on abdomen, and a few near each coxa.

Ducts: Microducts (fig. O) about 3.42 long, which open to the ventral surface through heavy rimmed orifices 2.93 in diameter, scattered over entire venter, more numerous in a submarginal band

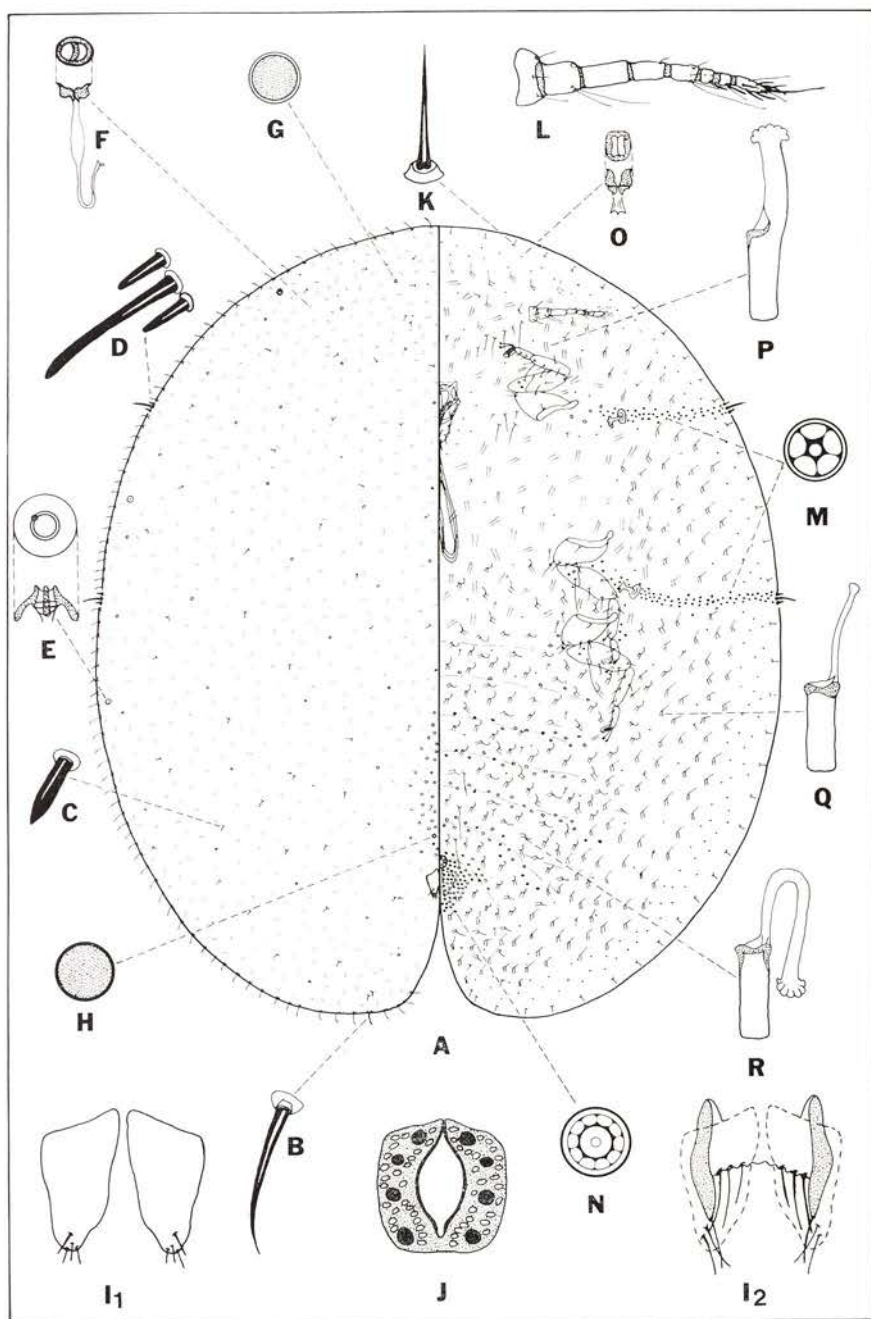


Plate 22. - *Pulvinaria* near *occidentalis* Cockerell

around body. Tubular ducts of three types: One type (fig. P) 16.4 (11.7-23.5) long, 3.91 (3.91) wide with broad flowery tipped filaments 19.2 (15.6-19.6) long, 3.90 (3.00-3.91) wide, in median area of head and thorax; second type (fig. Q) 8.70 (7.82-11.7) long, 3.91 (3.91) wide, with slender knobbed filaments 11.4 (7.82-15.6) long, scattered throughout submarginal area; third type (fig. R) 13.4 (11.7-15.6) long, 3.91 (3.91) wide, with a narrow flowery tipped filament 22.5 (19.6-23.5) long, 1.96 (1.96) wide, located predominately in mid-abdominal areas, but a few scattered elsewhere on body.

OTHER STAGES

Second instar females have 7-segmented antennae; well-developed legs without tibio-tarsal sclerotization or articulation; each tarsal claw with 1 broad and one slender digitule; about 26 marginal setae around head; spiracular setae in 3's, with the median seta of each group about 3 times the length of lateral setae; each spiracular pore band 1 or 2 pores wide and containing 10 to 15 quinquelocular pores; multilocular pores, tubular ducts, and submarginal tubercles absent. Other stages not seen by the authors.

HOSTS AND DISTRIBUTION IN VIRGINIA

Same as material studied.

ADDITIONAL HOSTS AND DISTRIBUTION IN U.S.A.

P. occidentalis is reported from California, Colorado, New York, Oregon and Washington. Its hosts include *Betula glandulosa*, *Grossularia divaricata*, *Populus alba*, *Pyrus decora*, *Ribes lacustre* and members of the following plant genera: *Alnus*, *Cornus*, *Crataegus*, *Deutzia*, *Prunus*, *Rosa* and *Salix*.

NOTES

The specimens described and illustrated here are very near *P. occidentalis*, but differ in several characters, all of which could be host induced. Since the material studied was collected only on *Ilex cassine*, and all the material is from one location, the authors choose to treat the specimens as *Pulvinaria* sp. near *occidentalis*. It differs from *P. occidentalis* in the following ways: claws without denticle; marginal setae rather stout and not as long as in *P. occidentalis*; body setae stout, rather parallel sided; and there are 3 pair of fringe setae. In *P. occidentalis* claw denticles are present; marginal setae are long

and slender; body setae are slender and tapering; and there are usually 2 pair of fringe setae, rarely 3.

After studying specimens of *P. coulteri* Ckll. and *P. erhorni* King, we agree that they are both synonyms of *P. occidentalis* as Steinweden (1946) had concluded in his revision of the *Pulvinaria* of North America.

Sanders (1909) called *P. occidentalis* a synonym of *P. vitis*, but Steinweden (1946) stated that even though he believed the two species to be very close, *P. occidentalis* should not be reduced to synonymy due to the uncertainty in the identity of the European *P. vitis*.

Genus SAISSETIA Deplanche, 1859

TYPE SPECIES

Lecanium coffeae Walker, 1852.

DESCRIPTION

Body of adult female convex to hemispherical, often with H-shaped ridges on dorsum. Derm heavily sclerotized at maturity and with pale areas, cellular patterns or polygonal reticulations. Legs well-developed; tibio-tarsal sclerosis either present or absent. Antennae 7-or 8-segmented. Marginal setae usually slender and pointed, blunt, or variously frayed. Spiracular setae in 3's with median seta longer than laterals. Submarginal tubercles present. Quinquelocular pores in spiracular furrow and multilocular pores in anal region and in transverse bands on abdominal segments. Tubular ducts present ventrally on abdomen and in a submarginal band around body. Anal plates with a discal seta, and varying numbers of apical, subapical and fringe setae. Hypopygial setae absent. Anal ring with 8 hairs.

NOTES

Species belonging to *Saissetia* are polyphagous. The eggs are protected by the body of the old female until they hatch. Mr. G. De Lotto, Plant Protection Research Institute, Pretoria, South Africa, is presently working on a revision of this genus.

In Virginia representatives of this genus do not overwinter outdoors, and are recorded mostly from greenhouses and homes. They are thus not treated individually in this study as those naturally occurring in the state.

Species reported in Virginia include: *S. coffeae* (Walker) (photos 37, 38) *S. miranda* (Cockerell & Parrott), (photo 39) and *S.*

oleae (Olivier), (photo 40.) All slides examined from Virginia which were previously identified as *S. oleae* were found to be *S. miranda* by the authors.

KEY TO THE SPECIES OF *SAISSETIA* IN VIRGINIA

1. Many tubular ducts in ventral submarginal band with inner filaments as wide or wider than ducts themselves; antennal segment 3 with 2 setae ----- *coffaeae*
 All tubular ducts in ventral submarginal band with slender inner filaments, these not as wide as the ducts; antennal segment 3 without setae ----- 2
2. With 40 to 60 marginal setae around head; many small marginal setae present; dorsal body setae coniform; tibio-tarsal sclerosis present ----- *miranda*
 With 14 to 30 marginal setae around head; few small marginal setae present; dorsal body setae spiniform; tibio-tarsal sclerosis usually absent ----- *oleae*

Genus *TOUMEYELLA* Cockerell, 1895

TYPE SPECIES

Lecanium mirabile Cockerell, 1895.

DESCRIPTION

Body of adult female convex to globular and often irregular in outline, naked or with a thin glassy test. Derm heavily sclerotized at maturity. Antennae and legs greatly reduced. Antennae 6-segmented although segmentation obscure. Legs without tibio-tarsal sclerotization. Marginal setae slender or stout, pointed or blunt but never frayed. Spiracular setae absent (*T. parvicornis*) or in 3's, variable in shape. Submarginal tubercles absent. Dorsal pores variable, all species with large discoidal pores near anal plates on dorsum. Quinquelocular pores in spiracular furrows and also in anal and abdominal region. Multilocular pores found in two species, *T. cerifera* and *T. mirabilis* where they are found in the abdominal region and mixed with quinquelocular pores in the spiracular furrow. Tubular ducts confined to the anal area except for *T. cerifera* and *T. mirabilis* where they may be found elsewhere on the abdomen. Anal plates with varying number of apical, subapical and fringe setae. Hypopygial setae present. Anal ring with 10 hairs.

NOTES

Some members of this genus are polyphagous, but most feed only on members of the genus *Pinus*. The eggs and young are protected by the sclerotized body of the adult female. Steinweden (1929) believed that *Neolecanium*, *Pseudophilippia* and *Toumeyella* all constituted a single genus. We consider these as separate, valid genera, and M. L. Williams is presently undertaking a revision of the genus *Toumeyella*.

Species reported in Virginia include: *T. cerifera*, *T. liriodendri*, *T. numismaticum* (which is synonymized in this study), *T. parvicornis*, *T. pini*, and *T. virginiana* which is described here as a new species.

KEY TO THE SPECIES OF *TOUMEYELLA* IN VIRGINIA

- 1. Spiracular setae, if present, not differing from marginal setae; pore plates present ----- *parvicornis*, p. 171
Spiracular setae differing from marginal setae; pore plates absent -----2
- 2. Multilocular pores in abdominal region predominately 10-locular; tubular ducts scattered throughout venter of abdomen ----- *cerifera*, p. 160
Multilocular pores in abdominal region 5-locular; tubular ducts, if present, confined to anal area of venter -----3
- 3. Dorsal discoidal pores anterior to anal plates strongly conical; median spiracular setae usually twice as long as others ----- *pini*, p. 177
Dorsal discoidal pores anterior to anal plates flat or only slightly convex; all 3 spiracular setae usually subequal in length -----4
- 4. Anal plates with 4 apical setae; spiracular setae short and stout, median spiracular setae about twice as long as wide ----- *liriodendri*, p. 164
Anal plates with 15 to 25 apical setae; spiracular setae slender, median spiracular setae 2½ to 4 times as long as wide ----- *virginiana*, p. 182

Toumeyella cerifera Ferris, 1921

*** Buttonbush Scale**

Plate 23, Photo 41

Toumeyella cerifera Ferris, 1921:90.

MATERIAL STUDIED

Albizzia occidentalis, 1, (2), Agua Caliente, Mexico, Aug. 1919, G. F. Ferris. *Cephalanthus occidentalis*, 2, (2), Arlington Farms, Aug. 13, 1902, J. B. Norton; 26, (42), Wakefield, Aug. 16, 1969, MLW.

GENERAL APPEARANCE

Adult females strongly convex, especially during the oviposition period. They are reddish-brown (10R 5/8) mottled, with black markings.

DESCRIPTION

Body (fig. A) often irregular in outline, 3841(3028-4872) long, 3426(2362-4180) wide. Derm not heavily sclerotized except for area around anal plates. Dorsal derm with numerous bilocular and disc type pores. Ventral derm with 5- to 10-locular pores in spiracular furrows and on abdomen. Legs and antennae greatly reduced. Anal cleft about 1/7 the body length.

DORSAL SURFACE AND MARGIN

Setae: Marginal setae (fig. B), sparse, about 16 around head, 17.2(11.7-23.5) long, slender, pointed, with a large base. Body setae (fig. C), scattered, 8.98(7.82-11.7) long, slender, straight, pointed, base not as large as in marginal setae.

Spiracular setae (fig. D): Normally 3 in each spiracular furrow, occasionally a fourth is found, all stout, subequal in length, sometimes irregular in shape. Median seta 33.6(27.4-43.0) long, 15.6(11.7-19.6) wide, sometimes forked or notched; lateral setae 31.3(19.6-39.0) long, 14.4(11.7-19.6) wide.

Submarginal tubercles: Absent.

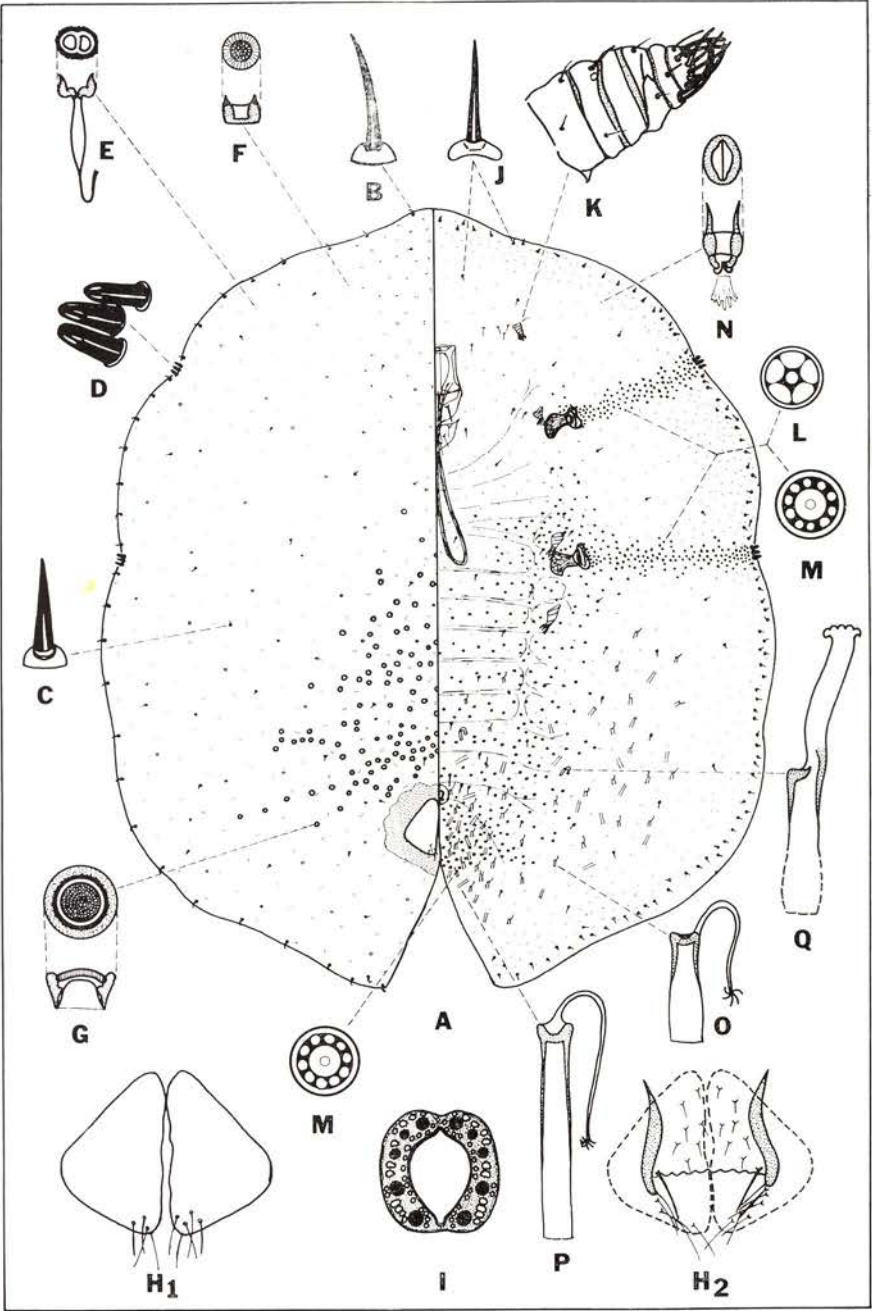


Plate 23. - *Toumeyella cerifera* Ferris

Pores: Bilocular pores with a slender inner filament (fig. E) about 3.90 in diameter, numerous, scattered over derm. Thick-rimmed disc pores (fig. F) about 3.41 in diameter, mixed with bilocular pores throughout dorsum. Large discoidal pores (fig. G), slightly convex, 9.76(7.82-11.7) in diameter, anterior and laterad of anal plates.

Anal plates (fig. H₁, H₂): Triangular, 221(215-235) long, 126(109-137) wide, outer angles somewhat rounded; cephalolateral margin longer than caudolateral margin. Cephalolateral margin 162(152-184) long; caudolateral margin 151(117-164) long. Each plate with 4 or 5 apical and 5 to 7 subapical setae. Anal fold with 1 pair of large fringe setae and 12 to 14 hypopygial setae.

Anal ring (fig. I): Ovate, about 97.8 long, 80.7 wide, with 10 hairs and 2 irregular rows of wax pores, the outer row larger and more irregular than the inner row.

VENTRAL SURFACE

Setae: Ventral submarginal setae (fig. J) 13.3(11.1-15.6) long, straight, tapering, acute, with a large base, arranged in an irregular row. Body setae similar to ventral submarginal setae, but not quite as stout, 12.1(11.7-15.6) long, scattered over venter. Prevalvar setae not differing from body setae.

Eyes: Not detected in specimens studied.

Antennae (fig. K): Greatly reduced, 6-segmented, 82.1(74.3-86.0) long. Scape 22.5(15.6-31.3) long, 44.1(27.4-62.6) wide. Length of segments II to VI: 12.4(7.82-15.6), 16.3(9.77-19.6), 9.98(7.82-11.7), 9.37(7.82-11.7), 14.0(11.7-15.6) long respectively. Terminal segment with 1 hairlike, 6 fleshy and 2 conical setae. Setae on other segments: I,2; II,2; III,0; IV,2; V,1 and 1 long fleshy seta which usually curves back over apex of terminal segment.

Legs: Greatly reduced, 5-segmented. Tibio-tarsal sclerotization and articulation absent. Claws without a denticle. Tarsus and claw each with a pair of knobbed digitules; claw digitules unequal, 1 stout, 1 slender, both 20.0(15.6-23.5) long; tarsal digitules subequal, slender, 27.4(23.5-35.2) long.

Part of leg	Lengths prothoracic	Lengths mesothoracic	Lengths metathoracic
Coxa	23.5(23.5)	—————	23.5(23.5)
Trochanter	39.1(39.1)	11.7(11.7)	15.6(15.6)
Femur	30.0(23.5-39.1)	23.5(19.6-39.1)	23.5(19.6-31.3)
Tibia	20.2(15.6-23.5)	18.8(11.7-23.5)	21.3(19.6-23.5)
Tarsus	12.8(7.82-15.6)	15.6(15.6)	14.1(11.7-15.6)
Claw	11.7(11.7)	12.9(11.7-15.6)	13.4(11.7-15.6)
Entire leg	About 121	About 108	About 125

Spiracles: Larger than legs, apodeme usually constricted on both sides, atrium as wide or wider than apodemal base. Spiracular pore bands 8 pores wide in places. Anterior spiracles 149(137-156) long, atrium 85.9(46.9-97.7) wide; posterior pair 184(172-207) long, atrium 114 (97.8-149) wide.

Pores: Quinquelocular pores (fig. L) and multilocular pores (fig. M), both 8.02(7.82-9.77) in diameter, are found in spiracular furrows and scattered on abdomen and thorax. The majority of the pores are 10-loculed. The presence of 10-locular pores on the abdomen is a distinctive specific character for *T. cerifera*.

Ducts: Microducts (fig. N), about 4.39 long and opening through oval orifices about 3.42 in diameter, scattered over entire derm, but more numerous in submarginal areas. Three types of tubular ducts are found on the venter: the first type (fig. O) 13.9(11.7-15.6) long, 3.91 (3.91) wide with slender filaments 19.0(15.6-27.4) long and the second type (fig. P) 20.8(15.6-23.5) long, 3.91(3.91) wide, with slender filaments 22.7(11.7-39.1) long, are numerous and are found scattered over the abdomen; the third type (fig. Q) 17.3 (11.7-19.6) long, 4.02(3.91-4.33) wide, with broad flowery tipped filaments 20.4(14.8-23.5) long, 3.32(1.95-3.91) wide, only occasionally found on abdomen, never more than 2 or 3 detected on specimens studied; sometimes entirely absent.

OTHER STAGES

First instar nymphs reddish-brown (2.5Y 5/8), well-developed 5-segmented antennae and legs; spiracular setae in 3's, median seta 1½ or 2 times longer than laterals, all rather stout and often irregularly shaped; about 34 marginal setae around body, these slender, pointed and curved; eyes present; 3 or 4 quinquelocular pores in each spiracu-

lar furrow; anal ring with 6 hairs. Second instar female with reduced legs and antennae; second instar male similar, but with tubular ducts around margin.

BIOLOGICAL NOTES

T. cerifera gives birth to living young, usually in August or September. It is a bisexual species. The insect seems to prefer the cracks and crevices of its host. Often, protective coverings are constructed over the developing coccids by ants of the genus *Crematogaster*. Many of the insects for this study were collected from plants which were in 6 to 8 inches of water at the edge of a pond.

PARASITES AND PREDATORS

Parasites were not reared from any specimens collected, although parasite emergence holes were noted in several dead females.

HOSTS AND DISTRIBUTION IN VIRGINIA

Same as material studied.

ADDITIONAL HOSTS AND DISTRIBUTION IN U.S.A.

Cephalanthus occidentalis, Florida, Louisiana, and North Carolina.

NOTES

This is the first U.S. record of *T. cerifera*. One specimen had previously been misidentified as *T. parvicornis*. Ferris first described it from Mexico in 1921. His collection was made from *Albizia occidentalis*. Ferris (1921) stated that the specimens he observed secreted a distinct ovisac, but in spite of the development of the ovisac, it was a *Toumeyella*. Material collected from *C. occidentalis* in Virginia was compared with paratype material at the USNM. The Virginia material did not produce an ovisac, had fewer ducts than the paratype specimens and there was a slight difference in the shape of the spiracular setae, but it seemed to agree in the remaining characters. Perhaps these differences are host-induced. It is very likely that this species occurs over much of the southern States.

***Toumeyella liriodendri* (Gmelin), 1789**

Tuliptree Scale

Plate 24, Photos 42, 43

Coccus liriodendri, Gmelin, 1789:2220. *Lecanium tulipiferae*, Cook, 1878:192. *Lecanium liriodendri*, Cockerell, 1899b:271. *Eu-*

lecanium tulipiferae, King, 1902a:59. *Eulecanium* (?) *liriodendri*, Fernald, 1903:190. *Lecanium* (*Toumeyella*) *liriodendri*, Pettit and McDaniel, 1920:10. *Toumeyella liriodendri*, Sanders, 1909:447; Dietz and Morrison, 1916:249; Wilson, 1917:38; Houser, 1918:301; Hollinger, 1923:63; Merrill and Chaffin, 1923:273; Trimble, 1925:6; McDaniel, 1930:9; Herrick, 1935:293; Doane, Van Dyke, Chamberlin, and Burke, 1936:380; Brimley, 1938:109; Slesman, 1945:44; Armitage, 1947:209; Craighead, 1950:144; Krombein, 1951:141; Beal, 1952:100; Merrill, 1953:109; Burns 1964:137, 1970:1; Donley and Burns, 1965:1; Burns and Donley, 1970:228.

MATERIAL STUDIED

On *Liriodendron tulipifera*, 20, (25), Broad Run, Waterhole #10, Craig Co., MLW; 1, (8), April 25, 1968; 1, (4), May 7, 1968; 1, (9), July 12, 1968; 1, (4), July 22, 1969; 2, (2), Hampton, let., July 10, 1916, P. Kinghorn; 1, Falls Church, Sept. 6, 1931, E. A. Chapin; 1, (3), Charlottesville, let., Sept. 23, 1937, C. L. Morris; 1, Alexandria, Aug. 22, 1944, E. A. Back; 1, Heards, June 12, 1945, DWC; 1, Charlottesville, July 18, 1946, DWC; 1, (6), Clarke Co., April 22, 1964, J. Gerhan; 1, (2), Craig Co., July 5, 1967, MLW; 2, (12), Blacksburg, Sept. 16, 1968, MLW; 6, (15), Montgomery Co., April 26, 1969, MLW; 1, (2), Danville, May 12, 1969, RCB. *Magnolia acuminata*, 1, (4), Cumberland Co., May 10, 1957, J. L. Jones; 1, (3), Amherst Co., Aug. 15, 1963, MK and D. Vest; 2, (2), Newport, May 19, 1968, MLW. *M. "nigra,"* 2, (4), Eggleston, May 9, 1967, G. B. Straley. *M. soulangeana* var. *alexandrina*, 5, (5), Falls Church, Sept. 10, 1968, JAW. *M. stellata*, 3, (3), Richmond, Sept., 1968, JAW. *M. virginiana*, 3, (3), Sussex Co., July 2, 1968, E. B. Parsons. *Magnolia* sp., 1, (2), Roanoke, Oct. 6, 1958, County Agent; 1, (4), Spotsylvania, June 16, 1959, R. W. Cash; 2, (2), Richmond, July 27, 1961, FRF; 4, (5), Cumberland Co., Sept. 6, 1966, E. L. Seay; 4, (8), Warsaw, Aug. 24, 1967, M. Coggin; 2, (4), Portsmouth, June 9, 1969, Jenkins and Whitehead; 8, (8), Portsmouth, June 9, 1969, JAW; 6, (6), Chesterfield, June 12, 1969, G. Hackett. *Populus* sp., 1, (3), Grafton, July 23, 1965, Tate and Deaton. "Japanese magnolia," 1, Norfolk, let., Sept. 28, 1911, H. N. Castle; 1, (4), Arlington, let., June 10, 1939, J. Mason. "Poplar," 1, (3), Barhamsville, let., July 23, 1918, Mrs. J. T. Crute. "Red magnolia," 1, (4), Fairfax Co., no date, Mrs. J. Ely. "Tree," 1, Delaplane, let., July 18, 1938, Mrs. B. Beverley. Unknown host, 1, Bon Air, let., Sept. 5, 1911, M. R. Talcott.

GENERAL APPEARANCE

Body extremely convex, oval, often irregular in outline due to crowding on stems. Color of adult female varies from a grayish-green to a pink-orange, mottled with black. The body fluid of live females is a pink-orange color. Large numbers of these coccids give an infested tree a warty appearance. The body is usually void of a noticeable wax secretion.

DESCRIPTION

Body usually subcircular (fig. A) 4240(2880-6332) long, 3662(2555-5879) wide, derm not heavily sclerotized except for an area around anal plates. Dorsal derm with many small bilobed pores and numerous discoidal pores. Legs and 6-segmented antennae reduced. Spiracular setae in 3's, short, conical, usually subequal. Anal plates together usually forming a bell shape. Quinquelocular pores in spiracular furrows and scattered over abdomen. Tubular ducts confined to anal area. Anal cleft about $1/6$ the body length.

DORSAL SURFACE AND MARGIN

Setae: Marginal setae (fig. B) numerous, 35 to 45 around head between anterior spiracular setae, 22.9(15.6-27.4) long, rather stout, tapered, pointed, with a well-formed socket. Body setae numerous, similar to marginal setae, 16.4(15.6-19.6) long, scattered randomly over body.

Spiracular setae (fig. C): 3 in each spiracular furrow, short, stout, conical with blunt tips, usually equal in size, occasionally median seta longest; median seta 41.5(23.5-54.7) long, 17.6(15.6-19.6) wide; lateral setae 33.2(27.4-39.1) long, 17.8(15.6-19.6) wide.

Submarginal tubercles: Absent.

Pores: Small bilocular pores (fig. D) 4.15(3.42-4.88) in diameter, very numerous, scattered over entire dorsum, located about equidistant from each other. Monolocular ring pores (fig. E) 2.93(2.93) in diameter, randomly mixed with bilocular pores, but not nearly as numerous. Large discoidal pores (fig. F) 11.9(7.82-15.6) in diameter, scattered over dorsum in median area anterior to anal plates, extending to rostrum and fanning out into submedian areas.

Anal plates (fig. G₁, G₂): Together forming a bell shape, length 252(227-297), width 141(109-168); cephalolateral margin concave, 191(168-207) long; caudolateral margin convex, 179(176-211) long;

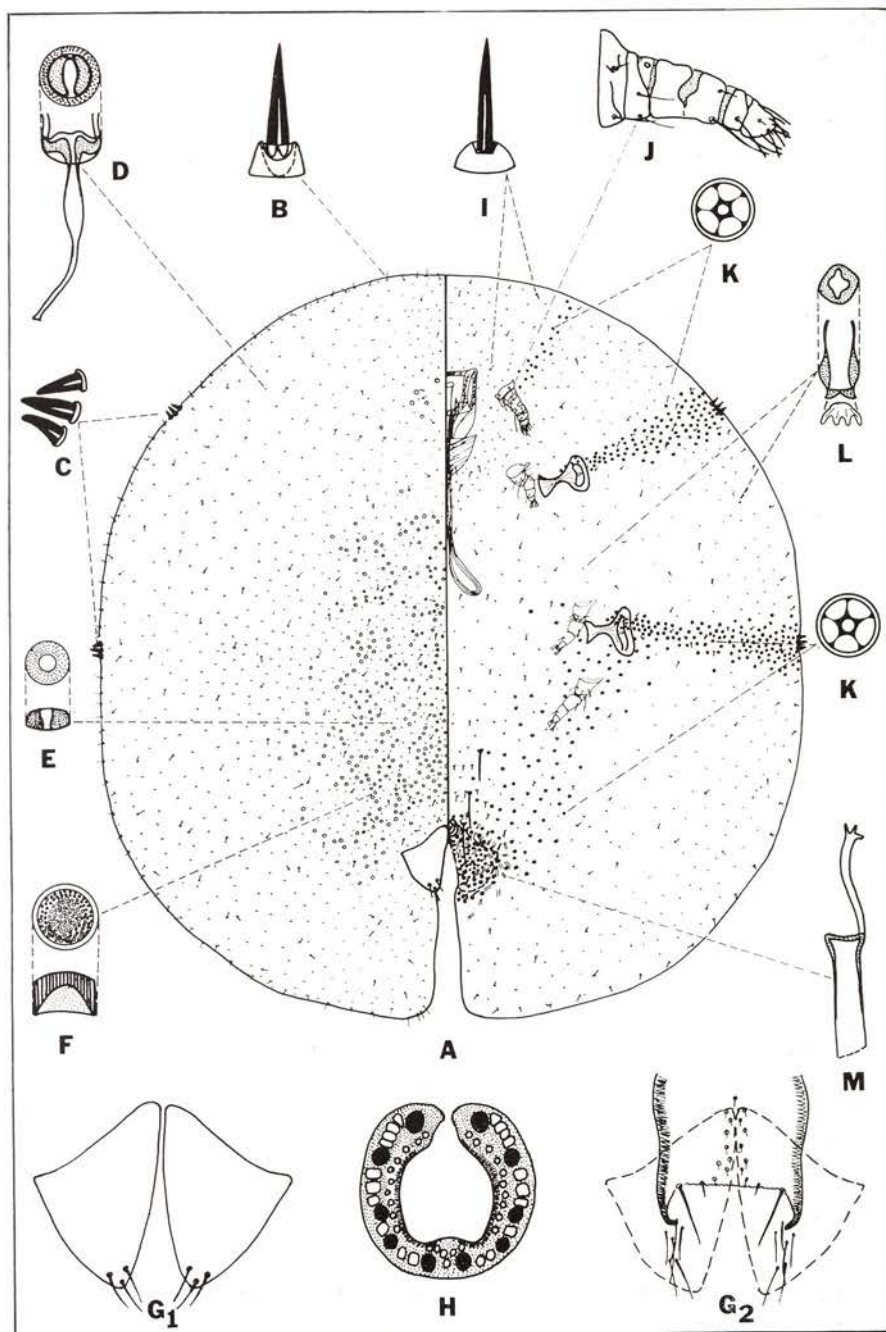


Plate 24. - *Toumeyella liriodendri* (Gmelin)

lateral angles pointed, other angles usually rounded. Each plate with 3 apical and 5 to 7 subapical setae. Anal fold with 2 pair of fringe setae, outer pair largest. Ten to 16 hypopygial setae.

Anal ring (fig. H): Subcircular, about 78.2 long, 82.1(74.3-89.9) wide, with 10 hairs and 2 rows of translucent wax pores, the outer row of pores larger and more irregular in outline.

VENTRAL SURFACE

Setae: Ventral submarginal setae (fig. I) 15.6(13.7-17.6) long, more slender and not as tapered as marginal setae, 16 to 20 around head. Body setae similar, 15.2(11.7-19.6) long, numerous over entire venter; 3 pair of prevulvar setae.

Eyes: Not detected in specimens studied.

Antennae (fig. J): Reduced, 6-segmented although often segmentation indistinct, 178(164-196) long. Scape 36.2(31.3-50.8) long, 84.4(70.4-93.8) wide. Length of segments II to VI: 33.0(27.4-39.1), 30.1(19.6-39.1), 32.5(23.5-43.0), 18.4(15.6-23.5), 28.2(23.5-31.3) long respectively. Terminal segment with 2 hairlike and 8 fleshy setae. Setae on other segments: I,2; II,2; III,0; IV,2; V,1 fleshy.

Legs: Reduced, 5-segmented although in most specimens segmentation is obscure. Tibio-tarsal sclerotization and articulation absent; claws with a slight denticle. Tarsus and claw each with a pair of knobbed digitules; claw digitules 28.6(23.5-31.3) long, slender, tarsal digitules 33.2(31.3-35.2) long, also slender.

Part of leg	Lengths prothoracic	Lengths mesothoracic	Lengths metathoracic
Coxa	—————	79.5(74.3-86.0)	62.0(46.9-74.3)
Trochanter	39.1(23.5-62.6)	32.9(23.5-39.1)	30.0(23.5-39.1)
Femur	58.7(46.9-66.5)	57.5(46.9-70.4)	56.3(46.9-70.4)
Tibia	40.4(23.5-54.7)	49.7(39.1-58.7)	52.4(46.9-62.6)
Tarsus	27.4(19.6-35.2)	36.4(23.5-46.9)	39.9(35.2-43.0)
Claw	18.3(15.6-23.5)	18.0(15.6-19.6)	17.2(15.6-19.6)
Entire leg	About 245	270(243-297)	257(219-297)

Spiracles: Rather large; equal to, or larger than, legs; apodeme constricted on both sides, atrium usually wider than apodemal base. Spiracular pore bands 5 to 8 pores wide. Anterior spiracles 229

(196-266) long, atrium 175(133-207) wide; posterior pair 253(188-301) long, atrium 216(180-254) wide.

Pores: Quinquelocular pores (fig. K) 7.63(5.87-7.82) in diameter, very numerous in spiracular furrows and in anal area, scattered over abdomen, and in some specimens, particularly those collected on *Magnolia*, a row of about 20 pores found extending from antennal scape to margin of body.

Ducts: Microducts (fig. L) about 3.90 long, opening to the ventral surface through square shaped orifices about 2.93 in diameter, numerous, scattered over entire venter and usually most numerous in a submarginal band around body, near spiracles and mouthparts. Tubular ducts (fig. M) 14.4(11.7-15.6) long, 4.30(3.91-5.87) wide, with slender filaments 23.1(11.7-31.3) long, numerous in anal area. In older specimens these ducts are not as apparent, but some are always detected.

OTHER STAGES

First instar nymphs have 5-segmented antennae, well-developed legs; spiracular setae in 3's, median seta 3 times longer than laterals, median seta bluntly pointed, lateral setae with rounded apex; about 32 marginal setae around entire body, these subequal in size to median spiracular seta, pointed and curved near apex; anal lobe setae small; 3 quinquelocular pores in each spiracular furrow; eyes present; 6 anal ring hairs. First and second instar nymphs are a dark slate or blue-gray color. Third instar nymphs with reduced antennae and legs; body more rounded; median spiracular seta less than twice the length of lateral setae; about 38 to 45 marginal setae, less curved and arranged in an irregular double row; about 12 quinquelocular pores in each spiracular furrow; eyes not detected; 6 or 8 anal ring hairs.

BIOLOGICAL NOTES

The tuliptree scale has one generation per year, except in the southernmost parts of its range. It gives birth to living young usually in August or September. It is a very prolific species, with one female sometimes producing over 3,000 young during her lifetime (Burns and Donley, 1970). The nymphs migrate to a suitable host and settle to feed and develop. They overwinter in the second instar stage. In early spring the coccids continue to feed and produce honeydew. The males begin pupation in late May and emerge in mid-June to mate with the partially grown females (Burns

and Donley, 1970). The females, after mating, continue to grow into large, extremely convex and noticeable insects, often giving infested trees a warty appearance.

PARASITES AND PREDATORS

In spite of the occurrence of various biological control agents, the tuliptree scale still is able to produce large populations. This is probably due to the suppression of biotic agents by the ants that collect honeydew produced by the coccids. Peck (1963) lists the following Hymenopterous parasites: *Aphycus flavus*, *Coccophagus flavifrons*, *C. lycimnia* and *Paraolinx* (= *Leucodesmia*) *typica*. In addition to these, Burns and Donley (1970) found *Baccha costata* parasitizing early instars and *Anicetus toumeyellae* emerging from male pupal cases in May. Predators include the larva of the moth *Laelitia coccidivora* and the larvae and adults of *Hyperaspis signata binotata* and *Chilocorus bivulnerus* (Donley and Burns, 1965).

ADDITIONAL HOSTS AND DISTRIBUTION IN VIRGINIA

On *Liriodendron tulipifera*, Arlington Co., Rosslyn; Fairfax Co., Dunn Loring; Loudon Co., Leesburg; Spotsylvania Co., Spotsylvania; Surry Co.; Alexandria; Portsmouth; Richmond (Brook Hill); Williamsburg. *Magnolia acuminata*, Amherst Co. *Magnolia* sp., Giles Co., Eggleston; Blacksburg. "Japanese magnolia," Fauquier Co., Warrenton; Prince William Co., Occoquan.

ADDITIONAL HOSTS AND DISTRIBUTION IN U.S.A.

According to Burns and Donley (1970), the tuliptree scale is probably native to the yellow-poplar area of North America ranging from New York and Connecticut to Florida and west through the Mississippi River Valley. It has also been recorded in California from shade tree and ornamental plantings of yellow poplar and magnolia (Armitage, 1947). Additional hosts include: *Michelia fuscata* (Wilson, 1917); *Cephalanthus* sp. (?), *Gardenia jasminoides*, *Gordonia lasianthus* and *Juglans* sp. (Merrill and Chaffin, 1923); *Tilia* sp. (Hollinger, 1923; Herrick, 1935); *Magnolia grandiflora* and *M. kobus* (Sleesman, 1945); *Magnolia lennei*, *M. sinensis*, (Merrill, 1953).

ECONOMIC IMPORTANCE

The most severe economic damage incurred by the tuliptree scale is the suppression and killing of pioneer yellow poplars that have

invaded abandoned fields and pastures (Burns and Donley, 1970). As few as 32 females have been known to kill 3-year-old saplings (Donley and Burns, 1965). The yellow poplar is also much used in shade tree and ornamental plantings. Under these conditions the tulip tree scale can be of economic concern in several ways. Often, because of their reproductive capacity, the population may become so large as to crowd together on the twigs in such numbers to give the tree a warty appearance. Large amounts of honeydew are also produced from such colonies, and this supports the production of sooty mold and attracts many noxious insects. Krombein (1951) listed 93 species of Hymenoptera that collected honeydew from tulip tree scale infesting about 12 tulip trees near Dunn Loring, Va. in 1949. Burns (1964) listed 10 species of ants tending the scale for honeydew. Merrill and Chaffin (1923) reported the tulip tree scale as occasionally becoming a serious pest on *Miche- lia fuscata* and magnolia.

NOTES

It is doubtful that *T. liriodendri* occurs on *Cephalanthus* sp. Most likely, this is a misidentification of *T. cerifera*.

Toumeyella parvicornis (Cockerell), 1897

Pine Tortoise Scale

Plate 25, Photos 44, 45

Lecanium parvicorne, Cockerell, 1897b:90. *Toumeyella parvicornis*, Cockerell, 1902:452; Fernald, 1903:179; Merrill and Chaffin, 1923:274; Merrill, 1953:110; Wray, 1967:34. *Lecanium (Toumeyella) numismaticum*, Pettit and McDaniel, **syn. nov.**, 1920:8. *L. numismaticum*, Gates, 1930:544. *Toumeyella numismaticum*, Orr, 1931:31; Craighead, 1950:144; MacAloney 1961:1; Wallner, 1969:29.

MATERIAL STUDIED

Pinus echinata, 1, (2), Wise, May, 1960, collector unknown. *P. mugo*, 2, (28), Hayward, Wisc., May 27, 1955, R. D. Shenefelt. *P. palustris*, 2, (15), Alachua Co., Fla., March 15, 1954, G. Merrill; 3, (4), Richmond, May 4, 1960, Mr. Propst; 2, (7), May 5, 1966, R. D. Jennings. *P. sylvestris*, 6, (7), Arlington, May 5, 1969, G. T. Kellog. *P. taeda*, 1, (2), Henrico Co., March 29, 1939, unknown;

1, (5), Orange Co., N. C., July 13, 1961, D. L. Wray; 1, (5), New Kent, Aug. 28, 1961, C. L. Morris; 1, (3), Seashore State Park, March 23, 1969, MLW. *P. virginiana*, 1, (4), Rosslyn, April 9, 1905, J. G. Sanders; 1, (3), Purcellville, Jan. 6, 1957, E. J. Hambleton; 2, (4), Pulaski Co., March, 1967, V. Trivett; 1, (2), Blacksburg, May 1, 1969, MLW; 7, (9), Maggie, Aug. 29, 1970, MLW. *Pinus* sp., 1, (2), Falls Church, March 10, 1927, W. Davidson; 2, (8), Charlottesville, May 6, 1946, DWC; 1, (5), Roanoke, April 19, 1951, A. Bronley; 5, (5), Virginia Beach, Oct. 20, 1967, MLW; 1, (2), Montgomery Co., Aug. 9, 1967, MLW.

GENERAL APPEARANCE

Mature females are oval to elongate and convex, reddish brown (10R 4/6) with black or dark-brown stripes or reddish brown mottled with dark spots.

Females with eggs and newly hatched nymphs may be overlapping each other on the twig. MacAloney (1961) describes the eggs as ellipsoidal, pinkish, almost transparent, and about 1/64 inch long.

DESCRIPTION

Body (fig. A) ovate to elongate, 3455(2171-4357) long, 3170(1950-3914) wide; derm not heavily sclerotized except in area around anal plates. Aggregations of bilocular pores scattered over dorsal derm. Spiracular setae absent or not differing from marginal setae. Legs and 6-segmented antennae greatly reduced. Tubular ducts confined to anal area. Anal plates usually with 10 to 12 dorsal setae. Anal cleft about 1/7 body length.

DORSAL SURFACE AND MARGIN

Setae: Marginal setae (fig. B), in an irregular row around body, hard to distinguish from ventral submarginal setae, about 36 around head, 17.8(15.6-19.6) long, straight, tapering, acute. Body setae (fig. C), scattered over dorsum, 11.5(9.78-15.6) long, similar to marginal setae but not as long or tapered as much.

Spiracular setae: Absent or not differing in form from marginal setae. This is a very distinctive feature of the species.

Submarginal tubercles: Absent.

Pores: Invaginated bilocular pores (fig. D) 4.69(3.91-5.87) in diameter, occurring singly or aggregated into groups or pore plates, larger groups sometimes containing 20 or more pores, scattered over dorsum. Thick rimmed disc pores (fig. E) about 2.93 in diameter, numerous, scattered over derm. Large discoidal pores (fig. F) 8.40(7.82-11.7) in diameter, slightly convex, scattered in median area anterior to anal plates.

Anal plates (fig. G₁, G₂): Triangular, 182(113-207) long, 105(93.8-121) wide, lateral angles rounded, apices bluntly pointed; cephalolateral margin 138(121-164) long, usually straight; caudolateral margin 139(121-149) long, slightly convex. Each plate with 8 to 12 dorsal setae, the usual being 10, and 6 subapical setae. Anal fold has 1 pair of fringe setae. Seven to 10 hypopygial setae.

Anal ring (fig. H): Subcircular, about 74.5 long, 73.3 wide, with 10 hairs and 2 irregular rows of translucent pores.

VENTRAL SURFACE

Setae: Ventral submarginal setae (fig. I) 11.1(7.82-11.7) long, very similar to marginal setae, almost impossible to separate except in old female specimens where they appear more slender; body setae (fig. J) 14.2(9.78-19.6) long, slender, curved, acute, numerous over entire venter. Numerous prevulvar setae, but none extremely larger than body setae.

Eyes: None detected in specimens studied.

Antennae (fig. K): Greatly reduced, 6-segmented although segmentation very indistinct, 100(66.5-125) long. Scape 24.2(19.6-31.3) long, 52.1(43.0-58.7) wide. Length of segments II to VI: 15.2(7.82-19.6), 20.9(15.6-27.4), 17.4(11.7-23.5), 9.98(7.82-15.6), 14.2(7.82-19.6) long respectively. Terminal segment with 1 hair-like, 6 fleshy and 3 spikelike setae. Setae on other segments: I,2; II,2; III,0; IV,2; V,1 and 1 fleshy seta.

Legs: Greatly reduced, without tibio-tarsal sclerotization or free articulation. Claws without denticles. Tarsus and claw each with a pair of knobbed digitules; claw digitules 14.5(11.7-19.6) long, slender, one slightly broader than the other; tarsal digitules subequal, 21.5(15.6-23.5) long, slender, extending past claws.

Part of leg	Lengths prothoracic	Lengths mesothoracic	Lengths metathoracic
Coxa	23.5(23.5)	27.4(19.6-35.2)	20.6(19.6-23.5)
Trochanter	26.8(19.6-35.2)	25.2(19.6-31.3)	24.5(19.6-31.3)
Femur	25.2(23.5-27.4)	22.7(15.6-27.4)	22.5(19.6-23.5)
Tibia	17.2(15.6-19.6)	18.4(15.6-19.6)	18.3(11.7-23.5)
Tarsus	9.38(7.82-11.7)	9.37(7.82-11.7)	9.28(7.82-11.7)
Claw	8.99(7.82-11.7)	9.96(7.82-11.7)	9.12(7.82-11.7)
Entire leg	108(104-115)	114(99.9-121)	104(97.8-110)

Spiracles: Equal to or larger than legs; apodeme constricted on both sides; atrium wider than apodemal base. Spiracular pore band about 7 pores wide, widely spaced in center, becoming more dense at each end. Anterior spiracles 115(82.1-141) long, atrium 71.7(50.8-86.0) wide; posterior pair 116(93.8-137) long, atrium 80.2(62.6-93.8) wide.

Pores: Quinquelocular pores (fig. L) 7.63(5.87-7.82) in diameter, in spiracular pore bands, near antennae, in anal area and extending in a band from anal area to posterior spiracle. From 65 to 130 pores in each spiracular pore band.

Ducts: Microducts (fig. M), about 4.94 in length which open through square shaped orifices about 3.71 in diameter, scattered over venter and often tend to congregate in groups of 3 or 4. Tubular ducts (fig. N) 11.1(7.82-15.6) long, 3.91(3.91) wide, with thick sclerotized rims and a slender filament 20.7(15.6-35.2) long, ducts confined to anal area, often obscured by anal plates.

OTHER STAGES

First instar nymphs are light reddish brown (7.5R 4/10), have well-developed, 5-segmented legs and antennae; 36 marginal setae around body; 2 setae in each spiracular furrow, which are usually slightly stouter than marginal setae; 10 groups of bilocular pore aggregations in submarginal area of each side of body; 6 anal ring hairs. Second instar nymphs similar except for reduced legs and antennae. Males are known to occur but have not been described.

BIOLOGICAL NOTES

Extracted from MacAloney (1961): There is one generation a year in the northern part of the range of this insect; in the southern

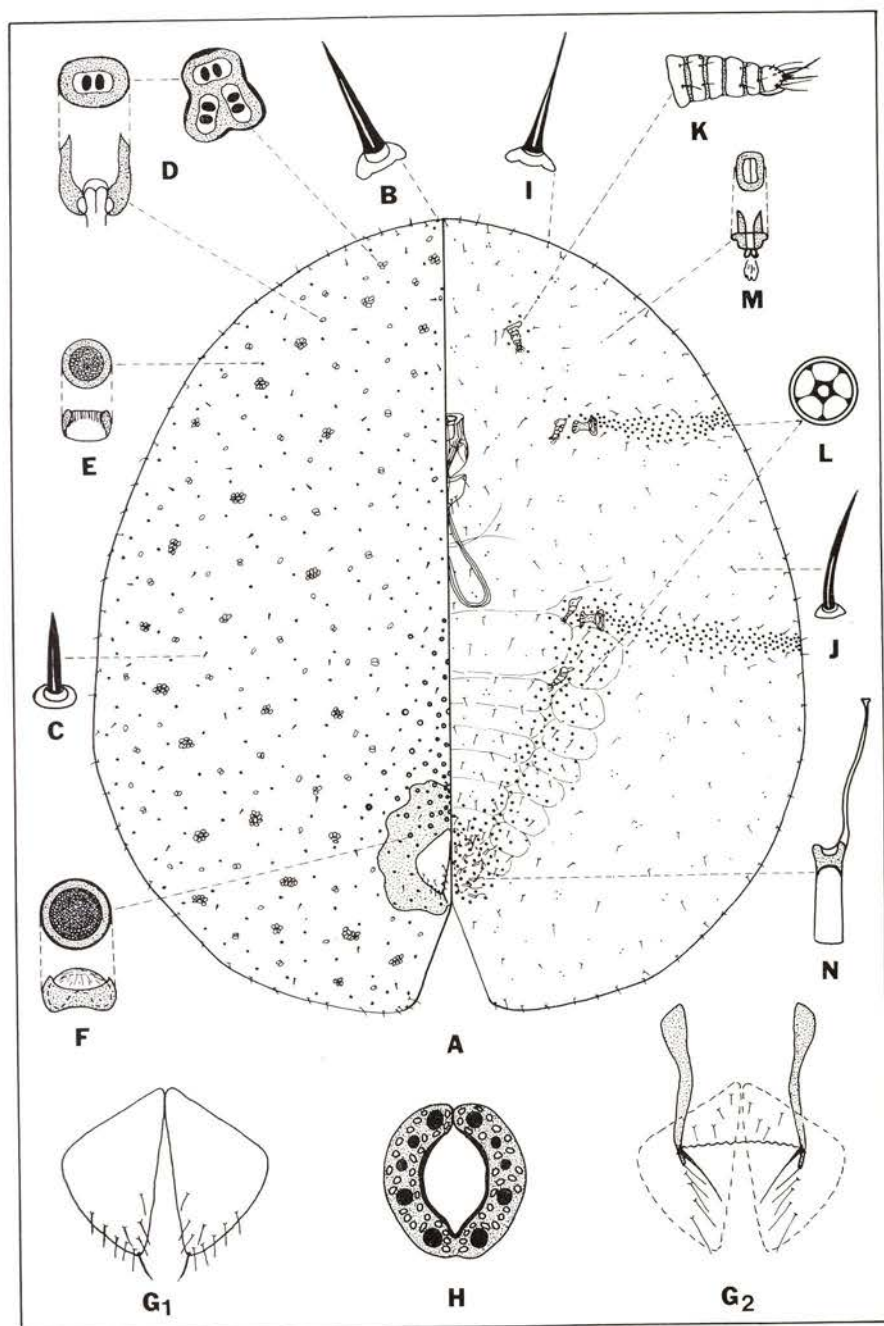


Plate 25. - *Toumeyella parvicornis* (Cockerell)

part there may be two generations. The overwintered, half-grown females resume activity in spring about the time buds begin to swell. These females are mature by early June in the north and somewhat earlier in the south, depending on bud development. Each female produces about 500 eggs; these develop under the mother's body. The nymphs appear from late June to early July. The nymphs begin to feed on the twigs almost as soon as they appear. A white powdery substance develops on the margins of the nymphs and in about 2 weeks sexual differentiation becomes apparent. In about 1 more week the males pupate. Following emergence, they fly immediately. They search out and fertilize the young females and die in a few days. These females are immobile; development continues until late in fall, when they go into hibernation.

PARASITES AND PREDATORS

The pine tortoise scale is often very effectively controlled by parasites and predators. Before chemical control is attempted, a check should be made to determine the abundance of natural enemies. Peck (1963) listed *Coccophagus immaculatus*, *C. quaestor* and *Microterys fuscicornis* as parasites of the scale. Orr (1931) listed the following coccinellids as predators of the pine tortoise scale: *Brachyacantha ursina*, *Chilocorus bivulnerus*, *Coccinella novemnotata*, *C. transversoguttata*, *Hyperaspis binotata*, and *Scymnus lacustris*. Other coccinellids known as predators of the scale insect are: *Coccinella trifasciata*, *Hyperaspis congressis*, and *H. signata* (MacAloney, 1961). MacAloney (1961) also reported that the larvae of the pyralid moth *Laetilia coccidivora* noticeably reduced scale populations.

ADDITIONAL HOSTS AND DISTRIBUTION IN VIRGINIA

Pinus strobus, Fairfax Co., Annandale. *P. taeda*, New Kent Co., New Kent; Seashore State Park. *Pinus* sp., Fairfax Co., Vienna; Newport News; Richmond Co., Warsaw; Virginia Beach; Washington Co., Bristol.

ADDITIONAL HOSTS AND DISTRIBUTION IN U.S.A.

The pine tortoise scale has been recorded from practically every state east of the Mississippi River, and as far north as Manitoba in Canada. MacAloney (1961) also reports its range to include North and South Dakota, Minnesota, Nebraska and Iowa. Additional hosts include *Pinus banksiana*, *P. mugo*, and *P. nigra*.

ECONOMIC IMPORTANCE

From MacAloney, 1961:

The pine tortoise scale periodically causes a noticeable amount of mortality of hard pines. Heaviest damage occurs on seedlings and young saplings, although pole stands are sometimes severely attacked. The injury causes noticeable branch mortality or death of the entire tree. In a heavy infestation a very large percentage of the trees may die in one or two seasons.

NOTES

The synonymy of *T. parvicornis* has long been questioned. Both *T. numismaticum* and *T. pini* have been confused and misidentified as *parvicornis*. *T. pini* is definitely a distinct species and can easily be separated from *parvicornis* by the presence of differentiated spiracular setae and by the absence of pore plates. We have compared hundreds of specimens labeled *T. numismaticum* with *T. parvicornis* "type material" from the USNM and concluded that *T. numismaticum* is a synonym of *T. parvicornis*. We were unable to locate type material of *numismaticum* for comparison, but specimens labeled *numismaticum* from the same area were utilized.

Toumeyella pini (King), 1901

* Striped Pine Scale

Plate 26, Photos 46, 47

Lecanium pini King, 1901f:334. *Lecanium corrugatum* Thro, 1903:216. *Toumeyella corrugatum*, Cockerell, 1903:19. *Lecanium* (*Toumeyella*) *corrugatum*, Pettit and McDaniel, 1920:6. *Toumeyella pini*, Cockerell, 1902:452; Fernald, 1903:179; Craighead, 1950:145; MacAloney, 1961:3.

MATERIAL STUDIED

Pinus echinata, 1, (2), Wise Co., Sept. 14, 1958, C. L. Morris. *P. mugo*, 1, (5), Richmond, let. Aug. 19, 1939, FRF; 2, (12) Waynesboro, May 29, 1941, FRF. *P. resinosa*, 2, (11), Slaterville Springs, N. Y., let. May 26, 1941, E. W. Sears; 2, (13), Tazewell, June. 1957, FRF. *P. rigida*, 1, (2), Karner, N. Y., April 21, 1899, J. Dearness. *P. sylvestris*, 1, Washington, D. C., Oct. 16, 1918, J. Kotinsky; 1, (3), Blacksburg, May, 1953, F. G. Keller. *P. virginiana*, 1, (3), Marysville, Pa., Dec. 15, 1927, F. M. Trimble; 7, (7), Blacksburg,

May 13, 1969, MLW. *Pinus* sp., 1, (14), Chain Bridge, and Washington, D. C., April 20, 1906, Pergande; 2, (9) Charlottesville, April 9, 1946, DWC.

GENERAL APPEARANCE

Body strongly convex, circular or irregular in outline. Color reddish brown, with a median dorsal stripe which is white or cream and small black pits scattered over dorsum, color 5YR 4/6.

DESCRIPTION

Body usually subcircular (fig. A) 4400(1743-7016) long, 4330(1593-6986) wide; legs and antennae greatly reduced; dorsal discoidal pores anterior to anal plates strongly conical; spiracular setae in 3's with median seta 2 or $2\frac{1}{2}$ times longer than laterals; anal plates each with 4 apical setae. Tubular ducts apparently absent. Anal cleft about $\frac{1}{5}$ of body length.

DORSAL SURFACE AND MARGIN

Setae: Marginal setae (fig. B) sparse, 10 to 12 around head, 21.9 (11.7-27.4) long, slender, curved, acute. Body setae numerous (fig. C) 16.6(11.7-19.6) long, slender, straight or slightly curved, acute and with a stout base.

Spiracular setae (fig. D): 3 in each spiracular furrow, median seta 2 to $2\frac{1}{2}$ times longer than lateral setae. Median seta 39.9(31.3-54.7) long, 11.7(11.7) wide, often widest near apex; lateral setae 21.8(15.6-27.4) long, 7.26(3.91-7.82) wide, tapering, rather straight, bluntly pointed.

Submarginal tubercles: Absent.

Pores: Bilocular pores (fig. E) 3.68(3.45-3.90) in diameter, numerous, scattered over entire dorsum; each pore having an elongate inner filament. Thick-rimmed disc pores (fig. F) about 2.93 in diameter, intermingled with bilocular pores but not as numerous and without a slender inner filament. Cone-shaped discoidal pores (fig. G) 11.9(9.76-15.6) in diameter scattered in area around anal plates and extending to about the midsection of the dorsum.

Anal plates (fig. H₁, H₂): Each triangular in shape, lateral rather acute; length 173(129-195), width 86.9(62.6-102); cephalolateral margin may be concave, 119(86.0-133) long, caudolateral margin convex, 126(97.8-145) long. Each plate with 4 apical and 4 sub-

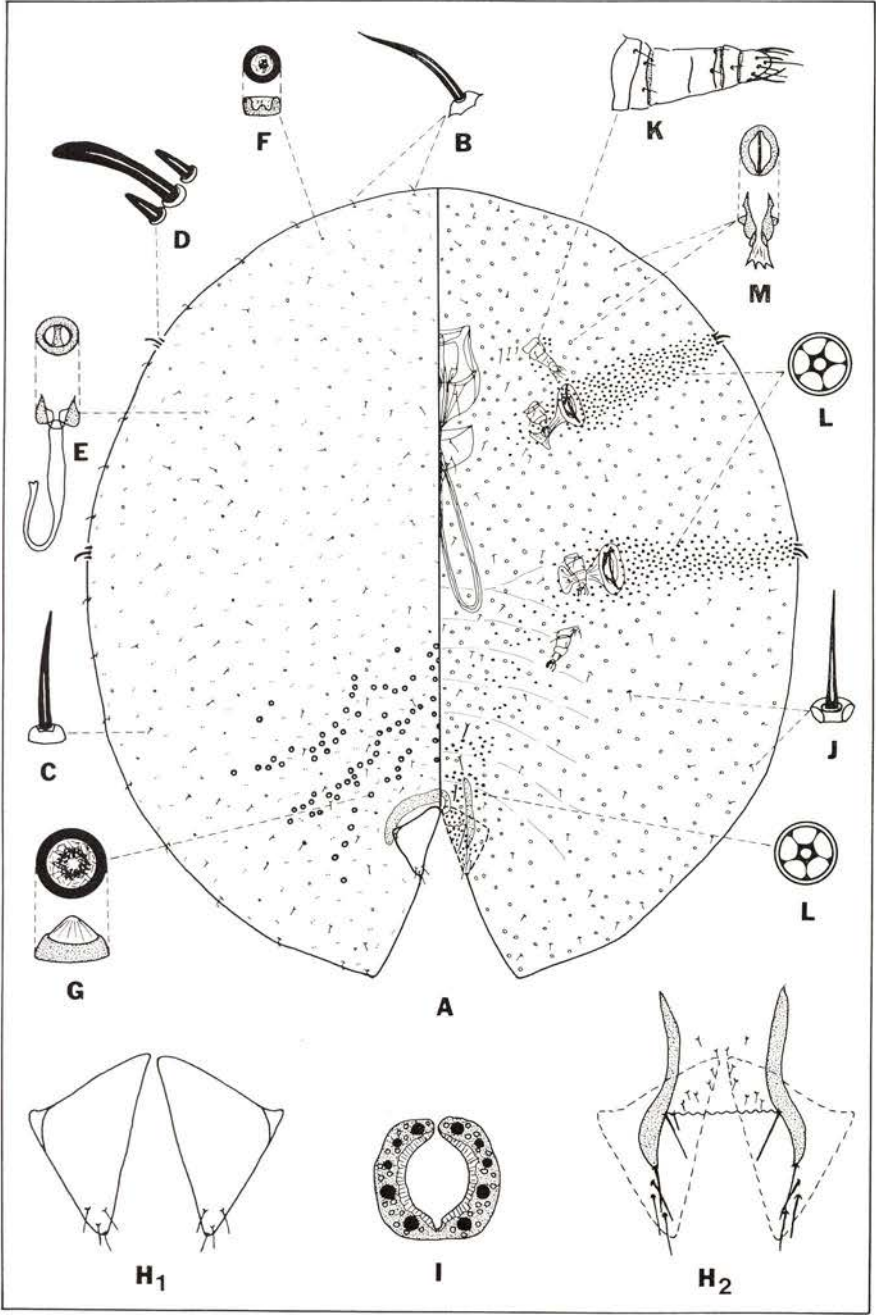


Plate 26. - *Toumeyella pini* (King)

apical setae. Anal fold with 1 pair of large fringe setae. Anal fold with 10 to 14 hypopygial setae.

Anal ring (fig. I): Ovate to subcircular, about 50.8 long, 46.9 wide, with 10 hairs and an irregular pattern of pores.

VENTRAL SURFACE

Setae: Submarginal setae (fig. J) 12.7(11.7-15.6) long, slender, acute, straight or slightly curved, about 16 around head. Body setae similar to ventral submarginal setae 12.9(11.7-15.6) long, scattered over entire venter. Usually 3 pair of large prevulvar setae can be found.

Eyes: Not detected in specimens studied.

Antennae (fig. K): Reduced, 6-segmented although often segmentation obscure and it appears to have only 3 segments. Antennae 98.2(74.3-117) long. Scape 15.1(11.7-23.5) long, 44.1 (35.2-54.7) wide. Length of segments II to VI: 7.82(7.82); 20.6(15.6-23.5); 22.0(19.6-27.4); 15.6 (7.82-19.6); 15.1(7.82-19.6) long respectively. Terminal segment with 2 hairlike and 6 fleshy setae. Setae on other segments: I,1; II,2; III, 0; IV,2; V,1.

Legs: Reduced, 5-segmented although segmentation is obscure. Tibio-tarsal sclerotization and articulation absent; claws simple, without denticle. Tarsus and claw each with a pair of digitules; tarsal digitules subequal 21.9(15.6-23.5) long, slender and spatulate; claw digitules unequal, one about 24.4 long, stout and spatulate, the other about 19.5 long, slender and spatulate.

Part of leg	Lengths prothoracic	Lengths mesothoracic	Lengths metathoracic
Coxa	22.2(19.6-23.5)	21.1(15.6-27.4)	17.6(15.6-19.6)
Trochanter	10.9(3.91-15.6)	7.17(3.91-7.82)	7.82(7.82)
Femur	27.8(19.6-39.1)	22.4(15.6-27.4)	25.2(23.5-27.4)
Tibia	20.9(11.7-27.4)	22.0(15.6-27.4)	21.3(19.6-27.4)
Tarsus	16.1(11.7-19.6)	14.0(11.7-19.6)	16.2(15.6-19.6)
Claw	12.6(7.82-15.6)	11.7(7.82-19.6)	12.8(11.7-15.6)
Entire leg	100(86.0-117)	99.5(89.9-106)	108(106-110)

Spiracles: Rather large, equal to or larger than legs; apodeme constricted on both sides; atrium larger than apodemal base. Spiracular pore band about 10- to 13-pores wide in places, and may be made

up of over 300 pores. Anterior spiracles 137(102-164) long, atrium 97.6 (62.6-113) wide; posterior pair 156(121-160) long, atrium 111 (86.0-133) wide.

Pores: Quinquelocular pores (fig. L) 7.24(5.87-7.82) in diameter, very numerous in spiracular pore bands, in anal area, and also forming a band from anal area to posterior spiracle. Occasionally there may also be a band from the antennae to the anterior spiracle.

Ducts: Tubular ducts were not detected in any of the specimens studied. Microducts (fig. M) about 3.90 long and 2.93 wide, which open through oval-shaped pores that appear to be bilocular, found scattered over the entire venter.

OTHER STAGES

First instar nymphs reddish-brown (7.5YR 6/10), have well-developed, 5-segmented antennae and legs; claws each with a slight denticle; eyes present; about 30 marginal setae around body; spiracular setae in 3's, median seta $2\frac{1}{2}$ or 3 times length of laterals; 3 quinquelocular pores in anterior spiracular pore band, 4 in posterior band; anal plates with 1 long apical, 3 dorsal and 1 ventral setae each, 1 pair fringe setae; anal ring with 6 hairs. Males and other instars not seen.

BIOLOGICAL NOTES

T. pini seems to prefer the outer tips or newer growth of its host, seldom being found on larger limbs. The young are usually born in early May. Very little is known of its life cycle. The overwintering form is not known. *T. pini* is often found in mixed infestations with *T. parvicornis*. This has led to many misidentifications of the two species.

PARASITES AND PREDATORS

None are known to the authors at this time.

ADDITIONAL HOSTS AND DISTRIBUTION IN VIRGINIA

Pinus sylvestris, Culpeper Co., Culpeper.

ADDITIONAL HOSTS AND DISTRIBUTION IN U.S.A.

The type specimen is from New York. It has also been recorded from Pennsylvania, Connecticut, Michigan and Florida (MacAloney, 1961).

The first author, M. L. Williams, has collected it in Maryland and Georgia. Additional hosts include *Pinus contorta*, *P. rigida*, and "cluster pines."

ECONOMIC IMPORTANCE

Because of its confusion with the pine tortoise scale, the true economic importance of *T. pini* is not known. It is possible that it may be economically important in Christmas tree plantings.

NOTES

There is a strong possibility that *T. corrugatum neglectum* (Pettit and McDaniel), described in 1920, is a synonym of *T. pini*. Because of the lack of comparative material, the authors could not resolve this problem at the present time. Ferris (1920) thought that *T. pini* was a synonym of *T. parvicornis* (Ckll.) but they are both valid species. The fact that no ventral tubular ducts were detected is very unique. It is possible that this might be later used as a diagnostic specific character if this holds true with a larger number of specimens.

***Toumeyella virginiana* n. sp.**

*** Virginia Pine Scale**

Plate 27, Photo 48

The first available records of this new species are from Yorktown, Virginia, hence the name *T. virginiana* was selected as the name for this new species.

MATERIAL STUDIED AND TYPE DESIGNATION

On *Pinus palustris*, 2, (2), Lee Co., May 16, 1969, J. E. Graham, (No. 1587a-b). *P. taeda*, 12, (14) Clark Co., Ga., July 16, 1968, W. Berisford, (MW 055a-l); 6, (6), Dorchester Co., Md., Sept. 16, 1971, MLW, (MW 349a-f). *P. virginiana*, 2, (3) Yorktown, May 11, 1940, collector unknown, (No. 3a-b); 4, (4), Craig Co., July 22, 1969, MLW, (MW 157a-d); 6, (6), Seashore State Park, Aug. 18, 1969, MLW, (MW 288a-f). *Pinus* sp., 4, (4), King George Co., March 14, 1971, S. Nakahara, (NM-80a-d).

The holotype female, from Clark Co., Ga., on slide number MW 055f, is deposited in the USNM Collection. All other females in ma-

terial studied are designated as paratypes and are deposited in the following collections: 4 in the USNM Collection; 2 in the British Museum Collection; 2 in the UGAES Collection; 2 in the FDA Collection; 2 in the Plant Protection Research Institute, Pretoria, S. Africa. The remaining paratype specimens are deposited in the VPI Collection and the personal collection of M. L. Williams.

GENERAL APPEARANCE

Body ranging from large and only slightly convex in specimens found under bark, to small and very convex in specimens collected on twigs or stems. Color of the adult female varies from a salmon-pink to reddish-brown. Younger specimens tend to be lighter in color. Often the coccids are found under protective coverings built by ants.

DESCRIPTION

Body (fig. A) oval to subcircular, 3263(2299-5760) long, 2664(1994-4726) wide. Dorsal derm usually with a heavily sclerotized area around anal plates, and with numerous pores. Legs and antennae greatly reduced. Spiracular setae in 3's, with the median seta longer than the laterals. Anal plates with 15 to 25 dorsal setae. Tubular ducts confined to anal area. Anal cleft about $1/6$ body length.

DORSAL SURFACE AND MARGIN

Setae: About 24 marginal setae (fig. B) around head, 16.2 (15.6-19.6) long, in an irregular row around body, sometimes hard to distinguish from ventral submarginal setae, but appear to be stouter and sometimes slightly expanded near apex. Body setae (fig. C) about 11.7 long, stout, tapering, bluntly pointed and with a large base, scattered over dorsum.

Spiracular setae (fig. D): 3 in each group, long and slender, bluntly pointed. Median seta usually longer than lateral setae but sometimes all 3 subequal. Median seta 37.8(27.4-46.9) long, 11.7 (11.7) wide; lateral setae 27.4(23.5-39.1) long, 9.37(7.82-11.7) wide.

Submarginal tubercles: Absent.

Pores: Thick rimmed bilocular pores (fig. E) 4.15(3.42-4.88) in diameter, very numerous over entire dorsum. Small discoidal pores (fig. F) 4.65(3.91-5.87) in diameter scattered over dorsum, most numerous in anal area. Minute bilocular pores (fig. G) and simple disc pores (fig. H) each about 1.95 in diameter scattered

over dorsum, most numerous in submarginal area. Large discoidal pores (fig. I) 12.8(11.7-15.6), in diameter, that are slightly convex in cross section, numerous anterior to, and surrounding, anal plate area.

Anal plates (fig. J₁, J₂): The anal plates provide the most distinctive character of this species. They are triangular, with the outer angles slightly rounded. Length 230(211-254), width 143(109-176). Cephalolateral margin rather straight, 178(145-207) long; caudolateral margin slightly convex, 181(156-199) long. Each plate with 15 to 25 dorsal setae including the apical setae and 5 or 6 subapical setae. Anal fold with 1 pair of fringe setae. Eight to 10 hypopygial setae, 1 pair near the anal fold resembling fringe setae.

Anal ring (fig. K): Subcircular to ovate, about 78.2 long, 70.4 wide, with 10 hairs and 2 irregular rows of translucent pores.

VENTRAL SURFACE

Setae: Ventral submarginal setae (fig. L) about 11.7 long, straight, tapering, pointed, about 32 around head. Body setae (fig. M) 8.26 (7.82-11.7) long, stout, tapering, pointed, scattered randomly over body. A cluster of prevulvar setae, 2 pair distinctly larger than the others.

Eyes: Not detected in the specimens studied.

Antennae (fig. N): Greatly reduced, 6-segmented, 133(113-149) long. Scape 30.0(27.4-31.3) long, 65.2(54.7-78.2) wide. Length of segments II to VI: 26.4(19.6-31.3), 30.7(27.4-39.1) 32.8(23.5-46.9), 15.1 (11.7-19.6), 22.0(19.6-27.4) long respectively. Terminal segment with 3 hairlike, and 7 fleshy setae. Setae on other segments: 1,2; II,2; III,0; IV,2; V,1 and 1 fleshy.

Legs: Reduced, 5-segmented although often the coxa and trochanter are hard to separate. Claw short and stout, normally without a denticle, but occasionally a slight denticle can be detected in some specimens. Tarsus and claw each with a pair of knobbed digitules; claw digitules slender, slightly broader than tarsal digitules, about 14.8 long; tarsal digitules about 28.4 long, also slender.

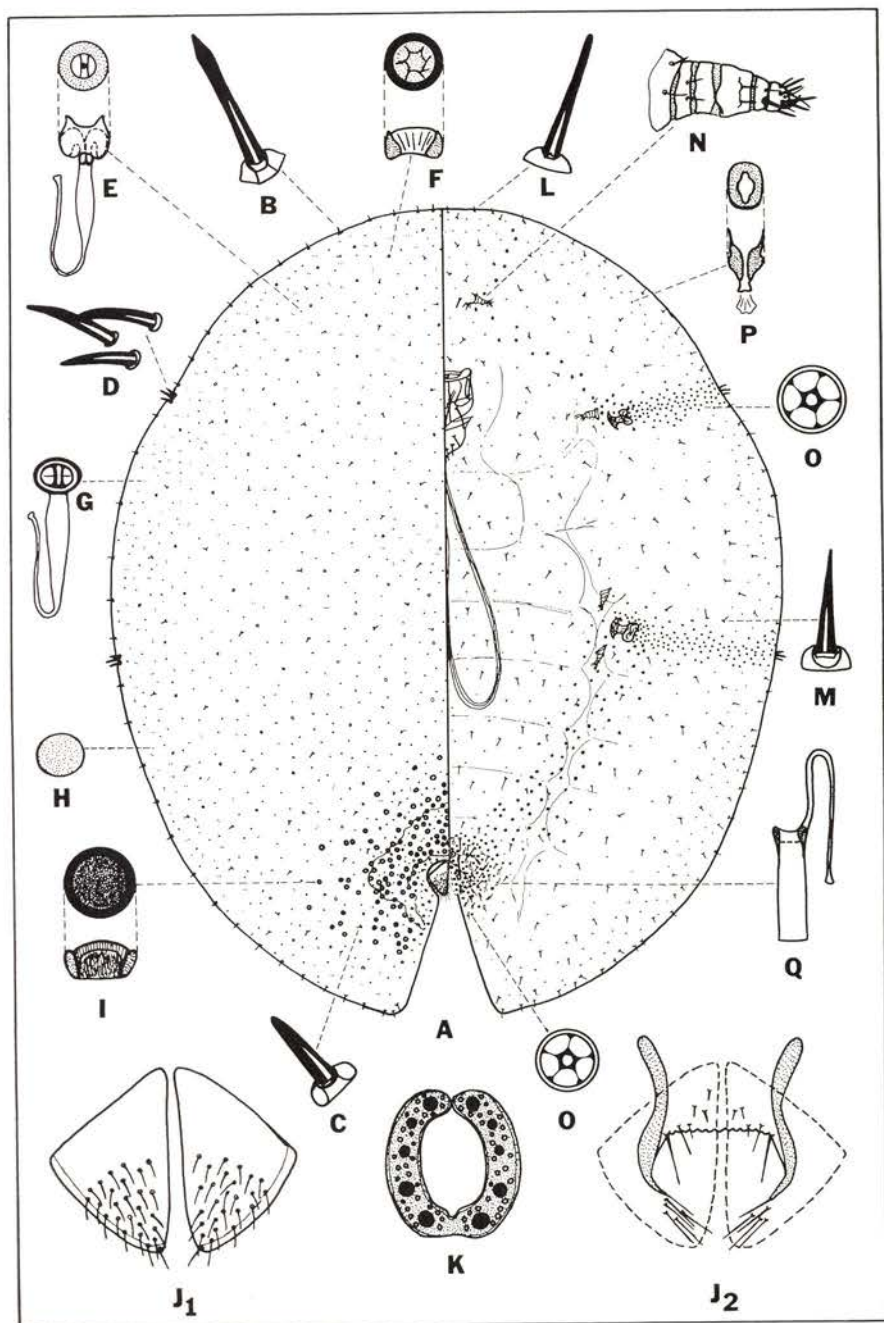


Plate 27. - *Toumeyella virginiana* n.sp.

Part of leg	Lengths prothoracic	Lengths mesothoracic	Lengths metathoracic
Coxa	46.9(46.9)	56.1(39.1-66.5)	35.2(31.3-39.1)
Trochanter	19.6(19.6)	28.4(23.5-31.3)	27.4(27.4)
Femur	35.6(31.3-39.1)	40.0(31.3-46.9)	34.7(31.3-39.1)
Tibia	23.5(23.5)	25.8(19.6-27.4)	25.5(19.6-27.4)
Tarsus	22.4(15.6-27.4)	27.8(19.6-31.3)	25.2(15.6-31.3)
Claw	15.0(11.7-19.6)	18.0(15.6-23.5)	16.5(11.7-23.5)
Entire leg	149(149)	203(180-223)	203(203)

Spiracles: Larger than total leg length. Apodemal base reticulated and as wide as atrium. Spiracular pore bands 5 to 12 pores wide. Anterior pair 193(156-239) long, atrium 126(106-137) wide; posterior pair 221 (188-258) long, atrium 145(129-156) wide.

Pores: Quinquelocular pores (fig. O) 7.62(5.87-7.82) in diameter, very numerous in spiracular pore band and in anal area. Each pore band containing 125 to 155 pores. Occasionally a few are scattered near the antennae.

Ducts: Microducts (fig. P) about 4.91 long, opening to the ventral surface through cruciform openings, about 3.91 in diameter, scattered over the entire venter, most numerous in a submarginal band around body. Tubular ducts (fig. Q) 16.5(15.6-19.6) long, 3.91(3.91) wide with a sclerotized cup and slender inner filaments 29.4(23.5-35.2) long, numerous but confined to the anal area.

OTHER STAGES

First instar nymphs with eyes, 5-segmented antennae, well-developed legs; spiracular setae in 3's, median seta 2 times longer than laterals; about 30 marginal setae around body; 3 to 5 quinquelocular pores in each spiracular pore band; each anal plate with 1 long apical seta, 3 dorsal setae and 1 ventral seta; with 1 pair fringe setae, and 6 anal ring hairs. Second instar females with eyes; reduced legs and antennae; spiracular setae in 3's with the median seta $1\frac{1}{2}$ or 2 times longer than laterals; about 40 marginal setae around body; 7 to 10 quinquelocular pores in each spiracular pore band; each anal plate with 5 dorsal and 2 ventral setae; with 1 pair fringe setae and 6 anal ring hairs. Although males are known to occur, they have not been described.

BIOLOGICAL NOTES

The coccid may be found under the bark of its host or on the twigs. Specimens found under the bark are larger and less convex than those found on the twigs. In all cases known to the authors, ants were associated with the coccids. *Crematogaster clara* Mayr, often builds protective coverings over the scale insects. These coverings are made of particles of soil, sand, and other debris cemented together forming a "tent" over the coccids. This covering protects the insects from parasites, predators, and adverse weather conditions. The coccids are bisexual, with mating taking place in early September. The young are born ovoviviparously during October and overwinter as second instar nymphs.

PARASITES AND PREDATORS

Parasitic wasps, *Tetrastichus* sp., and *Coccophagus fraternus* (Eulophidae), have been reared from the immature stages.

ADDITIONAL HOST AND DISTRIBUTION IN VIRGINIA

Pinus taeda, Seashore State Park.

ADDITIONAL HOSTS AND DISTRIBUTION IN U.S.A.

Pinus taeda, Clark Co., Georgia; Dorchester Co., Maryland. *Pinus* sp., Lake Placid, Florida.

ECONOMIC IMPORTANCE

Since the coccid has only been found in small numbers, it is assumed that it is of little economic importance at this time. It is quite possible that it has been confused with the pine tortoise scale, *T. parvicornis* in the past, which is often economically important to the Christmas tree grower.

NOTES

The number of generations per year is not known, but it appears there may be two overlapping generations, since all stages can be found during late summer and early fall.

SELECTED REFERENCES

Specific references with page citations for each species are given in the descriptions. References marked with an asterisk(*) were not available to the authors at the time of manuscript preparation. However, these are included to present a more complete list of references. The specific pages of some extensive articles are included in parentheses.

- Amos, J. M. 1970. Controlling scale insects. Va. Polytech. Inst. Ext. Div. Leaflet MS-126. 4 p.
- Armitage, H. M. 1947. 27th annual report of the Dept. of Agr. Report of the Bureau of Entomology and Plant Quarantine. Calif. Dept. Agr. Bul. 35:209.
- Ashmead, W. H. 1880. The white scale of the orange (*Ceroplastes rusci* Linn). Canad. Ent. 12:252-254, illus.
- Atkinson, E. T. 1890. Notes on Indian economic entomology. Indian Museum Notes 1(4):187-190.
- Baerg, W. J. 1947. The biology of the maple leaf scale. Univ. Ark. Agr. Exp. Sta. Bul. 470. 14 p., illus.
- Balachowsky, A. 1933. Sur la biologie de "*Ceroplastes floridensis* Comst." et sur la répartition géographique des *Ceroplastes* dans la région palé-arctique (Hem. Coccidae). Int. Congr. Ent. (Paris 1932) 5(2):79-87, illus.
- 1939. Les Cochenilles de France, d'Europe, du Nord de l'Africa et du bassin Méditerranéen III. Actual Sci. et Industr. Ent. Appl. 784:131-242, illus.
- Ballou, C. H. 1926. Los coccidos de Cuba y sus plántas hospederas. Cuba Estac. Expt. Agron. Bul. 51. 47 p.
- 1945. Notas sobre insectos daninos observados en Venezuela. 1938-43. 3rd Conferencia Interamericana de Agricultura, Caracas No. 34. 151 p., illus.
- Banks, N. 1902. Principal insects liable to be distributed on nursery stock. USDA Div. Ent. Bul. 34(n.s.). 46 p., illus.
- Beal, J. A. 1952. Forest insects in the southeast. Duke Univ. School Forestry Bul. 14. 168 p.
- Ben-Dov, Y. 1970a. A redescription of the Florida wax scale *Ceroplastes floridensis* Comstock (Homoptera: Coccidae). J. Ent. Soc. S. Africa 33(2): 273-277, illus.
- 1970b. The wax scales of the genus *Ceroplastes* Gray (Homoptera: Coccidae) and their parasites in Israel. Israel J. Ent. 5:83-92, illus.
- 1970c. Laboratory rearing of wax scales. J. Econ. Ent. 63(6): 1998, illus.
- Berger, E. 1917. Control of scale insects, or Coccidae of Florida. Fla. State Plant Board Quart. Bul. 2(4):66-80.
- Bethune, C. J. S. 1907. Insects affecting fruit trees. Ontario Dept. Agr., Agr. Col. Bul. 158. 36 p., illus.
- Bodenheimer, F. S. 1953. The Coccoidea of Turkey. III. Istanbul Univ. Facult. des Sci. Rev. 18 (Ser. B):91-164, illus.
- Boratynski, K. 1970. Advances in our knowledge of Coccoidea (Homoptera) with reference to studies of the males and the application of some numerical methods of classification. Polish Congr. Contemp. Sci. and Cult. in Exile 1:585-595, illus.

- Boratynski, K. and R. G. Davies. 1971. The taxonomic value of male Coccoidea (Homoptera), with an evaluation of some numerical techniques. Biol. J. Linn. Soc. 3(1):57-102, illus.
- Borchsenius, N. S. 1949. *Ceroplastes japonicus* Green (Homoptera, Coccoidea); a pest of citrus and other cultivated plants in Georgia [in Russian]. Acad. Sci. Georgia. SSR Rpt. 10:121-124.
- 1952. New genera and species of soft scales of the family Coccidae (=Lecaniidae) of the USSR fauna and adjacent countries (Insecta, Homoptera, Coccoidea) [in Russian]. Trudy Zool. Inst. Akad. Nauk. USSR 12:269-316, illus.
- 1953. New genera and species of scale insects of the family Coccidae (Homoptera, Coccoidea) [in Russian]. Ent. Obozr. 33:281-290, illus.
- 1957. Fauna of USSR, Homoptera, Coccidae [in Russian]. Akad. Nauk Zool. Inst. (n.s. 66) 9. 493 p., illus.
- 1958. On the evolution and phylogenetic interrelations of the Coccoidea (Insecta, Homoptera) [in Russian, English summary]. Zool. Zhur. 37:765-780, illus.
- 1959. Notes on coccid fauna of China. 7. A new family of soft scales Lecaniodiaspididae, fam. n. (Homoptera, Coccoidea) [in Russian, English summary and keys]. Ent. Obozr. 38:840-846, illus.
- Bouché, P. F. 1844.* Beiträge zur Naturgeschichte der Scharlachläuse (Coccina). Stettin. Ent. Ztg. 5:293-302.
- Brain, C. K. 1920. The Coccidae of South Africa. V. Bul. Ent. Res. 11:1-42.
- Brimblecombe, A. R. 1956. Studies of the Coccoidea. 5. The genus *Ceroplastes* in Queensland. Queensland J. Agr. Sci. 13(3):159-167.
- 1962. Studies of the Coccoidea 12. Species occurring on deciduous fruit and nut trees in Queensland. Queensland J. Agr. Sci. 19(2):219-229, illus.
- Brimley, C. S. 1938. The insects of North Carolina. North Carolina Dept. Agr. 560 p.
- Britton, W. E. 1915. The chief injurious scale-insects of Connecticut. Conn. Agr. Expt. Sta. Bul. 151. 16 p., illus.
- Brookes, H. M. 1964. The Coccoidea (Homoptera) naturalized in South Australia; a second annotated list. Trans. Royal Soc. of S. Australia 88: 15-20.
- Burmeister, H. 1835. Scharlachläuse. Schildläuse. Coccina. In Handb. der Ent. 2(1):61-83, illus.
- Burns, D. P. 1964. Formicidae associated with the tuliptree scale. Ann. Ent. Soc. Amer. 57(1):137-39.
- 1970. Insect enemies of yellow-poplar. NE. Forest Exp. Sta. USDA Forest Serv. Res. Paper NE-159. 15 p., illus.
- Burns, D. P. and D. E. Donley. 1970. Biology of the tuliptree scale, *Toumeyella liriiodendri* (Homoptera: Coccidae) Ann. Ent. Soc. Amer. 63(1):228-235, illus.
- Campbell, R. E. 1914. A new coccid infesting citrus trees in California (Hemipt.). Ent. News 25:222-224.
- Canard, M. 1958. Recherches sur la morphologie et la biologie de la cochenille *Eulecanium corni* Bouché (Homoptères-Coccoidea). Ann. de l'Ecole Nat. Sup. Agr. de Toulouse 6(2):185-271, illus.
- 1965a. Sur quelques Pulvinariini (Homoptera, Coccoidea) du midi de la France. Proc. XIIth Int. Congr. Ent. London, 1964 (1965): 170.

- Canard, M. 1965b. Observations sur une Pulvinaire peu connue du midi de la France: *Eupulvinaria hydrangeae* (Steinw.) (Coccoidea-Coccidae). Ann. Soc. Ent. France (n.s.), 1(2):411-419, illus.
- 1965c. Utilisation des larves néonates pour aider a la détermination des cochenilles floconneuses (Coccidae-Pulvinariini). Ann. Soc. Ent. France (n.s.), 1(2):421-424, illus.
- 1969. La lignée mâle de *Eupulvinaria hydrangeae* (Hom. Coccidae). Ann. Soc. Ent. France (n.s.) 5(2):457-460, illus.
- Carnes, E. K. 1907. The Coccidae of California. Calif. State Comnr. Hort. Bien. Rpt. 2(1905-06):155-222, illus.
- Chamberlin, J. C. 1923. A systematic monograph of the Tachardiinae or lac insects (Coccidae). Bul. Ent. Res. 14:147-212, illus.
- Chambliss, C. E. 1898. Scale insects: San José and other species. Univ. Tenn. Agr. Exp. Sta. Bul. 10(4):140-151.
- Clausen, C. P. 1940. Entomophagous insects. McGraw-Hill, New York-London. 688 p.
- Close, C. P. and W. R. Ballard. 1911. Peach culture. Mo. Agr. Exp. Sta. Bul. 159:111-190.
- Cockerell, T. D. A. 1893a. The West Indian species of *Ceroplastes*. Entomologist 26:80-83.
- 1893b. Notes on *Lecanium*, with a list of the West Indian species. Trans. Amer. Ent. Soc. 20:49-56.
- 1893c. A new *Lecanium* from Canada. Canad. Ent. 25:221-222.
- 1894a. Notes on some Trinidad Coccidae. Trinidad Field Nat. Club J. 1(12):306-310.
- 1894b. On a *Lecanium* from Rochester, N. Y. (U.S.A.) considered identical with *L. juglandis*, Bouché. Entomologist 27:332-336.
- 1895a. Coccidae or scale insects—VI. Bul. Botanical Dept. Jamaica. (ser. 2) (1):5-8.
- 1895b. Canadian Coccidae. Canad. Ent. 27:33-36, 58-61.
- 1895c. A new *Pulvinaria* found on orchids. Canad. Ent. 27:135.
- 1895d. New North American Coccidae. Psyche 7 (1894-1896) (sup.):1-4.
- 1895e. Miscellaneous notes on Coccidae. Canad. Ent. 27(9):253-261.
- 1896a. A check list of the Coccidae. Ill. State Lab. Nat. Hist. 4:318-339.
- 1896b. On a small collection of Coccidae from the island of Grenada. Trinidad Field Nat. Club J. 2:306-307.
- 1896c. Preliminary diagnoses of new Coccidae. Psyche 7 (1894-1896) (sup.):18-21.
- 1897a. Descriptive notes on two Coccidae. Entomologist 30:12-14.
- 1897b. New and little-known Coccidae from Florida. Psyche 8:89-91.
- 1898. A new scale insect of the genus *Lecanium*. Ent. News 9:145-146.
- 1899a. Some synonymy. Psyche 8(273):311.
- 1899b. Some notes on Coccidae. Acad. Nat. Sci. Phila. Proc. 1899:259-275.

- Cockerell, T. D. A. 1899c. Aleurodidae and Coccidae. Biol. Centr. Amer. Pt. 2, 2:1-37, illus.
- 1899d. New records of Coccidae. J. N. Y. Ent. Soc. 7(4):257-259.
- 1900. A new *Eriococcus*, with remarks on other species. Ent. News 11:594-596.
- 1901a. Notes on some Coccidae of the earlier writers. Entomologist 34:90-93.
- 1901b. Report of 3rd meeting Las Vegas Science Club (n.s.) 8(325):469.
- 1902. A contribution to the knowledge of the Coccidae. Ann. Mag. Nat. Hist. 9 (ser. 7):450-456.
- 1903. Some species of *Eulecanium* (Coccidae) from France. Psyche 10:19-22.
- 1905a. Three new Coccidae from Colorado. Canad. Ent. 37(4):135-136.
- 1905b. Three new South American Coccidae. Ent. News 16:161-163.
- 1905c. A new scale insect (Fam. Coccidae) on the rose. Zool. Anz. 29(16):514-515.
- 1906. The coccid genus *Eulecanium*. Canad. Ent. 38:83-88.
- 1910. The Coccidae of Boulder County, Colorado. J. Econ. Ent. 3(5):425-430, illus.
- 1922. The mealy-bug called *Pseudococcus bromeliae*, and other coccids. Science 56:308-309.
- Cockerell, T. D. A. and G. B. King. 1899. An apparently new *Lecanium* found on white cedar. Psyche 8(276):349-350.
- Cockerell, T. D. A. and P. J. Parrott. 1899. Contributions to the knowledge of the Coccidae. Industrialist 25:159-165, 227-237, 276-284.
- 1901. Table to separate the genera and subgenera of Coccidae related to *Lecanium*. Canad. Ent. 33:57-58.
- Compere, H. 1926. New coccid-inhabiting parasites (Encyrtidae, Hymenoptera) from Japan and California. Univ. Calif. Publ. Ent. 4(2):33-50.
- Comstock, J. H. 1881. Report of the entomologist. Part II. Report on scale insects. In USDA, Comn. Agr. Rpt., 1880:276-349, illus. Reprinted in Cornell Univ. Agr. Exp. Sta. Bul. 372(1916):425-500, 22 pl.
- 1883. Second report on scale insects. Including a monograph of the subfamily Diaspinae of the family Coccidae and a list, with notes, of the other species of scale insects found in North America. In Cornell Univ. Agr. Exp. Sta., Dept. Ent. Rpt. 2(1882-83):47-142, illus.
- Cook, A. J. 1878. *Lecanium tulipiferae*. Canad. Ent. 10:192-195, illus.
- Coquillett, D. W. 1891. A new scale insect from California. Insect Life 3:382-384.
- Cotes, E. C. 1891. White insect wax in India. Indian Mus. Notes 2(3):90-97, illus.
- Cottier, W. 1939. Citrus pests, VII. New Zeal. Agric. 58:421-422.
- Cox, J. A. 1942. Effect of dormant sprays on parasites of the San José and terrapin scales. J. Econ. Ent. 35(5):698-701.
- Craighead, F. C. 1950. Insect enemies of eastern forests. USDA Misc. Pub. 657. 679 p., illus.

- Craw, A. 1896. Injurious insect pests found on trees and plants from foreign countries. Fifth Bien. Rep. Calif. State Bd. Hort. (1895-96):33-47.
- Dalman, J. W. 1825.* Om nagra Svenska Arter af *Coccus*; samt de inuti dem forekummande Parasit-insekter. Kongliga Vetenskaps Akademiens Handlingar 1825:350-374.
- Dekle, G. W. 1963. A field key to wax scales in Florida. Fla. Dept. Agr. Div. Ent. Cir. 19. 1 p., illus.
- Del Guercio, G. 1900. Osservazioni intorno ad una nuova Cocciniglia nociva agli agrumi in Italia. Nuove Relaz. Intorno ai lavori della R. Stazione di Ent. Agr. Firenze. 3:3-26.
- De Lotto, G. 1959. Further notes on Ethiopian species of the genus *Coccus*. (Homoptera:Coccoidea:Coccidae) J. Ent. Soc. S. Africa 22(1):150-173, illus.
- 1965. On some Coccidae (Homoptera), chiefly from Africa. Bul. British Mus. Nat. Hist. (Entomol.) 16:175-239, illus.
- 1966. A new genus and four new species of Coccidae (Homoptera) from South Africa. Proc. Linn. Soc. Lond. 177(2):143-149, illus.
- 1967a. A contribution to the knowledge of the African Coccoidea (Homoptera). J. Ent. Soc. S. Africa 29:109-120.
- 1967b. The soft scales (Homoptera: Coccidae) of South Africa, I. S. Afr. J. Agr. Sci. 10:781-810, illus.
- 1968a. A generic diagnosis of *Takahashia* Cockerell, 1896 (Homoptera: Coccidae). Proc. Linn. Soc. Lond. 179(1):97-98, illus.
- 1968b. Second contribution to the knowledge of the African Coccoidea (Homoptera). J. Ent. Soc. S. Africa 31(1):83-86, illus.
- 1969a. On a few old and new soft scales and mealybugs (Homoptera: Coccoidea). J. Ent. Soc. S. Africa 32(2):413-422, illus.
- 1969b. A new genus of wax scales (Homoptera: Coccidae). Bol. Lab. d'Entomol. Agraria "Filippo Silvestri" de Portici 27:210-218, illus.
- 1971. On some genera and species of wax scales. (Homoptera: Coccidae). J. Nat. Hist. 5:133-153, illus.
- Deplanche, E. 1859. Analysis of a memoir on a disease of coffee by M. E. Deplanche, presented by M. Eudes-Deslongchamps. Soc. Linn. de Normandie Bul. 4:203-207.
- Dietz, H. F. and H. Morrison. 1916. The Coccidae or scale insects of Indiana. 8th Report, Office of State Entomologist. (1914-1915):195-321, illus.
- Doane, R. W., E. C. Van Dyke, W. J. Chamberlin, and H. E. Burke. 1936. Forest insects. McGraw-Hill, N. Y. 463 p.
- Donley, D. E. and D. P. Burns. 1965. The tuliptree scale. USDA Forest Pest Leaflet 92. 5 p., illus.
- Douglas, J. W. 1885. Notes on some British Coccidae (No. 1). Ent. Monthly Mag. 22:157-160.
- 1886. Note on some British Coccidae (No. 4). Ent. Monthly Mag. 23:77-82.
- 1887. Note on some British Coccidae (No. 6). Ent. Monthly Mag. 23:239-243.
- Douglass, B. W. 1911.* Scale insects of Indiana. In Fourth Rpt. Ind. State Ent.: 145-226, illus.
- Dozier, H. L. 1920. An ecological study of hammock and piney woods insects in Florida. Ann. Ent. Soc. Amer. 13(4):325-380.

- Dziedzicka, A. 1968. Studies on the morphology and biology of *Lecanium fletcheri* Ckll. (Homoptera: Coccoidea) and related species. Zool. Polon. 18(1):125-165, illus.
- Ebeling, W. 1938. Host determined morphological variations in *Lecanium corni*. Hilgardia 11(11):613-631, illus.
- Essig, E. O. 1915. Injurious and beneficial insects of California. Supp. Calif. State Comm. Hort. Monthly Bul. 4(4):1-541, illus.
- 1920. Control of the brown apricot scale and the Italian pear scale on deciduous fruit trees. Univ. Calif. Col. Agr. Exp. Sta. Cir. 224. 11 p., illus.
- 1931. A history of entomology. Hafner, N. Y. 1029 p., illus.
- Ezzat, Y. M. and N. A. Hussein. 1969. Redescription and classification of the family Coccidae in U.A.R. Bul. Soc. Ent. Egypte 51(1967):359-426, illus.
- Fabricius, J. C. 1776. Genera Insectorum. Chilonii, Bartsch. 14. 310 p.
- 1798.* Entomologiae Systematicae. Supplementum. Hafniae, Proft et Storch. 572 p. (546).
- 1803.* In Systema Rhynqtorum C. Reichard, Brunsvigae. x + 314 p.
- Felt, E. P. 1901. Scale insects of importance and list of species in New York state. N. Y. State Mus. Bul. 9(46):289-377, illus.
- 1906. Insects affecting park and woodland trees. N. Y. State Mus. Mem. 8(2):689-690.
- 1915. Manual of tree and shrub insects. Macmillan Co., N. Y. 382 p., illus.
- 1922. *Mycodiplosis moznettei* n.sp. Florida Ent. 5(3):46.
- Fenton, F. A. 1917. Observations on *Lecanium corni* Bouché, and *Physokermes piceae* Schr. Canad. Ent. 49:309-320, illus.
- Fernald, H. T. 1899. The San José scale, and other scale insects. Pa. Dept. Agr. Bul. 43. 22 p., illus.
- Fernald, M. E. 1902. On the type of the genus *Coccus* L. Canad. Ent. 34: 232-233.
- 1903. A catalogue of the Coccidae of the world. Mass. Agr. Exp. Sta. Spec. Bul. 88. 360 p.
- Ferris, G. F. 1920. Scale insects of the Santa Cruz Peninsula. Stanford Univ. Publ., Univ. Ser., Biol. Sci., 1:1-57, illus.
- 1921. Report upon a collection of Coccidae from lower California. Stanford Univ. Publ., Univ. Ser., Biol. Sci., 1(2):61-132, illus.
- 1922. Notes on Coccidae—IX (Hemiptera). Canad. Ent. 54: 156-161, illus.
- 1936. Contributions to the knowledge of the Coccoidea (Homoptera). Contribution No. 1. Microentomology 1:1-16, illus.
- 1950. Report upon scale insects collected in China. (Homoptera: Coccoidea) II. Microentomology 15:70-97.
- 1955. Atlas of the scale insects of North America Vol. 7, the families Aclerdidae, Asterolecaniidae, Conchaspidae, Dactylopiidae and Lacciferidae. Calif., Stanford Univ. Press. 233 p., illus.
- Fitch, A. 1857. 160.—Hickory bark-louse, *Lecanium caryae*, new species. In third report on noxious and other insects of the State of New York. N. Y. State Agr. Soc. Trans. 16 (1856):443.

- Fitch, A. 1859. 307.—White oak scale insect, *Lecanium quercifex*, new species. 308.—Quercitron oak scale insect, *Lecanium quercitronis*, new species. In fifth report on noxious and other insects of the State of New York. N. Y. State Agr. Soc. Trans. 18 (1858):805-806.
- 1860. *Lecanium acericorticis*. In sixth report on the insects of New York. 6 (1859):775.
- Fletcher, J. 1895. *Lecanium fletcheri*, Ckll. Canad. Ent. 27(1):6.
- 1896. Report of the entomologist and botanist. Ann. Rpt. Can. Exp. Farms. 1895:135-181.
- Fonscolombe, E. L. and J. H. de Boyer. 1834. Description des *Kermes* qu'on trouve aux environs d'aix. Soc. Ent. de France Ann. 3:201-218.
- Forbes, S. A. 1885. *Pulvinaria innumerabilis*. In Ill. State Ent. Ann. Rpt. 14 (1884):103.
- Froggatt, W. W. 1921. A descriptive catalogue of the scale insects ("Coccidae") of Australia. II. Dept. Agr. N. S. Wales Sci. Bul. 18:1-159, illus.
- Gahan, A. B. 1907. The peach lecanium or terrapin scale. Md. Agr. Exp. Sta. Bul. 123:153-160, illus.
- Gates, L. M. 1930. The pine tortoise scale *Lecanium numismaticum* Pettit & McD., in Nebraska. J. Econ. Ent. 23:544-547.
- Giliomee, J. H. 1967. Morphology and taxonomy of adult males of the family Coccidae (Homoptera: Coccoidea). Bul. British Mus. Nat. Hist., Ent. Ser., Supp. 7. 168 p., illus.
- Gillette, C. P. 1897. A few insect enemies of the orchard. Colorado State Agr. Col. Exp. Sta. Bul. 38:33-40, illus.
- Gillette, C. P. and G. S. Langford. 1925. Control of some scale insects infesting Colorado trees and shrubs. Colorado Agr. College Cir. 46. 14 p.
- Girault, A. A. 1909. The chalcidoid parasites of the coccid *Eulecanium nigrofasciatum* (Pergande). Psyche 16:75-86.
- Gmelin, J. F. 1789. Insecta, Hemiptera, *Coccus*. Systems Nat. Ed. XIII: 2215-2222.
- Gossard, H. A. 1900. Some common Florida scales. Fla. Agr. Exp. Sta. Bul. 51:106-128, illus.
- Gray, J. E. 1828. Spicilegia zoologica; or original figures and short systematic descriptions of new and unfigured animals. Pt. I. London, Treüttel, Wurtz and Co. 12 p., illus.
- Green, E. E. 1896. The Coccidae of Ceylon. Pt. I. Dulau, London. 103 p., illus.
- 1897. Notes on Coccidae from the Royal Gardens, Kew. (with additions by R. Newstead). Ent. Monthly Mag. 33:68-77, illus.
- 1899. Observations on some species of Coccidae of the genus *Ceroplastes* in the collection of the British Museum. Ann. Mag. Nat. Hist. (Ser. 7) 4(21):188-192, illus.
- 1900. Remarks on Indian scale insects (Coccidae) with descriptions of new species. Pt. I. Indian Mus. Notes 5:1-13, illus.
- 1904. The Coccidae of Ceylon.—Pt. III, Dulau, London: 171-249, illus.
- 1909. The Coccidae of Ceylon—Pt. IV, Dulau, London: 250-344, illus.
- 1917. Observations on British Coccidae; with descriptions of new species. III. Ent. Monthly Mag. 53:201-210, illus.

- Green, E. E. 1918. Some remarks on Mr. Kunhi Kannan's paper, "An instance of mutation." Trans. Ent. Soc. London. 1918:149-154, fig. 1-10.
- 1921. Observations on British Coccidae: with descriptions of new species—VII. Ent. Monthly Mag. 57:257-259, illus.
- 1930. Observations on British Coccidae, XII. Ent. Monthly Mag. 66:9-17, illus.
- Hall, W. J. 1922. Observations on the Coccidae of Egypt. Min. Agr. Egypt. Techn. and Sci. Serv. Bul. 22:iv + 1-54.
- Harrington, W. H. 1900. Notes on insects of the year—Division I, Ottawa District. Ann. Rpt. Ent. Soc. Ontario 30 (1899):94-96.
- Hart, W. G., J. W. Balock, and S. Ingle. 1966. The brown soft scale, *Coccus hesperidum* L. (Homoptera: Coccidae), in citrus groves in Rio Grande Valley. J. Rio Grande Valley Hort. Soc. 20:69-73.
- Hart, W. G. and V. I. Myers. 1968. Infrared aerial color photography for detection of populations of brown soft scale in citrus groves. Ann. Ent. Soc. Amer. 61(3):617-624.
- Hempel, A. 1900. As Coccidas Brasileiras. Rev. Mus. Paulista (Sao Paulo) 4:365-537, illus.
- Herrick, G. W. 1911. Some scale insects of Mississippi with notes on certain species from Texas. Miss. Agr. Exp. Sta. Tech. Bul. 2. 78 p., illus.
- 1931. The magnolia scale (*Neolecanium cornuparvum* Thro.). Ann. Ent. Soc. Amer. 24(2):302-304, illus.
- 1935. Insect enemies of shade trees. Comstock Pub. Co., Ithaca, N. Y. 417 p., illus.
- Hodgson, C. J. 1967a. Notes on Rhodesian Coccidae (Homoptera: Coccoidea): Part I: The genera *Coccus*, *Parasaissetia*, *Saissetia* and a new genus *Mashona*. Arnoldia (Rhodesia) 3(5):1-22, illus.
- 1967b. A revision of the species of the genus *Ceronema* Maskell (Homoptera: Coccoidea) recorded from the Ethiopian region. Arnoldia Rhodesia 3(22):1-7, illus.
- 1967c. A revision of the species of *Inglisia* Maskell (Homoptera: Coccoidea) recorded from the Ethiopian region. Arnoldia (Rhodesia) 3(23):1-11, illus.
- 1967d. Some *Pulvinaria* species (Homoptera: Coccidae) of the Ethiopian region. J. Ent. Soc. S. Africa. 30(2):198-211, illus.
- 1968. Four new species and a new genus of Coccidae (Homoptera: Coccoidea) from Africa. Proc. R. Ent. Soc. Lond. (ser. B). 37(7-8): 114-120, illus.
- 1969a. Notes on Rhodesian Coccidae (Homoptera: Coccoidea) Part II: The genera *Ceroplastes* and *Gascardia*. Arnoldia (Rhodesia) 4(3):1-43, illus.
- 1969b. Notes on Rhodesian Coccidae (Homoptera: Coccoidea): Part III. Arnoldia (Rhodesia) 4(4):1-42, illus.
- Hollinger, A. H. 1923. Scale insects of Missouri. Univ. Mo. Agr. Exp. Sta. Res. Bul. 58. 71 p., illus.
- Hood, C. E. 1907. The lecaniums, or soft scales. Mass. Agr. Exp. Sta. Cir. No. 6. 3 p.
- Houser, J. E. 1918. Shade and forest insects. In Ohio Agr. Exp. Sta. Bul. 332. 487 p., illus.
- Howard, L. O. 1894. Some scale insects of the orchard. USDA Yearbook of Agr. 1894:249-276, illus.

- Howard, L. O. 1897. A useful American scale insect. USDA Div. Ent. Bul. (n.s.) 9:38-40.
- 1898. *Pulvinaria acericola* (W.&R.) and *P. innumerabilis* Rathv. USDA Div. Ent. Bul. (n.s.) 17:57-58, illus.
- 1900. The two most abundant pulvinarias on maple. USDA Div. Ent. Bul. (n.s.) 22:7-23, illus.
- 1911. A new species of *Coccophagus* with a table of the host relations of those species of the genus known to the writer. J. Econ. Ent. 4(2):276-277.
- Howell, J. O. and M. Kosztarab. 1972. Morphology and systematics of the adult females of the genus *Lecanodiaspis*. (Homoptera: Coccoidea: Lecanodiaspididae). Va. Polytech. Inst. and State Univ. Res. Div. Bul. 70:248 p., illus.
- Hunter, S. J. 1899. The Coccidae of Kansas, II. Kansas Univ. Quart. (ser. A) 8:67-77, illus.
- Johnson, W. G. 1899a. Miscellaneous entomological notes. USDA Div. Ent. Bul. (n.s.) 20:62-68.
- 1899b. The odour of Coccidae. Canad. Ent. 31(2):87-88.
- Kawecki, Z. 1954. Studia nad rodzajem *Lecanium* Burm. II. Misczchnik cisowy, *Lecanium pomeranicum* sp. n. i gatunki pokrewne (Homoptera: Coccoidea: Lecaniidae). Ann. Zool., Warszawa. 16:9-23, illus.
- 1958. Studies on the genus *Lecanium* Burm. IV. Materials to a monograph of the brown scale *Lecanium corni* Bouché, Marchal (♀ nec ♂) (Homoptera: Coccoidea: Lecaniidae). Ann. Zool. 4(9):135-245, illus.
- 1961. A revision of the species of the genus *Lecanium* Burm. occurring in Poland and the description of *Lecanium slavum* sp. n. 11th Internatl. Kong. f. Ent. Wien 1 (1960):65-67, illus.
- Kell, D. 1912.* The longulus scale. Pomona Coll. J. Ent. 4:798-800.
- King, G. B. 1899. Contributions to the knowledge of the Massachusetts Coccidae. II. Canad. Ent. 31(6):139-143.
- 1900. A new *Pulvinaria* from New Mexico. Canad. Ent. 32:360.
- 1901a. Two new species of *Pulvinaria*. Canad. Ent. 33(5):144-146.
- 1901b. *Lecanium caryae* Fitch. Ent. News 12:50-51.
- 1901c. The Coccidae of British North America. Canad. Ent. 33(7):193-200.
- 1901d. The greenhouse Coccidae I. Ent. News 12:231-233; 310-314.
- 1901e. The Coccidae of British North America. Canad. Ent. 33(11):314-315.
- 1901f. The Coccidae of British North America. Canad. Ent. 33(12):333-336.
- 1902a. Further notes on Massachusetts Coccidae. Canad. Ent. 34(3):59-63.
- 1902b. Coccidae of British North America. Canad. Ent. 34(5):158-161.
- 1903. Some new records of Coccidae. Canad. Ent. 35(7):191-197.
- Kosztarab, M. 1956. Parasitologische Untersuchungen an Schildläusen. Acta Agronomica, Budapest 6(3-4):393-410, illus.

- Kosztarab, M. 1964. The armored scale insects of Ohio (Homoptera: Coccoidea: Diaspididae). Ohio Biol. Survey Bull. (n.s.) 2(1963). 120 p., illus.
- Krombein, K. V. 1951. Wasp visitors of tulip-tree honeydew at Dunn Loring, Virginia. Ann. Ent. Soc. Amer. 44(10):141-143.
- Kuwana, S. I. 1902. Coccidae (Scale Insects) of Japan. Calif. Acad. Sci. Proc. (ser. 3, zool.) 3:43-98, illus.
- 1909. Coccidae of Japan. (III). First supplemental list of Japanese Coccidae, or scale insects, with description of eight new species. J. N. Y. Ent. Soc. 17:150-158, illus.
- 1914. Coccidae of Japan, (V). J. Ent. Zool. 6:1-11, illus.
- 1923. Descriptions and biology of new or little-known coccids from Japan. (Japan) Dept. Agr. and Com., Imp. Plant Quar. Sta. Bul. 3:1-65, illus.
- Langford, G. S. and E. N. Cory. 1939. Common insects of lawns, ornamental shrubs and shade trees. Univ. Md. Ext. Bul. 84. 54 p., illus.
- Lawson, P. B. 1917. Scale insects injurious to fruit and shade trees. The Coccidae of Kansas. Bul. Kansas Univ., Biol. Ser., 18, (pt. I):161-279, illus.
- Leonardi, G. 1898. Diagnosi di cocciniglie nuove. Riv. di Patol. Veg. 6 (1897): 115-125 (273-283), illus.
- 1920. Monografia delle cocciniglie italiane. Della Torre, Portici (Naples). 555 p.
- Lindinger, L. 1907. Betrachtungen über die Cocciden-Nomenklatur. Ent. Wbl. 24(5):19-20; (6):22-23.
- 1912. Die Schildläuse (Coccidae) Europas, Nordafrikas, und Vorderasiens, einschliesslich der Azoren, der Kanaren und Madeiras. Ulmer Stuttgart. 388 p., illus.
- Linnaeus, C. 1758. Insecta, Hemiptera. *Coccus*. Systema Naturae (Ed. 10) 1:455-457.
- Lugger, O. 1900.* Bugs injurious to our cultivated plants. Univ. Minn. Agr. Exp. Sta. Bul. 69. 259 p., illus.
- Lull, R. S. 1899. A new species of *Pulvinaria*. Ent. News 10:237-242, illus.
- MacAloney, H. J. 1961. Pine tortoise scale. USDA Forest Pest Leaflet 57. 7 p., illus.
- MacGillivray, A. D. 1921. The Coccidae. Urbana, Ill. Scarab, 502 p.
- Marchal, P. 1908a. Notes sur le Cochenilles de l'Europe et du Nord de l'Afrique. Soc. Ent. de France Ann. 77:223-309, illus.
- 1908b. La *Lecanium* du *Robinia*. Compt. Rend. Seances Soc. Biol. Paris 65:2-5.
- Marlatt, C. L. 1899. Temperature control of scale insects. USDA Div. Ent. Bul. 20 (n.s.):73-76.
- Maskell, W. M. 1879. On some Coccidae in New Zealand. New Zeal. Inst. Trans. and Proc. 11 (1878):187-228, illus.
- 1887. An account of the insects noxious to agriculture and plants in New Zealand, The scale insects (Coccidae). Wellington, Didsbury. 116 p., illus.
- 1892. Art. XXVI—Further coccid notes: with description of new species from Australia, India, Sandwich Islands, Demerara, and South Pacific. New Zeal. Inst. Trans. and Proc. 25(1892):201-252.
- McConnell, H. S. 1949. A new North American species of *Pulvinaria*. Proc. Ent. Soc. Wash. 51(1):29-34, illus.

- McDaniel, E. I. 1930. Soft scales injurious to deciduous ornamentals. Mich. State Col. Agr. Exp. Sta. Bul. 133. 17 p., illus.
- Merrill, G. B. 1953. A revision of the scale insects of Florida. Fla. State Plant Bd. Bul. 1. 143 p., illus.
- Merrill, G. B. and J. Chaffin. 1923. Scale insects of Florida. Quart. Bul. Fla. State Plant Bd. 7(4):177-298, illus.
- Morrison, H. 1920. The nondiaspine Coccidae of the Philippine Islands with descriptions of apparently new species. Philippine J. Sci. 17(2):147-202, illus.
- 1921. Some nondiaspine Coccidae from the Malay Peninsula, with descriptions of apparently new species. Philippine J. Sci. 18(6):637-677, illus.
- 1927. Descriptions of new genera and species belonging to the coccid family Margarodidae. Biol. Soc. Wash. Proc. 40:99-109, illus.
- 1929. Some neotropical scale insects associated with ants (Hemiptera-Coccidae). Ann. Ent. Soc. Amer. 22:33-60, illus.
- Morrison, H. and E. Morrison. 1966. An annotated list of generic names of the scale insects (Homoptera: Coccoidea). USDA Misc. Pub. 1015. 206 p.
- Munsell Book of Color. 1965. Pocket Ed. Munsell Color Co., Inc., Baltimore. 41 color charts.
- Murtfeldt, M. E. 1893.* *Lecanium persicae*. Ann. Rpt. Mo. State Hort. Soc. (1892):186.
- 1894a. Notes on the insects of Missouri for 1893. USDA Div. Ent. Bul. 32 (old series):37-45.
- 1894b.* The peach bark louse. Colemans Rural World 46(17): 131.
- Newell, W. 1899. Some injurious scale insects. Iowa Agr. Col. Exp. Sta. Bul. 43:145-176, illus.
- Newstead, R. 1894. Scale insects in Madras. Indian Mus. Notes 3(5):21-32, illus.
- 1900. The injurious scale insects and mealybugs of the British Isles. J. Royal. Hort. Soc. 23. 44 p.
- 1903. The Coccidae of the British Isles II. Ray. Soc. 270 p., pls. 36-75.
- Olivier, G. A. 1791. Cochenille, Coccus, genre d'insectes de la première section de l'orders des Hémiptères. In Encycl. Method., Hist. Nat. Insectes 6:85-100, illus.
- Orr, L. W. 1931. Studies on natural vs. artificial control of the pine tortoise scale. Univ. Minn. Agr. Exp. Sta. Tech. Bul. 79. 19 p., illus.
- Packard, A. S. 1881. Insects injurious to forest and shade trees. U. S. Ent. Comm. Bul. 7. 275 p., illus.
- 1890. Insects injurious to forests and shade trees. Fifth Rpt. U. S. Ent. Comm. Government Printing Office, Washington. 957 p.
- Patch, E. M. 1905. The cottony grass scale. *Eriopeltis festucae* (Fonsc.). Maine Agr. Exp. Sta. Bul. 121:169-180, illus.
- Peck, O. 1963. A catalogue of the Nearctic Chalcidoidea (Insecta: Hymenoptera). Canad. Ent. Supp. 30. 1092 p.
- Pergande, T. 1898. The peach lecanium. (*Lecanium nigrofasciatum* n. sp.) USDA Div. Ent. Bul. (n.s.) 18:26-29, illus.
- Pettit, R. H. 1902. Some insects of the year 1901. Mich. Agr. College Exp. Sta. Bul. 200:181-190, illus.

- Pettit, R. H. 1904. Insects injurious to fruits in Michigan. Mich. State Agr. Col. Exp. Sta. Bul. 24. 79 p., illus.
- Pettit, R. H. and E. McDaniel. 1920. The Lecania of Michigan. Mich. Agr. College Exp. Sta. Tech. Bul. 48. 35 p., illus.
- Phillips, J. H. H. 1962. Description of the immature stages of *Pulvinaria vitis* (L.) and *P. innumerabilis* (Rathvon) (Homoptera: Coccoidea), with notes on the habits of these species in Ontario, Canada. Canad. Ent. 94(5):497-502, illus.
- 1965. Notes on species of *Lecanium* Burmeister (Homoptera: Coccoidea) in the Niagara Peninsula, Ontario, with a description of a new species. Canad. Ent. 97(3):231-238, illus.
- Putnam, J. D. 1878. Report on maple bark louse. Iowa State Hort. Soc. Ann. Rpt. 12(1877):317-324.
- 1880. Biological and other notes on Coccidae. Davenport Acad. Sci. Proc. 2(1879-1880):293-347, illus.
- Quaintance, A. L. 1897. New and little known Coccidae from Florida. II, biological observations. Psyche 8:91.
- 1905. The principal insect enemies of the peach; In USDA Yearbook: 325-348.
- Quayle, H. J. 1911. The black scale. Calif. Agr. Exp. Sta. Bul. 223:151-200.
- 1915. The citricola scale (*Coccus citricola*, Camp.). J. Econ. Ent. 8:291-292.
- 1917. Some comparisons of *Coccus citricola* and *C. hesperidum*. J. Econ. Ent. 10:373-376.
- 1932. Biology and control of citrus insects and mites. Univ. Calif. Agr. Exp. Sta. Bul. 542:1-87.
- Rathvon, S. S. 1854. *Coccus innumerabilis*, (bark louse). Penn. Farm J. 4: 256-258, illus.
- Reed, D. K., W. G. Hart, and S. J. Ingle. 1968. Laboratory rearing of brown soft scale and its hymenopterous parasites. Ann. Ent. Soc. Amer. 61(6): 1443-1446.
- Reinking, R. B. 1964. Brown soft scale in Texas. Proc. Fla. State Hort. Soc. 77:70-71.
- Richards, W. R. 1958. Identities of species of *Lecanium* Burmeister in Canada (Homoptera: Coccoidea). Canad. Ent. 90(5):305-313, illus.
- Riley, C. V. 1894. Notes on Coccidae. Proc. Ent. Soc. Wash. 3:65-71.
- Riley, C. V. and L. O. Howard. 1889. The Florida wax scale in California. Insect Life 1:325-326.
- 1890. The scale question in Florida. Insect Life 2:367-368.
- 1894. The fluted scale in Florida. Insect Life 6:347-348.
- Russell, L. M. 1970. Additions and corrections to an annotated list of generic names of scale insects (Homoptera: Coccoidea). USDA Agr. Res. Serv. Suppl. Misc. Pub. 1015. 13 p.
- Sanders, J. G. 1904. The Coccidae of Ohio, I. Ohio State Univ. Bul. (Ser. 8) No. 17:25-92.
- 1905. The cottony maple scale. (*Pulvinaria innumerabilis* Rathvon) USDA Cir. 64:1-6, illus.
- 1907. The terrapin scale. (*Eulecanium nigrofasciatum* Pergande). USDA Bur. Ent. Cir. 88. 4 p., illus.
- 1909. The identity and synonymy of some of our soft scale-insects. J. Econ. Ent. 2:428-448, illus.

- Sanders, J. G. 1910. A review of the Coccidae described by Dr. Asa Fitch. Proc. Ent. Soc. Wash. 12(2):55-61.
- Saunders, W. 1883. Insects injurious to fruits. J. B. Lippincott Co., Philadelphia. 436 p., illus. (Reprinted in 1909.)
- 1884. *Pulvinaria innumerabilis* Rathvon. Canad. Ent. 16(8): 141-143, illus.
- 1885. Popular papers on entomology. Ann. Rpt. Ent. Soc. Ontario 15:26-30.
- Savescu, A. 1943. Oekoarten bei Lecaniden. Bucharest Acad. Romana, Sect. Sci. Bul. 25 (1942-43):212-223, illus.
- Schmutterer, H. 1952a. Die Ökologie der Cocciden (Homoptera: Coccoidea) Frankens. (pts. 1-3) Ztschr. f. Angew. Ent. 33:369-420, 544-584, 34:65-100, illus.
- 1952b. Zur Kenntnis der Schildlausfauna Bayerns (Homopt. Coccoidea) Nachrichtenbl. d. Bayerischen Ent. 1:14-15, 18-21.
- 1954. Zur Kenntnis einiger wirtschaftlich wichtiger mitteleuropäischer *Eulecanium* Arten (Homoptera: Coccoidea: Lecaniidae). Zeitschr. f. Angew. Ent. 36:62-83, illus.
- Schumacher, F. 1919.* Die Schildlausgattung *Eriopeltis* in Nordamerika. Deutsche Ent. Zeitschr. 1919:119-120.
- Scott, W. M. 1900. Notes on the Coccidae of Georgia. USDA Div. Ent. Bul. (n.s.) 26:49-54.
- Signoret, V. 1869. Essai sur les Cochenilles (Homopteres: Coccides) II. Soc. Ent. de France Ann. (ser. 4) 8:829-876, illus.
- 1872. Essai sur les Cochenilles ou gallinsectes (Homoptères-Coccides) Part 8. Soc. Ent. de France Ann. (ser. 5) 1:421-434, illus.
- 1873. Essai sur les Cochenilles ou gallinsectes (Homoptères-Coccides). Part 10. Soc. Ent. de France Ann. (ser. 5) 3:27-48; 395-400.
- 1877. Essai sur les Cochenilles ou gallinsectes (Homoptères-Coccides). Part 18. Soc. Ent. de France Ann. (ser. 5) 6(1876):591-676, illus.
- Silvestri, F. 1920. Descrizione e notizie del *Ceroplastes sinensis* D. Guerc. (Hemiptera, Coccidae) Bol. Lab. Zol. Portici. 14:3-17.
- Simanton, F. L. 1916. The terrapin scale: an important insect enemy of peach orchards. USDA Bul. 351. 96 p., illus.
- Simmonds, F. J. 1957. A list of the Coccidae of Bermuda and their parasites. Dept. Agr. Bermuda Bul. 30. 12 p.
- Sleesman, G. B. 1945. The Coccidae or scale insects of Pennsylvania. Pa. Acad. Sci. Proc. 19:43-48.
- Smith, E. A. 1878a. *Lecanium aceris* Fitch. Canad. Ent. 10(9):176-177.
- 1878b. The maple tree bark louse. Amer. Nat. 12:655-661, illus.
- Smith, F. F., A. K. Ota, C. W. McComb, and J. A. Weidhaas, Jr. 1971. Development and control of a wax scale, *Ceroplastes ceriferus*. J. Econ. Ent. 64(4):889-893, illus.
- Smith, J. B. 1911. Insects injurious to the peach trees in New Jersey. N. J. Agr. Exp. Sta. Bul. 235. 43 p., illus.
- Snowball, G. J. 1970. *Ceroplastes sinensis* Del Guercio (Homoptera: Coccidae), a wax scale new to Australia. J. Austral. Ent. Soc. 9:57-64.
- Spiller, D. 1943. The seasonal cycle of the hardwax scale in New Zealand. New Zeal. J. Sci. and Technol. 25(3):129-130.

- Starnes, H. N. 1897. The San José and other scales in Georgia. Ga. Exp. Sta. Bul. 36. 31 p., illus.
- Steinweden, J. B. 1929. Bases for the generic classification of the coccid family Coccidae. Ann. Ent. Soc. Amer. 22(2):197-245, illus.
- 1930. Characteristics of some of our California soft scale insects, (Coccidae). Calif. Dept. Agr. Monthly Bul. 19(8):561-571, illus.
- 1946. The identity of certain common American species of *Pulvinaria* (Homoptera: Coccoidea: Coccidae). Microentomology. 11:2-28, 13 figs.
- Sulc, K. 1908. Towards the better knowledge of the genus *Lecanium*. Ent. Monthly Mag. 44:36.
- 1932. Československé druhy rodu puklice (Gn. *Lecanium*, Coccidae, Homoptera). Die tschechoslowakischen *Lecanium*—Arten. Prace Morav. Prirod. Spolec. (Acta. Soc. Sci. Nat. Morav.) 7(5). 134 p., illus.
- Symons, T. B. and E. N. Cory. 1910. The terrapin scale. Md. Exp. Sta. Bul. 149:83-92.
- Takahashi, R. 1955. *Pulvinaria* of Japan (Coccidae: Homoptera) Kontyu 23: 148-154, illus.
- Targioni-Tozzetti, A. 1866.* Come certe cocciniglie sieno cagione di alcune melate delle piante, e di alcune ruggini; e come la cocciniglia del fico dia in abbondanza una specie di cera. Atti Accad. Georg. Firenze (n.s.) 13: 115-146.
- 1968.* Introduzione alla seconda memoria per gli studj sulle cocciniglie, e catalogo dei generi e delle specie della famiglia dei Coccidi. Soc. Ital. di Sci. Nat. Atti. II: 694-738.
- Thomas C. 1878. Noxious and beneficial insects of State of Illinois. State Ent. Report 7:120-131, illus.
- Thompson, W. R. 1944. A catalog of the parasites and predators of insect pests. Sec. I, Part 3, Parasites of the Hemiptera. Imp. Agr. Bur. Inst. Ent. Belleville, Ont., Canada. 149 p.
- Thro, W. C. 1903. Distinctive characteristics of the species of the genus *Lecanium*. Cornell Univ. Agr. Exp. Sta. Bul. 209:205-221, illus.
- Trimble, F. M. 1925. Scale insects injurious in Pennsylvania. Pa. Agr. Dept. Bul. 398, Vol. 8(2):21 p., illus.
- Tyrell, M. W. 1896. The lecaniums of California. Calif. Agr. Exp. Sta. Ann. Rpt. 1894-95:262-270, illus.
- Uphof, J. C. Th. 1968. Dictionary of economic plants. (Second Ed.) Verlag Von J. Cramer, Lehre. 591 p.
- Voyle, J. 1883. Experiments upon scale insects affecting the orange. USDA Div. Ent. Bul. 1:19-30.
- Walker, F. 1852. List of the specimens of homopterous insects in the collection of the British Museum, (pt.4) Newman, London:908-1188.
- Wallner, W. E. 1969. Insects affecting woody ornamentals, shrubs and trees. Mich. State Univ. Coop. Ext. Serv. Bul. 530. 45 p., illus.
- Walsh, B. D. and C. Riley. 1868. A new bark louse on the osage orange. Amer. Ent. 1:14, illus.
- Watson, J. R. and E. W. Berger. 1932. Citrus insects and their control. Univ. Fla. Agr. Exp. Sta., Fla. State Col. Women and USDA Coop. Bul. 67. 140 p.
- Westwood, J. O. 1870. The camellia *Coccus*—*Coccus floccifera* Westw. Gard. Chron. and Agr. Gaz. No. 10:308.

- White, A. 1846. Descriptions of some apparently new species of homopterous insects in the collection of the British Museum. *Ann. Mag. Nat. Hist.* 17: 330-333.
- Williams, D. J. 1969. The family-group names of the scale insects (Homiptera: Coccoidea). *Bul. British Mus. Nat. Hist. (Ent.)* 23(8):317-341.
- Williams, M. L. and M. Kosztarab. 1970. A morphological and systematic study of the first instar nymphs of the genus *Lecanodiaspis* (Homoptera: Coccoidea: Lecanodiaspididae). *Va. Polytech. Inst. Res. Div. Bul.* 52. 96 p., illus.
- Wilson, C. E. 1917. Some Florida scale insects. *Fla. State Plant Bd. Quart. Bul.* 2:2-65, illus.
- Wray, D. L. 1950. Insects of North Carolina (Second Supplement). N. C. Dept. Agr. 59 p.
- 1967. Insects of North Carolina, Third Supplement. N. C. Dept. Agr. Div. Entomol. Raleigh. 181 p.
- Zeck, E. H. 1932. Investigations on two white wax scales (*Ceroplastes*) as pests in Australia. *Agr. Gaz. N. S. W.* 43:611-616.
- Zimmerman, E. C. 1948. Insects of Hawaii (Homoptera: Sternorhyncha). Vol. 5, Univ. Hawaii Press. Honolulu. 464 p., illus.

INDEX TO HOST PLANTS

The scientific names included, with some exceptions, are in accordance with listings from the following sources: *Standardized Plant Names* by H. P. Kelsey and W. A. Dayton (1942); *Manual of Cultivated Plants* by L. H. Bailey (1949); *New Britton and Brown Illustrated Flora* by H. A. Gleason (1968); and *Dictionary of Economic Plants* by J. C. Th. Uphof (1968). Host plant names which could not be found in the above references are enclosed in quotation marks.

- Abies* sp. 105
Acalypha sp. 140
Acer, sp. 6, 89, 120, 151
 negundo L. 76, 120, 146, 151
 nigrum Michx. 76, 146
 palmatum Thunb. 140
 pensylvanicum L. 125, 151
 platanoides L. 84
 pseudo-platanus L. 90
 rubrum L. 76, 84, 89, 120, 125, 146, 151
 saccharinum L. 10, 12, 76, 85, 89, 120, 146, 151
 saccharum Marsh. 76, 90
Agrostis
 alba L. 68
 perennans (Walt.) Tuckerman 63
Albizia
 julibrissin Durazz. 91
 occidentalis Brandegee 160, 164
Alder, see *Alnus*
Alnus sp. 152, 156
Amygdalus
 persica L. 90
Apple, see *Malus*
Ardisia sp. 140
Artemisia
 abrotanum L. 42
Ash, see *Fraxinus*
Avocado, see *Persea americana*

Basswood, see *Tilia*
Bauhinia sp. 107, 112
"Baybush" 56
"Bay tree" 56
Beech, see *Fagus*
Begonia, sp. 55, 61
 radicans Vell. 55
Berberis, sp. 96
 canadensis Mill. 91, 96
 julianae Schneider 8, 42, 96
 thunbergii DC. 42
 triacanthophora Fedde 42
Betula, sp. 75, 90, 98
 glandulosa Michx. 152, 156
 pendula Roth 42
Birch, see *Betula*

Blackgum, see *Nyssa*
Black locust, see *Robinia*
Blueberry, see *Vaccinium*
"Brassia actinophylla" F. Muell. 112
Bumelia
 angustifolia Nutt. 90
Buxus, sp. 37, 42
 sempervirens L. 42

Callicarpa
 americana L. 140
Camellia, sp. 12, 37, 61, 136, 141
 japonica L. 42
 sasanqua Thunb. 42, 136
Carpenteria
 californica Torr. 96
Carpinus
 caroliniana Walter 77
Carya, sp. 70, 75, 77, 97, 98, 146, 151
 glabra (Mill.) Sweet. 75
 illinoensis (Wagenh.) K. Koch 151
 ovata (Mill.) Koch. 77, 146
Castanea
 dentata (Marsh.) Borkh. 70, 77, 90
 pumila (L.) Mill. 98
Celtis, sp. 75, 77
 occidentalis L. 14, 37, 146
Cephalanthus, sp. 170, 171
 occidentalis L. 77, 160, 164
Cercis
 canadensis L. 55, 90
Chaenomeles
 japonica Lindl. 37, 90
Chestnut, see *Castanea*
Citrus, sp. 53, 61, 125, 129, 130
 aurantium L. 55
 limon Burmann. 55, 61
 mitis Blanco 43
 paradisi Macf. 55, 61
Clematis sp. 90
"Cluster pine" 182
Coleus sp. 61
Cornus, sp. 140, 151, 156
 florida L. 77, 120, 125, 126, 146, 151

- Crataegus*, sp. 37, 42, 152, 156
 oxyacantha L. 90
Cryptocoryne sp. 55
Cupressus sp. 83
Cydonia
 oblonga Mill. 90
 Cypress, see *Cupressus*

Daphne sp. 91, 96
Datura
 arborea L. 140
Deutzia sp. 42, 156
Diospyros, sp. 42
 kaki L. 126, 130
 virginiana L. 97, 146
 Dogwood, see *Cornus*

Elaeagnus, sp. 91
 angustifolia L. 90
 Elm, see *Ulmus*
Euonymus, sp. 2, 37, 42, 55, 56, 91, 96
 atropurpureus Jacq. 90
 japonicus L. 42
 japonicus var. *microphyllus* Sieb.
 42, 55, 91
Euphorbia sp. 14

Fagus, sp. 75, 82
 grandifolia Ehrh. 146
Fatsia
 japonica Decaisne & Planchon
 107, 112
 "Fern" 56, 61
 "Fern locust" 146
 "Festuca caespitosa" Desf. 68
Ficus sp. 55
 Fir, see *Abies*
 Firethorn, see *Pyracantha*
Fraxinus sp. 77, 90, 151
Fuchsia sp. 56

Gardenia, sp. 37, 43, 118
 jasminoides Ellis 170
Gleditsia sp. 75
Gordonia lasianthus (L.) Ellis 170
 Grape, see *Vitis*
 "Grass" 62, 63
 "Grossularia divaricata" Steud. 156

 Hackberry, see *Celtis*
Haworthia
 fasciata Haw. 56
 Hawthorn, see *Crataegus*
Hedera
 helix L. 56, 140
 Hemlock, see *Tsuga*
Hibiscus
 syriacus L. 126, 130
 Hickory, see *Carya*
 Holly, see *Ilex*
 Honeylocust, see *Gleditsia*
 Hornbeam, see *Carpinus*

 "Huckleberry" 135
Hydrangea, sp. 141
 macrophylla Seringe 145

Ilex, sp. 37, 43, 48, 49, 56, 61, 120, 125, 136
 aquifolium L. 42, 49, 140
 cassine L. 152, 156
 cornuta Lindl. 2, 4, 37, 42, 120, 136
 cornuta var. *burfordii* DeFrance
 2, 4, 37, 42, 43, 61, 136
 crenata Thunb. 37, 42, 61
 crenata var. *microphylla* Maxim.
 4, 42, 49, 53, 120
 crenata var. *rotundifolia* Hort.
 42, 49
 apaca Ait. 90, 120, 140
 vomitorea Ait. 42, 43
 Ivy, see *Hedera*

 "Japanese magnolia" 165, 170
Jasminum sp. 136
Juglans, sp. 170
 nigra L. 75
Juniperus, sp. 83
 virginiana L. 83

Laurus, sp. 56, 61
 nobilis L. 61
Lespedeza
 cuneata (Dumont) D. Don 61
 "Lily" 61
Lindera
 benzoin (L.) Blume 85, 89, 146
Liriodendron
 tulipifera L. 77, 165, 170
Lonicera sp. 96

Magnolia, sp. 100, 104, 165, 169, 170
 acuminata L. 104, 165, 170
 acuminata var. *cordata* (Michx.)
 Sargent 105
 grandiflora L. 105, 170
 kobus DC. 170
 "lennei" Topf. 170
 liliflora Desrousse 105
 "nigra" 165
 "sinensis" 170
 soulangeana Soul. 105
 soulangeana var. *alexandrina*
 Rehder 165
 stellata Maxim. 100, 165
 grandiflora L. 42
 virginiana L. 90, 165
Mahonia
 aquifolium (Lindl.) Don 56
Malus sp. 75
 Maple, see *Acer*
Melia
 azedarach L. 90
Michelia
 fusca Blume 170, 171

- Mimosa* sp. 89
Morus sp. 75, 90
Myrica
 pennsylvanica Lois.-Deslong. 77
Nephrolepis
 exaltata var. *bostoniensis* Davenport, 56
Nerium, sp. 61
 oleander L. 90
Nyssa
 sylvatica Marsh. 77, 120
 Oak, see *Quercus*
Olea sp. 90
Padus sp. 90
 "Palm" 56
 Peach, see *Prunus persica*
 Pear, see *Pyrus*
Persea, sp. 61, 112
 americana Mill. 56
 borbonia (L.) Raf. 61, 107, 112
 Persimmon, see *Diospyros*
Phoradendron sp. 85
Picea
 abies (L.) Karst. 10, 106
 pungens Engelm. 106
Pieris
 japonicus D. Don 120
 Pine, see *Pinus*
Pinus, sp. 10, 113, 117, 159, 172, 176, 178, 182, 187
 "australis" Michx. 113, 117
 banksiana Lamb. 176
 contorta Loud. 182
 echinata Mill. 171, 177
 mugo Turra. 117, 171, 176, 177
 nigra Arnold 176
 palustris Mill. 113, 117, 171, 182
 pungens Michx. 117
 resinosa Ait. 177
 rigida Mill. 117, 177, 182
 strobis L. 176
 sylvestris L. 171, 177, 181
 taeda L. 113, 117, 171, 176, 182, 187
 virginiana Mill. 18, 172, 177, 182
Platanus
 occidentalis L. 70, 76, 77, 85, 89, 97, 151
 orientalis L. 90
Plumeria
 acutifolia Poir. 56
Poa
 pratensis L. 68
Podocarpus
 macrophylla D. Don 42
 nagi Makino 37
 Poinsettia, see *Euphorbia*
 Poplar, see *Populus*
Populus, sp. 165
 alba L. 156
 deltoides Marsh. 90, 151
Prunus, sp. 75, 77, 89, 96, 145, 156
 cerasifera var. *atropurpurea* Dippel 85
 persica (L.) Batsch. 6, 75
 sinconii Carr. 90
Psidium sp. 140
Pyracantha, sp. 61, 126
 coccinea Roem 37, 42, 126
Pyrus, sp. 70
 communis L. 90
 decora (Sarg.) Hyland 156
 malus L. 90, 151
Quercus, sp. 71, 82, 98, 151
 alba L. 77, 98
 laurifolia Michx. 98
 palustris Muenchh. 82, 151
 phellos L. 77, 98
 rubra L. 6, 12, 70, 77, 146
 velutina Lam. 77, 98
 virginiana Mill. 82, 90, 151
 Redbay, see *Persea borbonia*
 "Red magnolia" 165
Rhododendron, sp. 135, 136
 molle Don 135
 nudiflorum Torr. 130, 135
 obtusum var. *kaempferi* Wils. 135
Rhus, sp. 151
 radicans L. 125
Ribes, sp. 77, 90, 152
 lacustre (Pers.) Poir. 156
Robinia
 pseudo-acacia L. 77, 82, 146
Rosa sp. 56, 90, 152, 156
Salix, sp. 6, 90, 151, 156
 babylonica L. 90
 nigra Marsh. 75, 77, 146
Sapindus
 marginatus Willd. 90
Sassafras, sp. 82
 albidum (Nutt.) Nees. 77, 89
 variifolium Gray 125
Schefflera sp. 107
Schinus sp. 61
Spiraea
 japonica L. 42
 "Spiny rutaceous tree" 107
 Spruce, see *Picea*
 "Sumac-like bush" 37
 Sycamore, see *Platanus*
Syzygium sp. 49
Taxodium
 distichum (L.) Richard 82
Taxus, sp. 6, 83
 baccata L. 140
 "Tea" 91

Thuja, sp. 83
 occidentalis L. 83
Tilia sp. 6, 77, 90, 146, 147, 170
Tsuga
 canadensis (L.) Carr. 37
Tuliptree, see *Liriodendron*

Ulmus, sp. 71, 75, 77
 alata Michx. 146
 americana L. 71, 151
 thomasi Sarg. 91

Vaccinium, sp. 90, 130, 135
 vacillans Torr. 12, 130
Vitis, sp. 61, 90, 91, 96, 146, 151
 vinifera L. 90

Walnut, see *Juglans*
Willow, see *Salix*

Yew, see *Taxus*

Zanthoxylum
 americanum Mill. 98

INDEX TO PARASITES, PREDATORS, AND ANTS ASSOCIATED WITH COCCIDAE IN VIRGINIA

Names of predators are preceded by an asterisk (*), names of ants, two asterisks (**). Names without markings are of insects found or reported as parasites. We were unable to find and check some names in the available insect catalogs; these are enclosed in quotation marks (""). The names of the 93 species of honeydew collecting Hymenoptera observed by Krombein (1951) at Dunn Loring, Virginia are not included in this list.

I N S E C T A

HEMIPTERA

Miridae

Camptobrochis

**nebulosus* Uhler 89

NEUROPTERA

Chysopidae

**Crysopa*, sp. 151

**nigricornis* Burmeister 89

Hemerobiidae

Hemerobius

**stigmaterus* Fitch 89

COLEOPTERA

Coccinellidae

Adalia

**bipunctata* (Linn.) 81

Brachyacantha

**ursina* (Fabr.) 176

Chilocorus

**bipustulatus* (Linn.) 81

**bivulnerus* Mulsant 89, 151,
170, 176

Coccinella

**novemnotata* Herbst 176

**transversoguttata* Faldeman
176

**trifasciata* Linn. 176

Hyperaspis

**binotata* Say, 89, 151, 176

**campestris* Herbst 81

**congressis* Watson 176

**signata* Olivier 89, 104, 125,
151, 176

**signata binotata* Say 170

Scymnus

**lacustris* Le Conte 176

LEPIDOPTERA

Blastobasidae

Holcocerca

**iceryaella* Riley 96

Pyalidae

***Dakrura coccidivora*" 151

Laetilia

**coccidivora* Comstock 89, 151,
170, 176

DIPTERA

Cecidomyiidae

Mycodiplosis

**moznettei* Felt 111

Chamaemyiidae

Leucopis

bellula Williston 67

"*nigricornis* Egger" 67, 125,
151

Syrphidae

Baccha

costata Say 170

HYMENOPTERA

Aphelinidae

Aneristus

ceroplastae Howard 53, 60

youngi Girault 48, 60

Aspidiotiphagus

citrinus citrinus (Craw) 60

Coccophagus

caridei (Brethes) 60

cinguliventris Girault 81, 89

eleaphilus Silvestri 60

flavifrons Howard 61, 170

fletcheri Howard 83

fraternus Howard 60, 89, 125,
187

immaculatus Howard 60, 176

japonicus Compere 61

longifasciatus Howard 89

lycimnia (Walker) 41, 48, 60,
81, 83, 89, 96, 98, 125, 140,
151, 170

"*notatus*" 81

ochraceus Howard 53

perflavus Girault 81

pulvinariae Compere 60

quaestor Girault 176

scutellaris (Dalman) 60, 81

yoshidai Nakayama 60

Marietta

javensis (Howard) 61

mexicana (Howard) 61, 89

Physcus

varicornis (Howard) 89

Prospaltella

aurantii (Howard) 89

Encyrtidae

Aenasioidea

trimblei Dozier 98

Anicetus

annulatus Timberlake 60

toumeyellae Milliron 53, 170

Aphycus

alberti Howard 60

albiceps (nomen nudum) 81

- angustifrons* (Compere) 60
annulipes (Ashmead) 81, 89
californicus Howard 89
ceroplastis Howard 48
eriococci Timberlake 60
flammeus (Compere) 98
flavus Howard 60, 81, 125, 170
(?) hederaceus (Westwood) 125
helvolus Compere 53, 60
jarvisi (nomen nudum) 83
johnsoni Howard 60, 89
lecanii Howard 98
lounsburyi Howard 81
luteolus Timberlake 60
maculipes Howard 60, 81
maculipennis Timberlake 42
orientalis Compere 61
pulvinariae Howard 61, 83, 89.
 125, 151
rileyi Timberlake 81, 89
stanleyi (Compere) 60
Apterencyrtus
microphagus (Mayr) 89
Atropates
collinsi Howard 151
Blastothrix
longipennis Howard 75, 81, 83,
 98
sericea (Dalman) 89
Cerapteroceris
mirabilis Westwood 81
Cheiloneurus, sp. 53
albicornis Howard 61, 75, 83,
 89, 125
"ceroplastis Ishii" 41
formosus Boheman 81
Coccidoxenus
(= Anagyrus) nubilipennis
 (Girault) 89
Diversinervus
elegans Silvestri 60
Encyrtus, sp. 125
bicolor (Howard) 60, 81, 83
californicus (Girault) 81, 98
(= Comys) fuscus (Howard)
 81, 89, 151
infelix (Embleton) 60
(?) lecaniorum (Mayr) 61
scutellatus (Swederus) 81
swederi Dalman 81
Ericydus
longicornis (Dalman) 81
Eusemion, sp. 41
californicum Compere 60
longipennis (Ashmead) 61, 81
Homalotylus
albitarsus Gahan 89
Metaphycus
mayri Timberlake 81
punctipes Dalman 81
Microterys, sp. 67
"aeneus" 81
"chalcostomas" 81
claripennis Compere 81
"clauseni" 48
"coccophagus" 81
"duplicatus" 81
flavus (Howard) 61, 81, 83,
 151
fuscicornis (Howard) 81, 176
lunatus Dalman 81
sylvius (Dalman) 81
xanthopsis Compere 81
"Phaenodiscus aeneus" 81
 New genus
 near *Phaenodiscus* 67
Quaylea
whittieri (Girault) 61
"Syrphophagus aeroginosus" 81
Eulophidae
Euderus (= *Chrysocharis*)
lividus (Ashmead) 81
Paraolinx (= *Leucodesmia*)
typica (Howard) 170
Tetrastichus, sp. 187
minutus (Howard) 81, 89
Eupelmidae
Eupelmus
coccidis Girault 60
neococcidis Peck 60
Formicidae
***Crematogaster*, sp. 14, 164
clara Mayr 187
Mymaridae
Anagrus
armatus (Ashmead) 81, 89
Pteromalidae
Eunotus, sp. 67
lividus Ashmead 89, 151
Moranila
californica (Howard) 61
Pachyneuron
altiseuta Cook 89, 125
californicum Girault 61
Scutellista
**cyanea* Motschulsky 42, 48, 53,
 61
Signiphoridae
Thysanus
elongatus (Girault) 61
fasciatus (Girault) 61
flavopalliatus (Ashmead) 61
niger (Ashmead) 61
pulcher (Girault) 89
Trichogrammatidae
Trichogramma
"flavum Ashmead" 61
Tridymidae
Aphobetoideus
comperei Ashmead 53

INDEX TO SCALE INSECT TAXA

Valid names in roman type, synonyms, homonyms, manuscript names and misidentifications in *italics*. Page numbers for description of taxa in **bold face**, of plates, in *italics*, of photographs, in parentheses.

- acericola* Walsh and Riley, *Lecanium* 120, 146
acericola (Walsh and Riley), *Pulvinaria* (10), (12), 27, 118, 119, **120**, *123*, 124
 152
acericorticis Fitch, *Lecanium* 146
 Aclerdidae 12
acuminatus Signoret, *Coccus* 106
alba Signoret, *Lacca* 36
antennatum Signoret, *Lecanium* 97
 Asterolecaniidae 12, 14
australiae Walker, *Ceroplastes* 36
 Beesoniidae 12
 Black scale, see *Saissetia oleae* 17
brassiae Cockerell, *Pulvinaria* 135
 Brown soft scale, see *Coccus hesperidum* 4, 17, 55, 60, 61
 Buttonbush scale, see *Toumeyella cerifera* 160
camelicola Signoret, *Pulvinaria* 135
caryae (Fitch), *Eulecanium* 70
caryae Fitch, *Lecanium* (6), 27, 29, 30, 31, 69, **70**, 71, *73*, 75, 76
caryae Fitch, *Lecanium* (*Eulecanium*) 70
cerifera (Anderson), *Ceroplastes* 36
cerifera (Fabricius), *Columnea* 36
cerifera (Anderson), *Gascardia* 36
cerifera Ferris, *Toumeyella* 6, 8, (14), 27, 29, 30, 31, 34, 158, 159, **160**, *161*,
 163, 164, 171
ceriferus (Fabricius), *Ceroplastes* (2), 17, 26, 27, 31, 35, **36**, *39*, 42
ceriferus Fabricius, *Coccus* 36
Ceroplastes Gray 17, 23, 24, 26, 28, 30, 33, **35**, 36, 48
 Ceroplastinae 16
Cerostigia De Lotto 48
chilensis Gray, *Coccus* 36
chilensis (Gray), *Coccus* (*Ceroplastes*) 36
 Chinese wax scale, see *Ceroplastes sinensis* 48, 53, 54
cirripediformis Comstock, *Ceroplastes* (2) 27, 35, 36, 53, 54
citricola (Kuwana), *Eupulvinaria* 125
citricola Kuwana, *Pulvinaria* 6, 29, 30, 31, 118, 120, **125**, *127*, 130
 Coccidae 1, 2, 4, 6, 8, 10, 12, 14, 16, 17, 20, 22, 23, 24, 26, 27, 28, 29, 30, 32
Coccidoidea 10
 Coccinae 16
 Coccini 16
Coccoidea 10, 12, 16
 Coccoid groups 23
Coccus Linnaeus 16, 17, 32, 33, 34, **54**, 69, 112

Coccus group 16
cockerelli Hunter, *Lecanium* 70
coffeae Walker, *Lecanium* 157
coffeae (Walker), *Saissetia* (14), 157, 158
coloradensis Cockerell, *Eriopeltis* 67
Common Soft Scales 10
convexa Hempel, *Protopulvinaria* 107
Corni complex 6, 70, 82, 98
corni (Bouche), *Eulecanium* 76
corni Bouche, *Lecanium* 1, (6), 24, 27, 69, 76, 77, 79, 82, 83, 84, 98
corni Bouche, *Lecanium* (*Eulecanium*) 76
corni (Bouche), *Parthenolecanium* 76
corni var. *robiniarum* Marchal, *Lecanium* 76
cornuparvum Thro, *Lecanium* 99
cornuparvum (Thro), *Neolecanium* (8), 27, 99, 100, 101
corrugatum Thro, *Lecanium* 177
corrugatum Thro, *Lecanium* (*Toumeyella*) 177
corrugatum (Thro), *Toumeyella* 177
corrugatum neglectum (Pettit and McDaniel), *Toumeyella* 182
coryli (Linnaeus), *Lecanium* 76
coryli (Linnaeus), *Parthenolecanium* 76
corylifex Fitch, *Lecanium* 76
Cottony azalea scale, see *Pulvinaria ericicola* 130
Cottony camellia scale, see *Pulvinaria floccifera* 135
Cottony citrus scale, see *Pulvinaria citricola* 125
Cottony grass scale, see *Eriopeltis festucae* 63, 67, 68
Cottony hydrangea scale, see *Pulvinaria hydrangeae* 141, 145
Cottony maple leaf scale, see *Pulvinaria acericola* 120, 125
Cottony maple scale, see *Pulvinaria innumerabilis* 146, 150, 151
coulteri Cockerell, *Pulvinaria* 152, 157
cynosbati Fitch, *Lecanium* 76

Dactylopiidae 63
deani Lawson, *Ceroplastodes* 14

ehrhorni King, *Pulvinaria* 152, 157
ericicola McConnell, *Pulvinaria* 6, (12), 27, 34, 118, 119, 130, 133, 135
Eriococcidae 12
Eriococcus Targioni-Tozzetti 12
Eriopeltinae 16
Eriopeltis Signoret 33, 62
Eriopeltis group 16
Eulecanium group 16
European fruit lecanium, see *Lecanium corni* 1, 76, 81, 82
European peach scale, see *Lecanium persicae* 91, 96, 97
Exaeretopus Newstead 16

festucae Fonscolombe, *Coccus* 62, 63
festucae (Fonscolombe), *Eriopeltis* 24, 27, 29, 31, 62, 63, 65, 67, 68
Filippia Targioni-Tozzetti 113
Filippiinae 16
fitchii Signoret, *Lecanium* 76

Fletcher scale, see *Lecanium fletcheri* 82
fletcheri (Cockerell), *Eulecanium* 83
fletcheri Cockerell, *Lecanium* (6), 69, 82, 83, 84
floccifera (Westwood), *Chloropulvinaria* 136
floccifera (Westwood), *Pulvinaria* (12), 27, 29, 31, 118, 119, 135, 136, 139, 140, 145
flocciferus Westwood, *Coccus* 135
floccosa (Westwood), *Pulvinaria* 136
 Florida wax scale, see *Ceroplastes floridensis* 43, 47, 48
floridensis Comstock, *Ceroplastes* (4), 27, 29, 30, 35, 36, 43, 45, 48
floridensis (Comstock), *Cerostigia* 43

hemicyphus Dalman, *Coccus* 105
hemicyphus (Dalman), *Physokermes* 6, 8, (10), 24, 106
hesperidum Linnaeus, *Coccus* (4), 10, 17, 26, 27, 54, 55, 59, 60, 68, 69
hesperidum Linnaeus, *Coccus* (*Lecanium*) 55
hesperidum (Linnaeus), *Lecanium* 55, 69
hesperidum (Linnaeus), *Lecanium* (*Coccus*) 55
hydrangeae (Steinweden), *Eupulvinaria* 141
hydrangeae Steinweden, *Pulvinaria* 6, 118, 119, 140 141, 143, 145

imbricatum Cockerell, *Lecanium* 99
 Inglisia group 16
innumerabills Rathvon, *Coccus* 146
innumerabilis (Rathvon), *Pulvinaria* (12), 27, 118, 119, 146, 147, 149, 152
innumerabilis var. *occidentalis* Cockerell, *Pulvinaria* 152

janeirensis Gray, *Coccus* (*Ceroplastes*) 35
 Japanese wax scale, see *Ceroplastes ceriferus* 17, 36, 41, 42, 43
japonicus Green, *Ceroplastes* 48
juglandifex Fitch, *Lecanium* 76

 Large hickory lecanium, see *Lecanium caryae* 70
Lecaniinae 2
Lecanium Burmeister 1, 2, 6, 17, 26, 32, 34, 54, 68, 69, 71, 83, 99
Lecanium Scales 6
Lecanium sp. 70
Lecaniums 8
Lecanodiaspididae 14, 16
Lecanodiaspis Targioni-Tozzetti 12, 14
liriodendri Gmelin, *Coccus* 164
liriodendri, *Eulecanium* (?) 165
liriodendri (Gmelin), *Lecanium* 164
liriodendri (Gmelin), *Lecanium* (*Toumeyella*) 165
liriodendri (Gmelin), *Toumeyella* (14), (18), 27 159, 164, 165, 167

magnoliarum (Cockerell), *Eulecanium* 91
magnoliarum Cockerell, *Lecanium* 91, 96, 97, 100
 Magnolia scale, see *Neolecanium cornuparvum* 8, 99, 100, 104, 105
magnoliarum var. *hortensiae* (Cockerell), *Eulecanium* 91
magnoliarum var. *hortensiae* Cockerell, *Lecanium* 97
mangiferae Green, *Coccus* 106

mirabile Cockerell, *Lecanium* 158
mirabilis (Cockerell), *Toumeyella* 158
miranda (Cockerell and Parrott), *Saissetia* 6, (14), 157, 158

Neolecanium Parrott 28, 31, 33, 99, 113, 159
newsteadi Leonardi, *Pulvinaria* 107
nigrofasciatum (Pergande), *Eulecanium* 84
nigrofasciatum Pergande, *Lecanium* (6), (8), 27, 31, 33, 34, 69, 70, 84, 87
nigrofasciatum Pergande, *Lecanium* (*Eulecanium*) 84
numismaticum Pettit and McDaniel, *Lecanium* 171
numismaticum Pettit and McDaniel, *Lecanium* (*Toumeyella*) 171
numismaticum (Pettit and McDaniel), *Toumeyella* 159, 171, 177

Oak *lecanium*, see *Lecanium quercifex* 97
occidentalis Cockerell, *Pulvinaria* 152, 156, 157
occidentalis, *Pulvinaria* sp. near 6, 118, 119, 152, 155, 156
occidentalis subalpina Cockerell, *Pulvinaria* 152
oleae (Olivier), *Saissetia* (14), 17, 158

parvicorne Cockerell, *Lecanium* 171
parvicornis (Cockerell), *Toumeyella* (18), 24, 26, 33, 34, 113, 158, 159, 164, 171, 175, 177, 181, 182, 187
persicae Fabricius, *Chermes* 91
persicae (Fabricius), *Eulecanium* 91
persicae (Fabricius), *Lecanium* (8), 24, 27, 29, 34, 68, 69, 84, 91, 93, 95, 96, 97
persicae (Fabricius), *Parthenolecanium* 91
phaiae Lull, *Pulvinaria* 136
Physokermes Targioni-Tozzetti 16, 28, 31, 32, 105
piceae Schrank, *Physokermes* 106
Pine tortoise scale, see *Toumeyella parvicornis* 171, 176, 177, 182, 187
pini King, *Lecanium* 177
pini (King), *Toumeyella* (18), 27, 29, 159, 177, 179, 181, 182
piriformis (Cockerell), *Protopulvinaria* 107
Protopulvinaria Cockerell 23, 28, 30, 32, 106, 107, 112
pruinoseum var. *kermoides* Tyrell, *Lecanium* 97
Pseudophilippia Cockerell 28, 31, 33, 34, 99, 112, 113, 159
psidii Maskell, *Pulvinaria* (12), 27, 31, 118, 119
Pulvinaria Targioni-Tozzetti 2, 26, 32, 34, 107, 118, 130, 157
Pulvinaria Scales 12
Pulvinariini 16
pyriformis Cockerell, *Pulvinaria* 107
pyriformis Cockerell, *Pulvinaria* (*Protopulvinaria*) 106, 107
pyriformis (Cockerell), *Protopulvinaria* (10), 27, 106, 107, 109
Pyriform scale, see *Protopulvinaria pyriformis* 107, 111

quaintancii Cockerell, *Pseudophilippia* (10), 24, 26, 27, 112, 113, 115, 117
quercifex Fitch, *Lecanium* 6, 69, 82, 97, 98
quercifex Fitch, *Lecanium* (*Eulecanium*) 97
quercitroneis (Fitch), *Eulecanium* 97
quercitroneis Fitch, *Lecanium* 97
quercitroneis Fitch, *Lecanium* (*Eulecanium*) 97
quercitroneis kermoides (Tyrell), *Eulecanium* 97
quercitroneis var. *kermoides* Tyrell, *Lecanium* 97

Rhizococcus n. sp. 63.
 rufus De Lotto, Ceroplastes 48
 rusci (Linnaeus), Ceroplastes 43

 Saissetia Deplanche 14, 17, 23, 28, 33, 157, 158
 Saissetia and Toumeyella Scales 14
 San Jose scale 90
 sinensis Del Guercio, Ceroplastes (4), 6, 8, 27, 29, 31, 35, 36, 48, 51, 53, 54
 Soft scale, see Coccidae
 Striped pine scale see Toumeyella pini 177
subaustrale Cockerell, *Lecanium* 97

 Terrapin scale, see *Lecanium nigrofasciatum* 84, 85, 89, 90
tinsleyi King, *Pulvinaria* 146
 Toumeyella Cockerell 14, 16, 18, 24, 28, 30, 31, 33, 99, 113, 158, 159, 164
 Toumeyella Scales 18
tulipiferae (Cook), *Eulecanium* 165
tulipiferae Cook, *Lecanium* 164
 Tuliptree scale, see Toumeyella liriodendri 164, 169, 170, 171

 virginiana Williams and Kosztarab, Toumeyella 6, 8, (18), 27, 29, 159, 182, 185
 Virginia pine scale, see Toumeyella virginiana 182
vitis Linnaeus, *Coccus* 118
vitis (Linnaeus), *Pulvinaria* 146, 152, 157

 Wax Scales 2, 4
 Woolly pine scale, see *Pseudophilippia quaintancii* 113