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**BIOSYSTEMATICS OF THE GENUS *CHIONASPIS***  
**(HOMOPTERA, COCCOIDEA, DIASPIDIDAE) OF NORTH AMERICA,**  
**WITH EMPHASIS ON POLYMORPHISM**

by,

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ENTOMOLOGY

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**BIOSYSTEMATICS OF THE GENUS *CHIONASPIS*  
(HOMOPTERA, COCCOIDEA, DIASPIDIDAE) OF NORTH AMERICA,  
WITH EMPHASIS ON POLYMORPHISM  
ASSOCIATED WITH FEEDING SITES**

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ENTOMOLOGY

(ABSTRACT)

The scurfy scales in the genus *Chionaspis* comprise a unique taxon among the armored scale insect genera in North America. The taxonomic reviews of the species belonging to the genus by Cooley (1899) and Ferris (1937, 1942) are far outdated.

The present research is a comprehensive review of all the species in this genus in North America, with special emphasis on polymorphism associated with feeding sites which has been discovered in some species. Seventeen species have been redescribed and illustrated in detail, each with a discussion of their morphological affinities and relationships. Their host habits and zoogeography are summarized.

The five species having typical bark and leaf forms, as well as intermediate forms, are discussed in more detail. A separate chapter deals with polymorphism, including a historical literature review of the subject. A hypothesis is given on the

modes of transfer from the bark form to the leaf form and vice versa, that results in different morphs in first or second generations. Two keys were prepared: one for the genera related to *Chionaspis* and another for the determination of the species of this genus in North America.

The three species that have been recently redescribed, *C. americana* and *C. kosztarabi* and *C. nyssae* are also discussed, and the most important morphological characters and the plates prepared by the original authors for each of these three species are given in order to better utilize the key to the species in North America.

As a direct result of this research, two new species have been discovered: *Chionaspis gilli* Liu and Kosztarab, and *C. hamoni* Liu and Kosztarab. In addition new morphs were found for *C. platani* and *C. wistariae*. This thesis also includes many new distribution and host records for several species.

The phylogenetic relationship of all the species in this study has been discussed, and as a result of the Ward's Minimum Variance Cluster Analysis (1985 version, SAS), a dendrogram has been provided based on 23 numerical characters.

TO

Agricultural University of Shandong,  
and the Ministry of Agriculture, Animal Husbandry and Fishery,  
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and

All former teachers of mine,  
who led me into the insect world,

and

My wife,                      and son,  
for their patience and understanding.



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## LEGEND FOR PLATES

A uniform labeling system was used for all standard plates as follows:

- A - Test of adult female
- B - Body of adult female (dorsal/ventral views)
- C - Pygidial margin
- D & E - Regular dorsal macroducts
- F and O - Small macroducts
- G and P - Microducts
- H - Body seta
- I - Antenna
- J - Anterior spiracle
- K - Trilocular pore near spiracle
- L - Gland spine
- M and N - Gland tubercles
- Q - Quinquelocular pore from perivulvar pore group

## LEGENDS FOR SPECIAL PLATES

### Plates 3 and 15

- A - Body of adult female
- B - Pygidium
- C - Pygidial margin, ventral & dorsal view
- D - Microduct
- E - Small macroduct
- F - Regular macroduct
- G, H, and I - Setae
- J - Antenna
- K - Anterior spiracle
- L - Trilocular pore near spiracle
- M - Gland tubercle
- N - Gland spine

### Plate 18

Adult female, dorsal/ventral views, bark form, and enlargement of pygidium.

### Plate 19

Adult female, dorsal/ventral views, leaf form, and enlargement of pygidium.

Plates 14 and 22, explanation at the bottom of each plate.

Plate 24 Median lobes of different forms:

- A - Bark form
- B - Intermediate form, close to bark form
- C - Intermediate form, between bark and leaf forms
- D - Intermediate form, close to leaf form
- E - Leaf form

Plate 26 Variation of main characters:

- A through D - Dorsal submedian ducts of abdominal segment VI
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Plate 29 Median lobes of different forms

- A - Bark form
- B - Leaf form
- C - Leaf form, abnormal median lobe on right side

Plate 31 Median lobes of different forms

- A - Bark form
- B - Intermediate form, close to bark form
- C - Intermediate form, between bark and leaf forms
- D - Leaf form

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Figure 1. Dendrogram showing relationship among 19 species of *Chionaspis* based on Ward's Minimum Variance Cluster Analysis using 23 numerical characters

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of *Chionaspis salicisnigrae* (Walsh) in North America

## INTRODUCTION

Signoret (1869) proposed the genus *Chionaspis* mainly based on the characters of the tests of both sexes, and designated 10 species as members. This is one of the earliest genera to be established in the Diaspididae. Unfortunately, of Signoret's species, only one, *Chionaspis salicis*, is considered a true member of this genus because the characters of the test in *Chionaspis* are not sufficient for identification of species.

Comstock (1883) listed 11 species of *Chionaspis* in North America. Of these, 6 species are accepted as members of this genus today, all of which are included in the present study. An early comprehensive work was completed by Cooley (1899). He gave detailed descriptions and listed synonyms for all species found in North America. Nine of his species are valid and included in this work. He also designated the European species, *Coccus salicis* Linnaeus, 1758, as the type of this genus, because Signoret used this species as an example but did not mention it as the type. Four years later, Cooley (1903) proposed a new genus, *Phenacaspis*, chose *Chionaspis nyssae* as the type, and described the new genus characterized by the pygidium with the terminal pair of lobes (median lobes) more or less sunken into the body, and having their inner edges serrate or crenate and strongly divergent. Thereafter, *Chionaspis* included only the species with produced, parallel, or more or less fused, median lobes. *Phenacaspis* was considered a valid genus until the 1960's, even though

Ferris (1937) mentioned that there certainly exists a group of species which may be associated with it, but the point at which this genus should be separated from *Chionaspis* was to some degree arbitrary.

Takahashi (1952, 1953) first challenged the American coccidologists based on his discovery that females of some species of *Chionaspis* are dimorphic. The forms infesting leaves were included in *Phenacaspis*, while those on bark or stems of the same host plant were considered members of *Chionaspis*. Ferris (1955, 1956) in his revision of *Phenacaspis*, stated that the two genera are distinct because intergradation of morphological characters separating these two genera was rare, and because *Chionaspis* was primarily Holarctic, while *Phenacaspis* was principally Oriental in distribution. Therefore, he rejected Takahashi's proposal, still insisting that no genuine species of *Chionaspis* occur in Japan.

Following Takahashi, Takagi and Kawai (1967) treated *Phenacaspis* as a junior synonym of *Chionaspis* based on later discoveries and observations, and stated that most species formerly placed in *Phenacaspis* in the Nearctic Region and in Japan belong mainly to *Chionaspis*, and few to other genera. They added that Balachowsky's definition of the genus *Chionaspis*, which they thought was excellent, should include the leaf-feeding form. They also concluded that the type species of *Phenacaspis*, *P. nyssae*, is the leaf form of *Chionaspis sylvatica* Sanders (synonym of *Chionaspis nyssae*), which feeds only on bark. Their work and proposal were later confirmed by Knipscher et al. (1976). Based on his own work and observations, Chen (1983), however, still

considered *Phenacaspis* as a valid and good genus and recognized 37 species in China even though he knew of the discoveries of Takagi and Kawai, and Knipscher et al. Takagi (1970, 1985) restated his opinion as before, and published several additional papers.

In North America, *Phenacaspis* was first treated as a synonym of *Chionaspis* by Nakahara (1975) and leaf forms and bark forms have been reported in five species (Nakahara, 1975; Takagi and Kawai, 1967; Tippins and Beshear, 1970, 1974; Knipscher et al., 1976).

*Chionaspis* is a unique genus among scale insect genera. All species are extremely similar to one another in general appearance and morphology. The pygidial margin bears the characters most useful for identification. But identification is not simply a matter of discerning differences between specimens, and the non-specialist may find it exceedingly difficult to identify an unknown specimen because the adult females of five species in North America have been discovered to be dimorphic, trimorphic, or polymorphic in association with different feeding sites on the same host. Furthermore, because of the polymorphism, some species considered earlier as distinct species and even different genera have now been combined as different morphs of the same species. The morphological variation within one species is greater than that between some genera of diaspidids. Consequently, not only may specimens be hard to identify correctly, but also identifications reported in the earlier literature cannot be fully used as reliable records.

The present work was proposed as a comprehensive biosystematic study of all species of the genus found in North America. Seventeen species have been redescribed and illustrated in detail. Three other species which were recently redescribed are also included, *C. americana* and *C. kosztarabi* by Willoughby and Kosztarab (1974), and *C. nyssae* by Knipscher et al. (1976). In addition, two new species have been described, bringing the total number of species presently included to 22 for North America.

A separate chapter dealing with polymorphism has been presented. Evidence of dimorphism of some species discovered by former workers is discussed, and a hypothesis to explain polymorphism of several species is proposed based on both the discoveries made during the present study and the author's own ideas.

After the detailed description of each species, the diagnostic characters revealing similarities and differences among related species are presented. It is my hope that it will provide supplementary information for the user in addition to the descriptions.

An attempt was made to prepare practical keys to assist users with the identification procedure. Based on that aim, two keys were prepared, one for *Chionaspis* and related genera, and one for the species of *Chionaspis* in North America. Use of these keys depends on quality slide-mounted specimens.

The phylogenetic relationship of all the species in this study has been discussed, and the Ward's Minimum Variance Cluster Analysis method (1985



## MATERIALS AND METHODS

Most of the specimens used in this study were borrowed from a number of institutions and individuals throughout the United States and from many other countries. These Institutions and individuals are listed under "Collections and Collectors" and are recognized in the "Acknowledgements" section. We also collected some additional material and mounted the specimens on slides.

**Collection and Preservation.** Most adult females occur on leaves, leaf petioles, and on bark of twigs. They are easily recognized because of the white color of their test, and may be found either singly or in dense clusters. We collected the heavily infested plant parts on which the specimens occurred, and placed them into 15 x 7.5 cm cellophane envelopes with collecting information, or into 70% EtOH in 4 dram glass vials. It was our experience that if we placed the live specimens in heated EtOH either on an electric hot plate in the laboratory or simply by heating the EtOH in the vials in the field using 1 or 2 matches, we obtained better fixed specimens for mounting.

**Preparation of Material.** As needed for detailed morphological studies under a phase contrast microscope, all specimens were slide-mounted. Live or dry, or alcohol-preserved specimens, were all suitable for slide mounting. The tra-

ditional slide mounting procedure used in our laboratory is a modified method of Wilkey (1962), as follows:

1. If the insect is alive, kill it in 70% EtOH (preferably warm). Leave it in alcohol for at least 2 hours.
2. If the insect is dead (dried on twig or stored in alcohol), place it in 10% KOH in a small glass dish for at least 2 hours, then test to see if the body contents are soft by gently pressing the body with a spatula. If body fluid does not come out easily, leave the specimen longer in KOH. or heat it (do not boil) for a few minutes over an electric hotplate, and check again.
3. When soft and ready, press out body contents with a spatula. Specimen should be clear (transparent, or nearly so) when it is done. Transfer it to 70% alcohol for about 10 minutes.
4. Place specimen in Essig's Aphid Fluid and add 2 drops of Wilkey's Double Stain. Leave for 2 hours and check for the intensity of staining by checking the specimen in alcohol. If it is sufficiently pink, leave it in 70% alcohol for about 10 minutes. If not, put it back in the stain.
5. From the 70% alcohol, transfer the insect to 100% EtOH and leave it for about 5 minutes.
6. Transfer to clove oil for further clearing for about 20 minutes. The insect can be stored in this for weeks.
7. To prepare a slide, put a drop of Canada balsam (fairly thin) diluted with xylene on the center of a slide and place the specimen in the cen-

ter of the drop, head end down. Press it to the bottom of the balsam to keep it from drifting when the cover slip is added. Place a round cover slip (12, 15 or 18 mm in diameter) over the specimen, label the slide with your initials, date, and an identification number, and place it on a slide tray in a drying oven for two weeks. We usually place 2 specimens on each slide, one ventral side up, the other dorsal side up.

**Measurements and Counts.** All measurements in descriptions are in microns except for those of tests of adult females which are in millimeters. An ocular micrometer and a Zeiss RA phase contrast microscope were used for measuring. When available, 10 specimens were described and measured for each species or form. In order to provide an accurate range, when possible the specimens were selected from different common hosts and from representative major geographical areas. The range for measurements and quantitative data is chiefly based on selected and measured specimens, while the descriptions are usually based on all the examined specimens. Length and width were measured at the longest and widest points for each morphological structure. Because of the shortage of specimens in some species and forms, the data presented may be based on all the specimens available. Material available for the present study was often limited. Therefore, the actual quantitative data presented here may represent only a small portion of the total variation which may occur in the species or forms.

The numbers given in the key and descriptions for ducts, pores, setae, gland spines, and tubercles refer to the number counted on half of the body, as is the case for the illustrations.

**Material Examined.** Unfortunately, for some species few slides were available (e. g., *C. floridensis* and *C. triformis*), while for other species there were thousands. For the species having large numbers of slides (e. g., *heterophyllae* and *pinifoliae*) it is impossible to list all under "Material Examined" because of the time and space limitations, therefore, an appendix was prepared.

Records on each species are arranged alphabetically first by host, then by locality, date, collector(s), the number of slides available from the same lot, and the institutions where the materials are deposited.

**Terminology.** The terminology used for the description of adult females in general is that used by Ferris (1942), Balachowsky (1954), Ghauri (1962), Kosztarab (1963), Willoughby and Kosztarab (1974). However, a new term, small macroduct(s), is introduced here to refer to the ducts on the marginal/submarginal areas of both dorsal and ventral surfaces. Normally these are located on the three thoracic segments and on abdominal segments I-III. These ducts are small compared with the macroducts on the pygidium, therefore a new term seemed necessary.

**Illustrations.** Bodies of adult females mounted on slides were outlined by using a Leitz Prado 500 microslide projector. Details and enlargements of

morphological structures were illustrated by using a Zeiss RA phase contrast microscope with an attached drawing tube. For each species, there is a central drawing for the entire body, with the left half representing the dorsal surface, and the right half the ventral.

The proportions for enlargements of morphological structures within the same plate or from plate to plate are not uniform. If there is a question as to their size or proportion, the measurements given in the description should be utilized.

### Abbreviations

**Collections and Collectors.** Names of curators appear in parenthesis. Collectors listed here have contributed three or more lots of material.

ABH	A. B. Hamon
AEG	A.E. Graham
AMNH	American Museum of Natural History, New York, NY (R.T. Schuh)
AU	Auburn University, Auburn, AL (M.L. Williams)
BM	British Museum (D. Williams)
CDA	California Department of Agriculture, Sacramento (R.J. Gill)
CHR	C.H. Ray
CKL	T.D.A. Cockerell
DRM	D.R. Miller

ERS E.R. Sasscer

FSCA Florida State Collection of Arthropods, Gainesville  
(A.B. Hamon)

FWH F.W. Howard

GFF G.F. Ferris

GWD G.W. Dekle

HHT H.H. Tippins

HLM H.L. McKenzie

JGS J.G. Sanders

JOH J.O. Howell

McC H.S. McConnell

McM H. McKenzie

MK M. Kosztarab

MLW M.L. Williams

PANS Philadelphia Academy of Natural Sciences, PA (W.W. Moss)

PRL P.R. Lowry

RB R. Beshear

RBM R.B. McKee

RFW R.F. Wilkey

RJG R.J. Gill

SN S. Nakahara

UCD University of California, Davis (R.O. Schuster)

UGAES University of Georgia Agricultural Experiment Station

(J.O. Howell)

USNM United States National Museum (Natural History), Washington,  
DC, and Beltsville, MD (D.R. Miller)

VPI Virginia Polytechnic Institute and State University, Blacksburg  
(M. Kosztarab)

**States.** Names for states and countries in the material studied section of the species descriptions are capitalized and in boldface type.

AL	Alabama	MN	Minnesota
AR	Arkansas	MO	Missouri
AZ	Arizona	MS	Mississippi
CA	California	NC	North Carolina
CO	Colorado	ND	North Dakota
CT	Connecticut	NE	Nebraska
DC	District of Columbia	NH	New Hampshire
DE	Delaware	NJ	New Jersey
FL	Florida	NM	New Mexico
GA	Georgia	NY	New York
HI	Hawaii	NV	Nevada
IA	Iowa	OH	Ohio
ID	Idaho	OK	Oklahoma
IL	Illinois	OR	Oregon
IN	Indiana	PA	Pennsylvania

KS	Kansas	RI	Rhode Island
KY	Kentucky	SC	South Carolina
LA	Louisiana	SD	South Dakota
MA	Massachusetts	TN	Tennessee
MD	Maryland	TX	Texas
ME	Maine	VA	Virginia
MI	Michigan	VT	Vermont
MO	Missouri	WI	Wisconsin
MT	Montana	WV	West Virginia
		WY	Wyoming

**Other abbreviations.**

C	Centigrade or Celsius	mi.	miles
ca.	about	min.	minutes
Co.	County	Mt.(s).	Mount or mountain(s)
coll.(s).	collector(s)	N	North
Comp.	company	Natl.	National
Cr.	Creek	NE	northeast
dia.	diameter	no.	number
E	East	Pk.	Park
elev.	elevation	Rd.	Road
fig.(s).	figure(s)	ref.	reference
fr.	from	Rt.	Route

Ft.	fort	S	south
Gar.	Garden	St.	Saint
Hwy.	Highway	Sta.	Station
KOH	Potassium hydroxide	Str.	Street
let.	letter	Univ.	University
		W	West

**Literature citations.** Original species descriptions, subtitle major references on *Chionaspis*, and articles cited in the general part are included in the Cited References list. Articles of lesser importance, often providing only new host or distribution records, are also listed for completeness in the literature list for each species, but the reader should find full citations for these in Morrison and Renk (1957), Morrison and Morrison (1965), also in Russell, Kosztarab and Kosztarab (1974).

## GENERAL BIOLOGY

**Life history.** All species of *Chionaspis* found in North America appear to have somewhat similar life history patterns. The female has four developmental stages: egg, first nymphal instar (crawler), second nymphal instar, and adult. The male has five stages: egg, first nymphal instar, second nymphal instar, prepupa, pupa, and adult. Most species have two generations per year, but a few are known to have only one.

The overwintering stage is the adult female or eggs under the protection of the adult female cover. This was the case even in our samples from south Florida. First generation crawlers appear in early spring and are active for a period of several days during which time they disperse to find new sites on which to settle. On leaves, most of them prefer to settle near the main and secondary veins, while some settle on petioles or even next to buds. It was reported that there is a noticeable difference between the sexes in their choice of settling sites in some species (Knipscher et al., 1976). Males seem to prefer areas away from the main vein of the leaf, either in close proximity to a secondary vein, along the margin of the leaf, or in the space between the secondary veins. On bark, males usually settle in cracks or crevices of the one or two year old twigs, although some of them settle on exposed surfaces. It also appears that the individuals of the same sex gather together in clusters. The

crawlers may move from bark to leaves, petioles, or buds to settle, and can move from leaves to bark, petioles or buds, and vice versa.

The sexes can be separated in the field when they reach the second instar. Usually the females' test is pear-shaped, composed of smooth wax and without carinae, whereas the covers of males are elongate, have parallel margins, and two or three carinae.

Adult females appear in early summer, and the eggs of the second generation begin to appear from summer to early fall. Crawlers emerge again in the summer, and then move to the tips of new branches or to new leaves where they settle. Second generation females mature usually from late summer to early fall; eggs are then laid for overwintering.

For detailed life histories of some North American species, readers can consult Hill (1953) for *C. furfura*; Cumming (1953), Brown (1958, 1959), and Luck and Dahlsten (1974) for *C. pinifoliae*; Willoughby and Kosztarab (1974) for *C. americana* and *C. kosztarabi*; also Knipscher et al. (1976) for *C. nyssae*

**Reproduction.** Both uniparental and biparental reproduction have been reported in *C. pinifoliae* (Luck and Dahlsten, 1974).

**Natural enemies.** Hymenopterous parasites of *Chionaspis* spp. are common and often effective natural biological control agents. Willoughby and Kosztarab (1974) reared eight different parasite species and two hyperparasites from *C. americana* colonies in Southwest Virginia. The

parasitization rate was 62% for generation I, and between 17 and 23% for generation II. Moreover, Kosztarab (1963) reported an 84% parasitization rate for generation I of *C. americana* in Ohio. Two mite species were important predators of *C. americana* in Virginia (Willoughby and Kosztarab, 1974).

Natural enemies of *C. pinifoliae* were recently reviewed by Luck and Dahlsten (1974). These included 14 species of predaceous coccinellid beetles. They found a dramatic effect of predation on the parasite population of *C. pinifoliae*.

**Economic importance.** Some species of *Chionaspis* have an adverse economic impact in neglected orchards and can cause severe damage on ornamental and shade trees in urban and recreational areas as well as home landscapes.

*Chionaspis furfura*, the apple scurfy scale, was considered a pest in apple orchards. *C. gleditsiae* recently became a pest of honey locust trees in New York, and *C. corni* and *C. salicisnigrae* are pests of nursery stock. *C. pinifoliae*, the pine needle scale, is a well known pest of ornamental and forest conifers. It causes heavy damage to Christmas trees in eastern North America, to Colorado spruce and Scots pine in shelter-belts in the prairie regions, and in Douglas fir stands in the western United States (DeBoo and Weidhaas, 1973). *C. heterophyllae* was considered a pest of mugho pine in Maryland (Miller, unpublished).

## THE GENUS *CHIONASPIS* SIGNORET, 1869

### Synonymy.

*Phenacaspis* - Cockerell and Cooley, 1899:398 (type species:

*Chionaspis nyssae* Comstock);

*Fundaspis* - MacGillivray, 1921:307 (type species: *Chionaspis*

*americana* Johnson);

*Marchaliella* - Bodenheimer, 1951:331 (type species: *Chionaspis*

*lepineyi* Balachowsky).

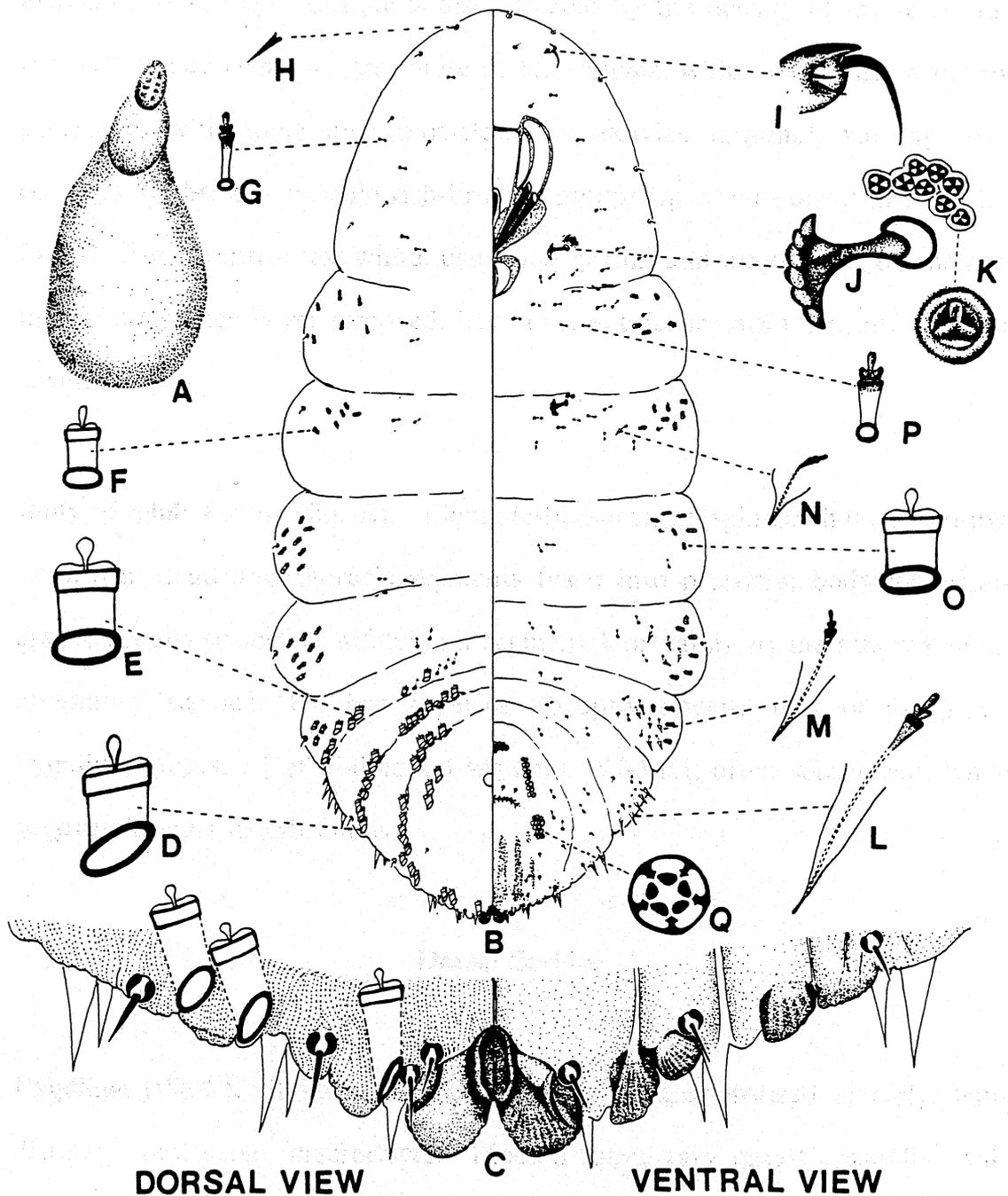
**Literature.** Signoret 1869a:442; Ferris 1937:13, 91; 1955:42 ; Balachowsky 1954e:317; Takagi and Kawai 1967:31; Takagi 1985:1-8.

**Type species.** *Coccus salicis* Linnaeus, 1758, designated by Cooley (1899:9) because in the original description of the genus Signoret mentioned this species as an example, but did not indicate that this species was selected as the type.

## GENERAL MORPHOLOGY OF SPECIES OF *CHIONASPIS*

### Plate 1

**Test of adult female (fig. A).** Usually oystershell-shaped, pear-shaped or teardrop-shaped; elongate, nearly parallel-sided, or plainly broadened



DORSAL VIEW

VENTRAL VIEW

Plate 1. - General Morphology of *Chionaspis (C. salicis)*

posteriorly, or bent to right or left side immediately beyond the second exuvium; its shape or outline is also affected by the density of the tests, and the settling site (Plate 1); test more or less convex; white or grayish white, or sometimes with some dust particles; two exuviae terminal, varying from colorless to brown or yellowish-brown, occupying about one third to one fourth of test; ventral test white, usually very thin and may be left on the surface of host when cover removed, but in some thicker ones taken off with the cover.

**Body of adult female (fig. B).** Elongate-fusiform, or spindle-shaped, reddish or brown; head and thoracic segments fused into prosoma; body lobed laterally; usually widest at abdominal segment I or rarely at metathorax or at abdominal segment II, then tapering abruptly toward apex of pygidium. Pygidium composed of abdominal segments VI-VIII, often sclerotized, while prepygidial part membranous.

#### **Dorsal Surface**

**Pygidium (fig C).** Triangular, or somewhat oval, sclerotized apically, with distinct lobes, setae, macroducts. Median lobes vary greatly, usually well-developed; strongly divergent and elongate, forming a distinct notch on apex of pygidium, in some species and in almost all leaf forms, with a separation wider than width of one lobe; some parallel at base, then strongly divergent

from middle; others broad, and close together basally, then more or less divergent; produced beyond pygidium and adjacent to each other, apically rounded, some also pointed or with notches or serrations; even though basally fused for more than half of their length, except for an apical notch. Usually with a zygotis at the bases of median lobes; this may be distinct, indistinct, short and broad, or elongate. Second pair of pygidial lobes bilobed, inner lobule larger than outer one; may extend beyond apex of median lobes, may be short and broad or similar in shape and size to median lobes; apex rounded, notched, with or without serrations; some also oblique mesally. Third pair of lobes usually bilobed, most with only inner lobule distinct, while outer one reduced to several small projections; some with wide, apically rounded or serrated inner lobule, some elongate or pointed. Macroducts, setae and marginal macroducts present on all pygidial segments.

**Macroducts (fig. D&E).** Two-barred; arranged in rather regular rows on submedian, submarginal areas of abdominal segments II-V or III-VI, and on marginal area at abdominal segments III-VII.

**Small macroducts (fig. F).** Two-barred, smaller than regular macroducts described above; irregularly arranged on submarginal-marginal areas of 2 or 3 thoracic segments and abdominal segments I-III; these becoming smaller and fewer anteriorly.

**Microducts (fig G).** One-barred, very small; only a few scattered on cephalic area, thorax, and some abdominal segments, including pygidium.

**Setae (fig. H).** Very short and hair-like, scattered on or along margins or submargins of cephalic region, margins of thoracic and abdominal segments I-VIII, and laterad of median lobes on each side of body; about 5-8 on cephalic region, almost always 1 on each margin of thoracic and abdominal segments I-VIII, with only few exceptions the setae usually become larger and longer posteriorly.

**Anal area.** Anal opening circular or somewhat oval, located about middle of pygidium, in some species its location either close to median group of perivulvar pores under microscope, or close to base of median lobes.

### **Ventral Surface**

**Eyes and legs.** Entirely lacking.

**Antennae (fig. I).** Reduced to small tubercles, each with a large fleshy seta, curved or more or less straight; each with 2 very short and stout terminal sensory setae, nearly equal in length or one larger than the other.

**Clypeolabral shield and labium.** Normal diaspidid-type; the four piercing-sucking stylets modified from mandibles and maxillae, often as long as the body.

**Spiracles (fig. J).** A long and narrow bar supports opening of spiracles; anterior one on prothorax, laterad of mouthparts, usually somewhat larger than posterior one located between mesothorax and metathorax; anterior spiracle with 0-30 trilocular (fig. K) or rarely 4-locular pores (e.g.: *C. nyssae*, Knipscher et al. 1976:18, fig. 7), posterior spiracle with 0-10 pores.

**Gland spines (fig. L).** Located marginally, usually well-developed, each with an associated one-barred microduct, arranged on abdominal segments III or IV-VIII, number on each margin varies from species to species, and specimen to specimen, but in some species, nearly always in pairs from abdominal segments V or VI to VII.

**Gland tubercles (figs. M&N)** Located submarginally, spinelike, or basally conical and distally spinelike, very small, each with an associated one-barred microduct; 1-4 arranged on three thoracic segments and abdominal segments I-II, or sometimes lacking on prothorax.

**Small macroducts (fig. O).** Same shape, size and location as those on dorsal surface except more numerous.

**Microducts (fig. P).** Same shape, size as those on dorsal surface but much more numerous, especially on prosomal area.

**Setae (fig. H).** Same shape, location and size as those on dorsal surface, but usually 5-6 along the margin or submargin of cephalic region, and the ones on abdominal segments VI-VIII more or less smaller than those on dorsal surface. Often 1-3 tiny setae on submedian or submarginal areas of each of abdominal segments I-V and pygidium, and 2 located above vulvar opening.

**Vulvar area.** Situated about the middle of pygidium; opening more or less curved; perivulvar pores quinquelocular (fig. Q), and always in 5 groups; usually median group smallest in number, anteriolateral group largest, and posteriolateral group in between the other two in number of pores.

**Note.** Some coccidologists, such as Takagi and Kawai (1967), and Tang (1985), noted that there are not two prominent but small setae at the inner corner of the median lobe bases as depicted in Ferris' (1937 to 1955) illustrations, who considered these as important characters to separate *Chionaspis* from *Pseudaulacaspis*. Takagi and Kawai (1967) stated that the pair of clear spots present in these areas might very well be the bases of broken off setae and these spots are probably present in all species of the genus. The conclusion they gave is that not all the species of *Chionaspis* bear prominent setae.

In order to confirm whether or not these spots bear tiny setae, I have checked many slide-mounted specimens at 1000-1500x magnification, and found out that all the leaf forms and the species with divergent median lobes have very clear spots at the bases of the median lobes. In a few species with somewhat fused median lobes the spots are also clear, but it is hard to detect if the spots bear or do not bear tiny setae because of the limitation of the microscope. To clarify this question, preparation of micrographs of this area by using a scanning electron microscope is recommended.

**Distribution.** The genus is represented by about 62 species, mostly in the Holarctic Region.

**KEY TO THE ADULT FEMALES OF THE SUBTRIBE**

**CHIONASPIDINA IN NORTH AMERICA**

- 1. Pygidial margin crenulate, only 2 pairs of small semicircular pygidial lobes developed . . . . . *Nepalis*
- Pygidial margin not crenulate, normally more than 2 pairs of pygidial lobes developed, these not semicircular . . . . . 2
- 2(1). Dorsal macroducts on abdomen definitely assymmetrically distributed; only on grasses . . . . . *Duplachionaspis*
- Dorsal macroducts on abdomen more or less symmetrically distributed; normally on plants other than grasses . . . . . 3
- 3(2). Median lobes well separated . . . . . 4
- Median lobes fused into a single lobe or at least mesal margins or median lobes closely appressed . . . . . 7
- 4(2). Median lobes united basally, zygotic . . . . . 5
- Median lobes not united basally, nonzygotic; dorsal median pygidial furrow present, extending from anal opening posteriorly to bases of median lobes; preferred host *Euonymus* . . . . . *Unaspis*
- 5(4). Prosoma swollen, more or less quadrate, wider than the rest of body; median lobes forming a distinct notch in apex of pygidium; preferred hosts *Rosa* and *Rubus* . . . . . *Aulacaspis*
- Prosoma not swollen, and not quadrate; body turbinate or spindle-

- shaped . . . . . 6
- 6(5). Body turbinate or pear-shaped, widest beyond middle of
  - prosoma; median lobes large and prominent; some pygidial gland
    - spines often branched at apex . . . . . *Pseudaulacaspis*
    - Body spindle-shaped, widest on metathorax or first
      - abdominal segment; median lobes widely divergent or close
        - together; no pygidial gland spines branched at apex . . . . . *Chionaspis*
  - 7(3) Median lobes fused into single lobe without division;
    - submedian macroducts present; only found on oaks
      - (Fagaceae) . . . . . *Quernaspis*
      - Median lobes closely appressed; submedian macroducts
        - absent; not restricted to oaks . . . . . *Pinnaspis*

**KEY TO THE SPECIES OF *CHIONASPIS* IN NORTH AMERICA**

**Based on Adult Females**

- 1. Median lobes fused for half of their length . . . . . 2
  - Median lobes separated for more than half of their length . . . . . 5
  
- 2(1). Median lobes almost triangular, with fine serrations on lateral margins; only 0-3 dorsal submedian macroducts on each of abdominal segments III-V; commonly on *Nyssa*; Plate 18 . . . . . *nyssae*, bark form
  - Median lobes not triangular, rounded at apex, lacking fine serrations on lateral margins; normally with dorsal submedian macroducts on each of abdominal segments III-V . . . . . 3
  
- 3(2). Median lobes short and rounded, margins with or without very small irregular notches; normally associated with hickory and walnut; Plate 4 . . . . . *caryae*
  - Median lobes with a deep notch on lateral margins . . . . . 4
  
- 4(3). No dorsal submedian macroducts on abdominal segment VI;

- usually less than 60 dorsal macroducts on abdominal segments III-V; common on *Ulmus* but polyphagous; Plate 3 . . . . . *americana*
- Several dorsal submedian macroducts on abdominal segment VI; usually more than 60 dorsal macroducts on abdominal segments III-VI; on *Fraxinus*; Plate 7 . . . . . *floridensis*
- 5(1). Median lobes more or less elongate, their width less than half of their length; usually completely separated or divergent; on needles or leaf petioles of trees . . . . . 6
- Median lobes usually broad, wider than half of their length; often close together at base, or not strongly divergent . . . . . 12
- 6(5). Two dorsal submarginal macroducts on abdominal segment VI; commonly on leaf of *Nyssae*; Plate 19 . . . . . *nyssae*, leaf form
- No dorsal submarginal macroducts on abdominal segment VI . . . . . 7
- 7(6). Inner margins of median lobes without serrations; distance between median lobes and inner lobule of second pair of lobes as wide or wider than width of inner lobule; on needles of conifers . . . . . 8
- Inner margins of median lobes with fine serrations; distance

- between outer margin of median lobes and inner lobule  
of second pair of lobes much less than width of inner  
lobule . . . . . 9
- 8(7). Mesal margins of median lobes parallel or nearly so;  
space between mesal margins about one-fourth to  
one-half of width of one lobe; outer lobule of third  
pair of lobes bilobed, well-developed and rounded  
apically; Plates 21 and 22 . . . . . *pinifoliae*
- Mesal margins of median lobes widely divergent,  
space between mesal margins more than width of one  
lobe; outer lobule of third pair of lobes strongly  
reduced, with 3-5 prominent teeth; Plates 13  
and 14 . . . . . *heterophyllae*
- 9(7). Inner lobule of second pair of lobes protruding beyond  
apex of median lobe . . . . . 10
- Inner lobule of second pair of lobes shorter than median  
lobes, not protruding beyond the apex of median lobe . . . . . 11
- 10(9). At least 4 dorsal submedian macroducts on each of  
abdominal segments III and IV; inner margins of median  
lobes divergent from their base; on *Platanus* leaf;

- Plate 24, figs. A-F . . . . . *platani*, leaf form
- Less than 4 dorsal submedian macroducts on each of abdominal segments III and IV; inner margins of median lobes parallel for over one-third their length; on *Gleditsia* leaf; Plate 11 . . . . . *gleditsiae*, leaf form
- 11(9). Each of abdominal segments III-VI with 0 or only 1 dorsal submedian macroduct, and with less than 20 total dorsal macroducts; on *Betula* leaf; Plate 28 . . . . . *triformis*, leaf form
- Each of abdominal segments III-VI with more than 2 dorsal submedian macroducts; with more than 30 total dorsal macroducts; on *Wistaria* leaf; Plate 31, fig. D . . . *wistariae*, leaf form
- 12(5). About one-half or more of ducts in dorsal submedian groups of abdominal segments II-V very small; dorsal submedian group of ducts on abdominal segment VI entirely or mostly of small ducts, seldom mixed with macroducts; sometimes 3 dorsal marginal macroducts present on abdominal segments VI, or sometimes 1 pair of toothlike projections present between bases of median lobes; associated chiefly with *Salix* and *Populus*; Plates 25 and 26 . . . . . *salicisnigrae*
- Not as described above . . . . . 13

- 13(12). Distance from posterior margin of anus to base of median lobes much less than distance from anterior margin of anus to midpoint between abdominal segments V and VI; associated with *Tamarix* in southwestern U.S. and Mexico . . . . . 14
- Distance from posterior margin of anus to base of median lobes much less than distance from anterior margin of anus to midpoint between abdominal segments V and VI . . . . . 15
- 14(13). Median lobes relatively long and semicircular at apex; strongly divergent and poorly sclerotized, with 2 gland spines and 1 long seta overlapping with median lobes, and protruding beyond apex of median lobe; Plate 9 . . . . . *gilli*
- Median lobes short and broad, notched on both sides, well sclerotized basally, very close to each other; gland spines and setae laterad of median lobes; Plate 6 . . . . . *etrusca*
- 15(13). No dorsal submedian macroducts on abdominal segment III; if present, lacking dorsal submedian macroducts on abdominal segment VI, or rarely only 1 present on each side of body . . . . . 16

- More than 1 dorsal submedian macroduct on each side of abdominal segments III and VI . . . . . 20
- 16(15). Median lobes distinctly broad, wider than long, semicircular, close to each other; basal zygotis elongate, protruding anteriorly; a distinct sclerotized horizontal bar at base of each median lobe; common on apples and other Rosaceae; Plate 8 . . . . . *furfura*
- Median lobes not as above . . . . . 17
- 17(16). Median lobes with one distinct notch on lateral margins and 2-3 notches on mesal margins, without fine marginal serrations; Plate 2 . . . . . *acericola*
- Median lobes without notches on mesal or lateral margins, with regular or irregular fine marginal serrations . . . . . 18
- 18(17). Dorsal submedian and submarginal macroducts totaling less than 6 from abdominal segments III-VI; on *Betula*; Plates 28 & 29, fig. A . . . . . *triformis*, bark form
- Dorsal submedian and submarginal macroducts totaling at least 7 or more from abdominal segments III-VI . . . . . 19
- 19(18). Ventral microducts on prosoma not clustered in two

- groups laterad of anterior spiracles; outer lobule  
of second lobes indistinct triangular; on *Fraxinus*  
and *Ostrya*; Plate 15 . . . . . *kosztarabi*
- Ventral microducts on prosoma clustered in two groups;  
laterad of spiracles; outer lobule of second lobes well  
developed, broad at apex; commonly on *Gleditsiae*;  
Plate 10 . . . . . *gleditsiae*, bark form
- 20(15). Divergent inner margins of triangular median lobes  
much longer than outer margins; commonly on *Cornus*;  
Plate 7 . . . . . *corni*
- Median lobes not matching above characters . . . . . 21
- 21(20). Both mesal and lateral margins of median lobes with  
fine serrations or irregular notches . . . . . 22
- Both mesal and lateral margins of median lobes without  
serrations or notches . . . . . 26
- 22(21). Median lobes distinctly pointed or tapering towards  
apex . . . . . 23
- Median lobes broad and semicircular, inner margins  
basally parallel or nearly so; found only on *Wistaria*;  
Plate 32 . . . . . *wistariae*, bark form

- 23(22). Mesal and lateral margins of median lobes with irregular notches; no dorsal submedian macroducts on abdominal segment II; Plate 25 . . . . . *platani*, bark form
- Mesal and lateral margins of median lobes with fine serrations . . . . . 24
- 24(23). No dorsal submedian and submarginal macroducts on abdominal segment II; median lobes more or less pointed mesal and lateral margins nearly equal in length; not all pygidial lobes with serrations, on *Salix* and *Populus*;  
Plate 19 . . . . . *longiloba*
- Several dorsal macroducts on both submedian and submarginal areas of abdominal segment II . . . . . 25
- 25(24). Mesal and lateral margins straight, with pointed apex; base of each median lobe without sclerotized horizontal bar; Plate 18 . . . . . *lintneri*
- Mesal and lateral margins not straight, forming a somewhat rounded apex; base of each median lobe with a more or less distinct sclerotized horizontal bar; only found in Florida; Plate 14 . . . . . *hamoni*

- 26(21). Median lobes distinctly broad and rounded, widely separated basally; margin of 3rd lobes usually smooth; found on west coast area of U.S.; Plate 29 . . . . . *sassceri*
- Median lobes rounded apically but close to each other with a very narrow separation; 3rd pair of lobes often distinct, their margins usually finely serrate;
- Plate 21 . . . . . *ortholobis*

*Chrysomelidae: Chrysomelinae: Melyridae* (Holl, 1913: 79; Ferris, 1977: 213, 24; 1982: 464; Burrows, 1983: 44, 47; Krombein, 1963: 62; Takagi and Kawanabe, 1964: 26; McCrea and Danks, 1968: 1; Vignino and Pascoe, 1969: 21; Ashmead, 1912: 2; Nakamura, 1974: 33; 1987: 4; Sjöstedt, 1963: 11.

Test of width (width 1/3-1/4). Ovipositor-shaped, or shape of 3rd pair of legs white to light gray, often partly covered with brown, and reflective with spots above. 3rd pair long, flat and widest distally; relative broadness similar to that of relatively large ovipositor, but length is one third of the length of ovipositor. Relative length of 3rd pair of legs (width) and length of ovipositor (width) are similar.

GENERAL DESCRIPTION

Body of width (width) spindle-shaped, expanding toward posterior end; morphologically similar to those of *Chrysomelidae*; rounded at abdominal segment 10. H. 1.5-2.00; L. 1.5-1.75; W. 1.5-1.75 wide (fig. 21).

## *Chionaspis acericola* Hollinger

### Plate 2

**Common name.** Maple scurfy scale

**Literature.** *Chionaspis acericola*-Hollinger, 1923: 20; Ferris, 1937: 14, 23, 24; 1942, 446; Slesman, 1945: 44, 47; Kosztarab, 1963: 62; Takagi and Kawai, 1967: 30; McComb and Davidson, 1969: 1; Tippins and Beshear, 1970: 1023; McDaniel, 1971: 282; Nakahara, 1975: 201; 1982: 17; Takagi, 1985: 38.

**Test of adult female (fig. A).** Oystershell-shaped, or more or less irregular; white to light gray, often partly covered with extraneous adhesive material; about 2.0 mm long, flat and rather thin; exuviae brownish, situated apically, relatively large, occupying one fourth to one third of test length. Ventral test definitely developed, white and thin, but thicker around edge of test; it remains on surface of host when upper test removed.

### GENERAL DESCRIPTION

Body of adult female spindle-shaped, expanding toward posterior end, margins prominently lobed laterally; broadest at abdominal segment I or II, 637-1206 long and 464-574 wide (fig. B).

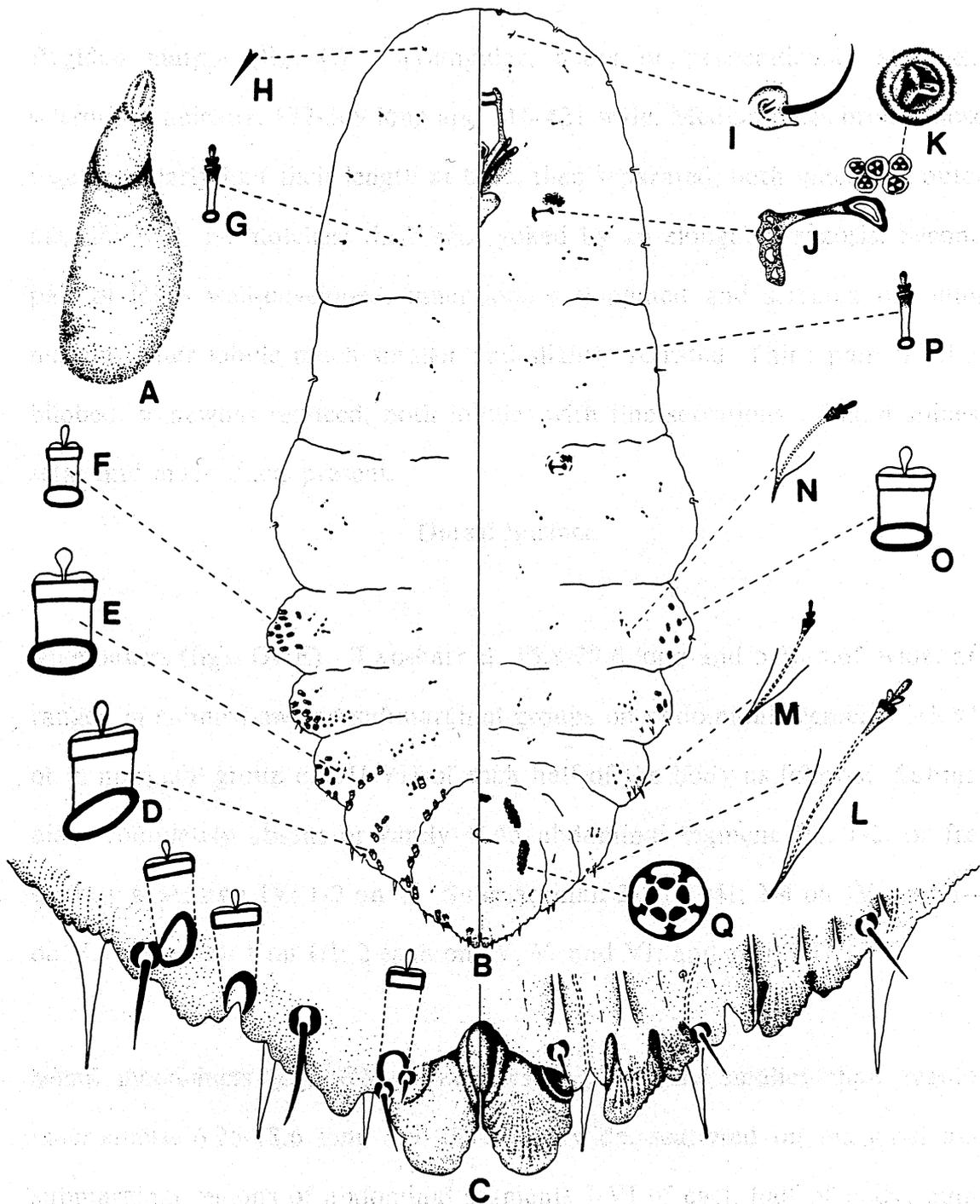


Plate 2. - *Chionaspis acericola* Hollinger

**Pygidial margin (fig. C).** Triangular, acute or perpendicular at apex, sclerotized apically, 172-309 long and 316-421 wide. Median lobes broad, close together nearly half their length at base, then separated; both inner and outer margins with 1-3 notches; their base yoked by an elongated zygotis. Second pair of lobes well-developed, inner lobule elongated and serrated on outer margin, outer lobule much smaller and slightly serrated. Third pair of lobes bilobed, somewhat reduced, both lobules with fine serrations. Gland spines, setae and macroducts present.

#### **Dorsal Surface**

**Macroducts (figs. D&E).** Two-barred, 15.8-29.6 long and 5.56-8.65 wide, arranged in submedian and submarginal groups on abdominal segments III-VI, or in marginal group on III-VII of each half of the body as follows: Submedian: completely absent or rarely 1 on abdominal segment III; 1-2, or frequently absent on IV; 1-2 on V. Submarginal: 3-5 on III; 2-4 on IV, and 1-4 on V. Marginal: 1 on III; 2 each on IV, V, and VI; and 1 on VII.

**Small macroducts (fig. O):** Two-barred, obviously smaller than regular macroducts, 6.25-18.6 long and 3.78-7.82 wide, scattered on marginal and submarginal regions of abdominal segments I-VI of each half of body; numbers as follows: on abdominal segment I, 3-5; II, 4-6; III, 2-3; and sometimes 1-2 on IV. Their small number and the fact that they are limited to abdominal

segments are two of the main characters separating this species from similar ones in the genus.

**Microducts (fig. G).** One-barred, 5.22-9.02 long, and 3.23-5.41 wide at orifice, arranged somewhat irregularly in front of or mixed with submedian groups of macroducts on abdominal segments IV and V, 2-6 in row on abdominal segments I and II, or 3-5 or more in front of these rows in similar position on the segments; or scattered on submarginal region of abdominal segments I-V, but their numbers are remarkably reduced on latter segments.

**Setae (fig. H).** Few very short and small setae along margins or dispersed irregularly on cephalic region, 5.88-7.16 long; stouter and shorter or sometimes longer setae on margins from abdominal segments I to VII; 1, rarely 2, on IV-VII; the ones on I-III much shorter, similar in length to those on cephalic region, while those ones on IV-VII much longer, four to six times as long as ones on basal segments.

**Anal area.** Anal opening circular, located just posterior to median group of perivulvar pores, 8.40-11.9 in diameter; distance from the anterior edge of anus to mid-point of the line between abdominal segments V and VI, 49.4-88.9; distance from posterior edge of anus to base of median lobes, 93.9-134.

## Ventral Surface.

**Antennae (fig. I).** Very small sclerotized tubercles, 6.05-8.20 long and 4.69-8.78 wide at base; each with a long lateral fleshy seta, 12.7- 25.7 long; 2 short terminal hair-like sensory setae, 2.44-4.28 long. Distance between antennal bases 49.8-79.7.

**Clypeolabral shield.** Shape typical, 104-134 long and 77.1-98.8 wide.

**Labium.** Cup or oval shaped, 36.8-42.0 long and 32.1-51.4 wide.

**Spiracles (fig. J).** Anterior spiracle with narrow bar supporting opening, 21.7-25.4 long, atrium 6.6-8.5 wide, each with 4-10 associated trilocular pores (fig. K), each pore 3.74-3.90 in diameter. Posterior spiracles nearly same shape as anterior, but slightly smaller, 19.5-21.7 long; each with 1-5 associated trilocular pores; sometimes these pores entirely absent.

**Gland spines (fig. L).** Marginal gland spines present on abdominal segments III-VII of each side of body; length remarkably variable, 39.9-65.2, each with one-barred associated microduct. Number on each margin as follows: III, 4-7, rarely 2-3; IV, 2-6; V, VI and VII, 1 on each. Gland spines on abdominal segment III frequently on submarginal region; their shape between that of normal gland spines and of gland tubercles.

**Gland tubercles (figs. M&N):** Distally spinelike and basally conical, 4.94 -6.53 long and 3.88-4.99 wide at base, arranged in submarginal groups on abdominal segments I-II; 0-3, mostly 1-2 on I, usually 2-6 on II. These gland tubercles completely lacking on thoracic segments.

**Small macroducts (fig. O).** Few, two-barred, 4.66-11.6 long and 4.85-6.61 wide, scattered on submarginal-marginal regions of abdominal segments I-III; on abdominal segment I, 2-3; II, 2-4; III, 2-3; and rarely 1 on IV. body.

**Microducts (fig. P):** One-barred, 4.94-8.39 long and 2.85-4.77 wide at orifice; only very few scattered on entire

**Setae (fig. H).** Very few, short, small hair-like setae scattered on or along the margins of cephalic region. Stouter and longer setae on margins, only 1 on each, from abdominal segment I to VII; some of these located on posterior segments laterad of median lobes as well as on second and third pair of lobes.

**Vulvar area.** Vulvar opening in middle of pygidium; perivulvar pore (fig. Q) groups: median, 8-14; anteriolateral, 16- 32; posteriolateral, 12-31.

**Material studied.** *Acer rubrum*, MD, College Park, Oct. 27, 1940, coll. McC, 8(13) USNM.; NC, near Saluda Co., July 6, 1968, coll. MK, 2(4) VPI.; OH,

Rock house, Hocking Co., April 24, 1960, coll. MK, 1(3) VPI.; *Acer* sp., MD, College Park, April 8, 1940, coll. McM, 6(9) USNM.; Sugarloaf Mt., Frederick, July 20, 1971, coll. SN, 1(4) USNM.; OH, Flint, Sept. 20, 1917, coll. PRL, 1(4) USNM.; PA, Freeport, June 1, 1911, coll. RBM, 1(2) BM. *Betula nigra*, GA, Spalding Co., Feb. 11, 1968, coll. RB, 1(1) FDA.; *Fraxinus* sp., OH, Rockbridge, Sept. 30, 1917, coll. PRL, 1(4) USNM.;

**Host and distribution.** This species was first collected on bark of "silver maple", *Acer saccharinum* L. (Aceraceae), in Gentry Co., Missouri in 1919. It has now also been found on *Acer rubrum* L. and *Acer* sp. in North Carolina, Maryland, and Ohio. It is also distributed in Texas (Ferris, 1947) and Pennsylvania (Nakahara, 1982).

**Affinities and discussion.** Generally, this species is quite easy to identify and recognize, but sometimes it seems to be confused with several other species such as *Chionaspis gleditsiae* Sanders, *C. parkii* Hollinger (= *C. platani*), and the bark form of *C. triformis* Tippins and Beshear. We also noted that it was misidentified on several slides as *C. sylvatica* Sanders, a synonym of *C. nyssae* Comstock.

The combination of the following characters applying to *acericola* can distinguish it from *C. gleditsiae*: (a). The zygotis at base of median lobes is distinct and elongated; (b). Absence of gland spines on three thoracic seg-

ments; (c). One dorsal submedian macroduct present on abdominal segment IV.

The following characters applying to *acericola* differentiate it from *C. parkii*: (a). No dorsal submedian macroducts on abdominal segment VI; (b). Only 1 gland spine on each of abdominal segments V-VII; (c). Gland tubercles completely wanting on thoracic segments; (d). Zygotis at base of median lobes more elongated.

Characters applying to *acericola* separating it from the bark form of *C. triformis* are: (a). Median lobes laterally notched; (b). Several small macroducts on abdominal segments III and IV.

The following characters found in *acericola* make it different from the bark form of *C. nyssae*: (a). Median lobes parallel and close together at base about half of their length, and then markedly separated; (b). Not more than one or 2 dorsal submedian macroducts on abdominal segments III and IV, or, in some specimens, several microducts occupying this position.

## *Chionaspis americana* Johnson

### Plate 3

**Common name.** Elm scurfy scale.

This species was first designated as a distinct species by Johnson (1896) based on the morphological characters of the pygidial margin of the adult female. Since then, it has been treated as a species of *Chionaspis* even though its generic assignment was changed to *Fundaspis* by MacGillivray (1923).

Takagi and Kawai (1967) found some external morphological differences between the specimens collected on *Fraxinus* from Florida and those on *Ulmus* and *Celtis*. As a result of their work, they designated the specimens from Florida on *Fraxinus* as a new species, *Chionaspis floridensis*. The most important morphological characters of *C. americana* are as follows: (1) lack of dorsal submedian macroducts on abdominal segment VI, and (2) few (less than 60) dorsal macroducts on abdominal segments III-V. In *C. floridensis* there are several dorsal submedian macroducts present on abdominal segment VI, and numerous (more than 61) dorsal submedian macroducts on abdominal segments III-VI.

This species most often infests *Ulmus*. The accompanying illustration is from Willoughby and Kosztarab (1974).

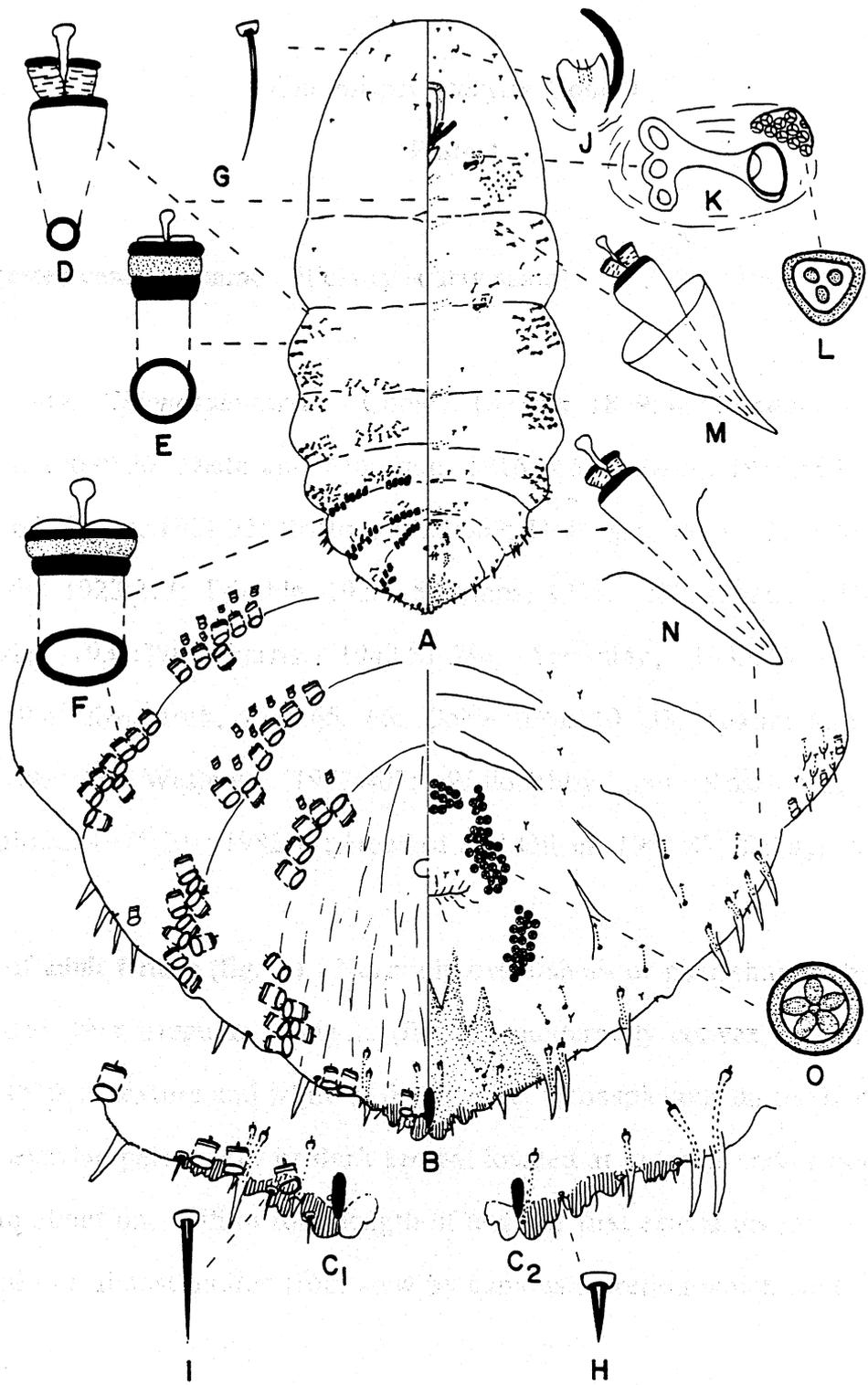


Plate 3. - *Chionaspis americana* Johnson

*Chionaspis caryae* Cooley

Plate 4

**Suggested common name.** Hickory scurfy scale

**Literature.** *Chionaspis caryae* - Cooley, 1898:86; 1899: 40; Sanders, 1904: 44; Smith, 1909:126; Dietz and Morrison, 1916:266; Lawson, 1917:263; Britton, 1920:64; Ferris, 1921:93; Britton, 1923:363; Hollinger, 1923: 22; Merrill and Chaffin, 1923:213; Trimble, 1928:45; Amos, 1933: 207; Doane, 1936: 377; Quayle, 1938:398; Ferris, 1942:SI-386; Slesman, 1945:46; Lindinger, 1958:366; Kosztarab, 1963:65, 66; Dekle, 1965:10, 33; Takagi and Kawai, 1967:30, 37; Westcott, 1973:407; Willoughby and Kosztarab, 1974:5; Nakahara, 1975:201; 1982:17; Howard and Oliver, 1985:47; Takagi 1985:38.

**Test of adult female (fig. A).** Normally oystershell- or pear-shaped, but when crowded, very irregular, elongate (fig. A); moderately convex; length 1.5-2.0 mm; thick in texture and white or dirty white, inconspicuous on the bark of the host; exuviae pale yellow or dark brown, located at anterior end of body, taking up about one fifth of total length of test; the first exuvia distinct, while the *second one almost hidden from view by copious secretion which covers it.*

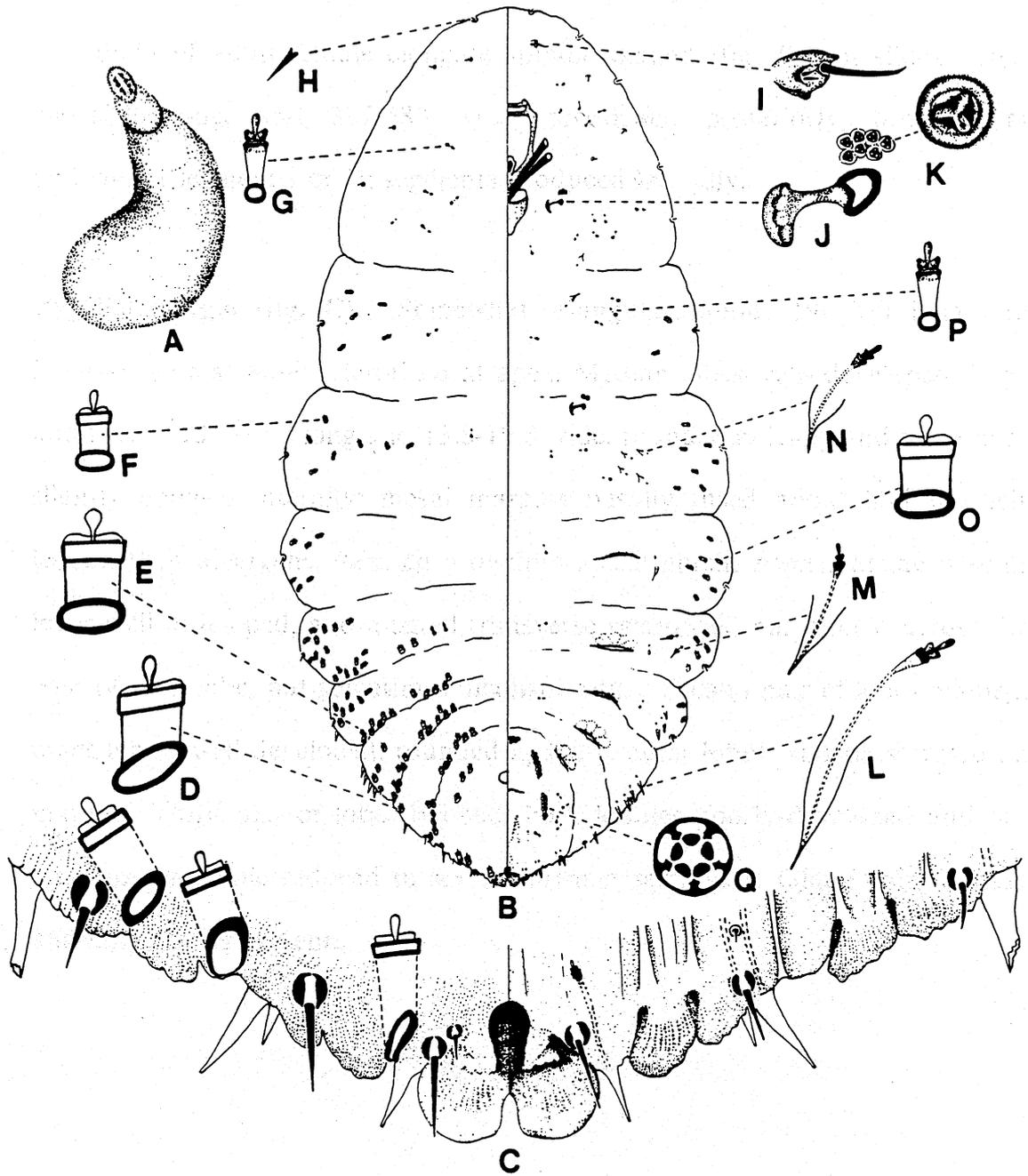


Plate 4. - *Chionaspis caryae* Cooley

## GENERAL DESCRIPTION

Body of adult female elongate spindle-shaped (fig. B), on slides about 746-1206 long, and 387-583 wide, broadened posteriorly, broadest at abdominal segment I or II; segments produced laterally.

**Pygidial margin (fig. C).** Somewhat triangular, about 196-230 long and 338-441 wide at base; sclerotized at apex. Median lobes well-developed, large and broad, 13.8-17.8 long and 13.8-19.8 wide, rounded apically and sometimes slightly notched laterally; mesal margins basally fused about half of their length, then divergent, forming a distinct apical notch; zygotis at the base of lobes well developed, and a small transverse sclerotized bar almost across the base of each lobe, but sometimes inconspicuous. Second pair of lobes bilobed, inner lobule well-developed, rounded apically; outer lobule shorter, serrated on margin. Third pair of lobes bilobed, both lobules poorly-developed and obscure, outer lobule reduced to several distinct serrations. Gland spines, setae and macroducts present.

### Dorsal Surface

**Macroducts (figs. D&E).** Two-barred, 7.91-15.8 long and 6.24-7.81 wide, arranged in submedian groups on abdominal segments II-VI or III-VI, in submarginal groups on II-V, and in marginal groups on III-VII on each side of

body; numbers in each group remarkably variable in different specimens. Submedian: on abdominal segment II, usually absent, or in some individuals 1-4 present; III, 1-8 or rarely wanting; IV, 1-8; V, 2-9 and VI, 0-5, at least 1 on one side. Submarginal: II, absent or 2-8; III, 3-6; IV, 3-9; and V, 3-6. Marginal: III, 1 or 2; IV, 2, rarely 3; V and VI, each with 2; and VII, 1 only.

**Small macroducts (fig. F).** Two-barred, 7.02-8.59 long and 2.34-5.46 wide, clustered on marginal-submarginal areas of abdominal segments I-III and thoracic segments of each side of body; the number, arranged on each segment as follows: usually absent on prothorax and cephalic region; 2-6 on mesothorax; 4-7 on metathorax, 8-13 on abdominal segment I, 5-9 on II, 3-6 on III.

**Microducts (fig. G).** One-barred, 7.90-13.8 long and 1.17-1.48 wide at orifice, irregularly scattered on cephalic region and thoracic segments, regularly on abdominal segments I-5, and also on pygidium; on cephalic region, very few, with a range of 5-10; on each thoracic segment, 3-5 on submarginal and submedian areas; usually 1-3 on submedian region of abdominal segment I, 1-2 or as many as 7-9 on II, 1-4 on III, and rarely 1-2 on IV; in some specimens the microducts on abdominal segments II occupying the position of macroducts, or mixing with macroducts on II, III or IV; about 5-9 on pygidial area.

**Setae (fig. H).** Very slender, short, hair-like, 3.95-5.92 long, 5-12 scattered on cephalic region, 1 or rarely 2 on each margin of thoracic and abdominal segments I-III, usually very few on submedian and submarginal areas; slightly longer (5.83-15.1) and stouter setae, one or rarely 2 on each margin of abdominal segments IV, V and laterad of three pairs of lobes on pygidial margin.

**Anal area.** Anal opening rounded, diameter 8.89-9.88, situated at about basal one third of pygidium; distance from the anterior edge of anus to mid-point on the line between abdominal segments V and VI, 47.3-75.1; distance from the posterior edge of the anus to the base of median lobes, 109-138.

### Ventral Surface

**Antennae (fig. I).** Rudimentary, just like small sclerotized tubercles, and distinct; 5.92-9.37 long and 5.47-9.88 wide at base; each with 1 slender and fleshy seta, 9.37-19.8 long, usually curved, and with 2 very short and stout terminal sensory setae, 1.56-2.54 long; distance between antennal bases, 41.5-71.5.

**Clypeolabral shield.** Length, 109-152; width, 79.1-122; shape typical of the genus.

**Labium.** Length, 29.6-59.3; width, 33.6-59.3; cup- or shield-shaped.

**Spiracles.** Anterior (fig. J), 23.7-27.7 long and atrium 6.9-8.6 wide, each with 7-13 associated trilocular pores (fig. K), usually it is very difficult to count the number exactly; each pore 3.95-4.94 in diameter; posterior spiracle similar in shape to the anterior ones, and slightly smaller, 17.8-25.7 long, each with 0-4 associated trilocular pores.

**Gland spines (fig. L).** Marginal, 15.8-21.7 long, arranged on each margin of abdominal segments IV-VII, and laterad of median lobes of each half of body; on abdominal segment IV, 2-6; V, 1 or 2; VI, 1 or rarely 2; VII and laterad of median lobes, each with 1 only.

**Gland tubercles (fig. M&N).** Basally conical and distally spinelike, 5.93-9.88 long and 3.95-7.90 wide at base, submarginally clustered on basal three abdominal segments and thoracic segments on each half of body, becoming smaller anteriorly; prothorax, 0-2; mesothorax, 1-2 or sometimes none; metathorax 2-4; the ones on prothorax and mesothorax usually situated near the border of the two segments; on abdominal segment I, 1-4; II, 2-4; III, 2-5.

**Small macroducts (fig. O).** Similar both in shape and in size to ones on dorsal surface, but little difference in number: absent on prothorax, 2-5 on mesothorax, 8-14 on metathorax, usually 7-13 on abdominal segment I, 6-10 on II, 3-5 on III.

**Microducts (fig. P).** One-barred, with the same shape and size as ones on dorsal surface, but more numerous on cephalic region and thoracic segments, and few on other segments of each half of body; usually 12-22 on cephalic region, most of them around the anterior spiracle and next to clypeolabral shield; 3-6 on each of thoracic segment; only a few, 2-5, on each of abdominal segments I-V, and 5-9 on pygidial area.

**Setae (fig. H).** Very slender and hair-like, with same length as ones on dorsal surface, scattered along inner margin of and on cephalic region. Short tack-like setae on submarginal areas of thoracic segments, often 1-3 on submedian and submarginal areas of each segment of abdomen. Slightly longer (5.87-11.8) and stouter setae, 1 or 2 on margin of abdominal segments I-VI, and laterad of each pair of lobes of pygidial margin; usually ones on ventral surface smaller and shorter than those on dorsal surface.

**Vulvar area.** Vulvar opening located about middle of pygidium; perivulvar pore (fig. Q) groups: median, 8-19; anteriolateral, 15-30; posteriolateral, 13-24; each pore 3.91-4.69 in diameter.

**Type material studied.** Cotypes from *Carya* sp., DC: Sept. 27, 1896, coll. unknown, 7(13) USNM; coll. unknown, 3(4) USNM; April 15, 1895, coll. Pergande, 2(5) USNM; Sept. 27, 1896, coll. unknown, 1(6) USNM.

**Other material studied.** *Carya alba*, NC, Highlands, Aug. 6, 1931, coll. E.R. and J.N. Couch, 1(4) USNM. *Carya glabra* "Megacarpa", FL, RFD Lake City, Oct. 27, 1977, coll. AEG, 6(6) FDA. *Carya illinoensis*, FL, Monticello, Feb. 19, 1964, coll. GWD and R.H. Miller, 5(5) FDA; Monticello, March 30, 1965, coll. R.H. Miller, 15(21) FDA; Monticello, Oct. 11, 1968, coll. R. H. Miller, 4(4) FDA; Live Oak, April 19, 1979, coll. C. Webb, 3(3) FDA; LA, Baton Rouge, May 15, 1971, coll. F.W. Howard, 1(2) VPI. *Carya ovata*, OH: Wooster, July 1, 1917, coll. J.S. Houser, 1(5) VPI; O.A.E.S. Wooster, Aug. 8, 1917, coll. PRL, 1(4) VPI. *Carya* sp., FL: Summerfield, May 20, 1921, coll. Fogg and Hunt, 8(14) FDA; Anthony, March 23, 1962, coll. AEG 4(4) FDA; Blichton, April 6, 1967, coll. AEG, 5(5) FDA; Anthony, May 8, 1968, coll. E. W. Holder, 5(5) FDA; Indrio, Jan 14, 1980, coll. E.W. Campbell, 1(1) FDA. OH, Flint, Sept. 28, 1917, coll. PRL, 1(4) USNM.

**Host and distribution.** This species was first described from hickory, *Carya* sp., at Washington, DC, in 1883. Since then it has been collected from the same host genus in CT, DC, FL, KS, OH, VA, and recorded in IA, MO, NC, and PA; it was also collected on *Juglans nigra* in IN. Therefore it is widely distributed in the eastern United States.

**Affinities and discussion.** According to Cooley (1899: 40), this species has a close relationship with *C. americana*, but the two species are easily distin-

guishable in that the notched median lobes and fused inner margins are present in *C. americana*, whereas in *C. caryae* the median lobes are entire and their inner margins are only fused about half of their length.

Two other species, *C. furfura* and the bark form of *C. platani*, are more or less similar to this species. In *C. furfura*, the median lobes are shell-like, rounded and close together; a transverse and well sclerotized bar is present at the base of each lobe; and usually 0-1 dorsal macroducts on abdominal segment VI; these characters are not present in *C. caryae*. The following main characters are present in the bark form of *C. platani* and are not in *C. caryae*: the median lobes are somewhat triangular and pointed apically, and the basal zygotis is stout, and with fewer dorsal macroducts on abdominal segments III-VI.

During this study, it was noted that all specimens collected on the host, *Carya illinoensis*, in both FL and OH showed the host-induced morphological variation which makes them distinctly different from the type material by the presence of: (1) 2-5 dorsal submedian macroducts on abdominal segment II, or rarely 1, along with several microducts; (2) dorsal submedian macroducts on abdominal segment VI more numerous (4-7). These characters are not present in the type material, and have not been described and figured in any previous studies, therefore it is concluded that host-induced morphological variation exists in this species, but we are not sure if another species is involved because of the scarcity of available material.

*Chionaspis corni* Cooley

Plate 5

**Common name.** Dogwood scurfy scale.

**Literature.** *Chionaspis corni* - Cooley, 1899: 15; King, 1901: 315; 1902:61; Webster and Burges, 1902: 113; Fernald, 1903: 215; Osborn, 1903: 46; Dean, 1909: 369; Severin and Severin, 1909:297; Smith, 1909: 126; Douglass, 1911: 187; Dietz and Morrison, 1916 (1914-1915): 267; Hartman, 1916: 101; Lawson, 1917: 264; Houser, 1918: 290; McGillivray, 1921: 331; Miller, 1922: 60; Britton, 1923: 363; Felt, 1924: 152; Swaine and Hutching, 1926: 51; Felt and Morrison, 1928: 198; Trimble, 1928: 45; Sheaffer, 1930: 25; Anonymus, 1931: 18; Felt and Rankin, 1932: 202; Chambers, 1933 (1930-1932): 96; Couch, 1935: 30; Ferris, 1937: SI-16; Couch, 1938: 57; McDaniel, 1939: 7, 9; Schmidt, 1939: 57; Ferris, 1942: SI-446; Frost, 1942: 311; Dodge and Rickett, 1943: 236; Anonymus, 1955: 26; McKenzie, 1956: 93; Lindinger, 1958: 366; Kosztarab, 1963: 66, 67; Westcott, 1964: 360; Takagi and Kawai, 1967: 30, 38; Weidhaas, 1968: 256; McComb and Davidson, 1969: 1; Daker, 1972: 109; Harrison, 1972: 74; Swan and Papp, 1972: 165; Westcott, 1973: 398; Nakahara, 1975: 201; English, 1976: 20; Nakahara, 1982: 17; Takagi, 1985: 39.

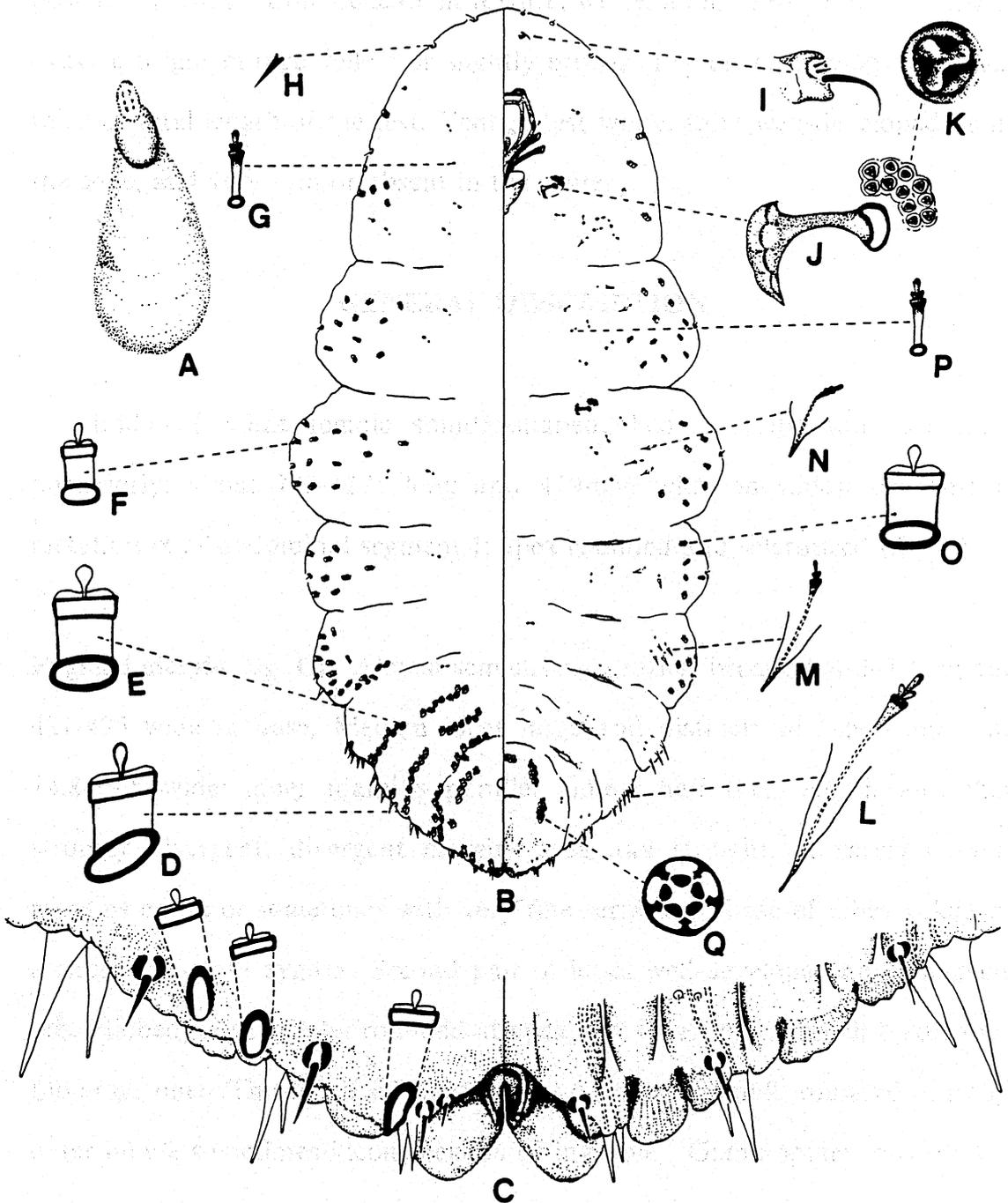


Plate 5. - *Chionaspis corni* Cooley

**Test of adult female (fig. A).** Elongate, of irregular shape; distinctly broadened posteriorly; rather thin, delicate in texture; white; about 1.6-2.5 mm in length; exuviae bright orange yellow or slightly brown in color, occupying about one third of total length of the test. Ventral test white, thin; well-developed along the edge, and very thin or absent in the center.

### GENERAL DESCRIPTION

Body of adult female spindle-shaped, lobed laterally and expanding posteriorly; about 743-1275 long and 470-656 wide on slides; broadest at metathorax or abdominal segment I; apex rounded and sclerotized (fig. B).

**Pygidial margin (fig. C).** Almost semicircular, rather broad; 204-241 long and 421-495 wide at base. Median lobes large and distinct; 24.7-29.6 long and 14.8-19.8 wide; inner margins parallel almost half their length and then strongly divergent; divergent margins long and straight, or rarely curved; margins entire or sometimes with very fine serrations; base of lobes yoked by a short and stout zygois. Second pair of lobes well-developed and conspicuous, bilobed; both lobules rounded at apex, but inner lobule much larger than the outer one. Third pair of lobes poorly-developed, small; rounded apically, outer lobule sometimes inconspicuous or invisible. Gland spines, macroducts and setae present.

## **Dorsal Surface**

**Macroducts (figs. D&E).** Two-barred, 5.85-13.7 long and 7.80-9.76 wide, arranged in submedian groups on abdominal segments III-VI, or sometimes on II-VI; in submarginal groups on II-V and in marginal groups on II-VII of each side of the body. Numbers in each group on abdominal segments as follows: Submedian: completely absent or rarely 1 or 2 on II, 4-12 each on III and IV, 3-8 on V, and 4-8 on VI. Submarginal: 7-12 on II, 8-15 on III, 7-15 on IV, and 6-12 on V. Marginal: 1 on III, 2 or rarely 3 on IV, 2 on each of V and VI, and only 1 on VII.

**Small macroducts (fig. F).** Two-barred, 3.90-8.79 long and 3.80-4.88 wide, scattered submarginally on abdominal segments I-III and thoracic segments of each half of the body; occasionally several on prothorax, 4-14 on mesothorax, 5-12 on metathorax, usually 6-15 on abdominal segment I, 7-16 on II, 2-5 on III.

**Microducts (fig. G).** One-barred, 3.90-9.88 long and 1.17-1.76 wide at orifice, scattered irregularly on cephalic region, submarginal area of thoracic segments and pygidial area, also anterior of macroducts of submedian group on abdominal segment III and submedian regions of abdominal segments I and II, on each side of body. Numbers variable in different specimens: usually 7-17 on cephalic region, 3-9 on each thoracic segment, 0-6 on abdominal segment

I, 2-5 on II, 0-3 on III, 0-3 on IV and sometimes 1-2 on V. The ones on abdominal segments III-V sometimes mixed with macroducts.

**Setae (fig. H).** Few, short and slender, hair-like, 8.76-11.7 long, scattered along the margins and on cephalic region, and some on thoracic segments as well. Shorter and stouter setae, 6.83-7.21 long, 1 on each margin of abdominal segments I-III, sometimes absent on basal two segments; stouter but longer setae, 7.88-15.6 long, 1 or rarely 2 on each margin on abdominal segments IV-VII, but ones on posterior 2 or 3 segments laterad of lobes on pygidial margin.

**Anal area.** Anal opening circular, 12.4-17.3 in diameter, located at about basal third of pygidium; distance from anterior edge of the anus to the mid-point of line between abdominal segments V and VI, 49.4-74.1; distance from posterior edge of the anus to base of median lobes, 114-151.

### Ventral Surface

**Antennae (fig. I).** Reduced into small sclerotized tubercles, 4.94-9.88 long and 7.91-9.88 wide at base; each antenna with 1 slender and curved fleshy seta, 7.41-22.23 long, and 2 very short terminal sensory setae, 2.02-3.70 long. Distance between the antennal bases 54.3-105.

**Clypeolabral shield.** Length, 130-163; width, 79.0-119; shape typical of the genus.

**Labium.** Length, 29.6-51.9; width, 49.4-69.2; cup-shaped.

**Spiracles.** Anterior (fig. J) 22.2-34.0 long and atrium 7.6-9.5 long; each with 4-30 associated trilocular pores (fig. K). Posterior similar in shape and size to the anterior, or slightly smaller, 19.8-29.6; each with 1-8 associated trilocular pores. Sometimes it is very difficult to count the number of associated trilocular pores, especially the ones near anterior edge of spiracles.

**Gland spines (fig. L).** Marginal, 14.8-26.4 long, well-developed and numerous on each margin on abdominal segments III-VII on each side of the body; numbers on abdominal segment III, 4-10; IV, 3-7; V, mostly 2, rarely 1 or 3; VI, 2; VII, 1-2, and laterad of median lobe, 1-2. Frequently the ones on abdominal segment III arranged on submarginal area.

**Gland tubercles (fig. M&N).** Basally conical and distally spine-like, 7.80-14.6 long and 4.39-4.88 wide at base, scattered in small groups on abdominal segments I and II, and thoracic segments of each half of the body; numbers vary greatly, wanting or rarely 2-5 on prothorax; 0-8 on mesothorax, 0-4 on metathorax, usually 0-5 on abdominal segment I, 1-8 on II; usually becoming smaller anteriorly.

**Small macroducts (fig. O).** Two-barred, about same size as those on dorsal surface, marginally and submarginally clustered on abdominal segments I-III, and thoracic segments of each side of body; prothorax, 2-6; mesothorax, 2-7; metathorax, 3-9; numbers on abdominal segment I, 3-8; II, 2-6; III, 2-5; sometimes completely absent or much fewer on thoracic segments.

**Microducts (fig. P).** One-barred, 3.90-9.88 long and 1.24-1.88 wide at orifice, scattered irregularly on cephalic region, thoracic segments and abdominal segments I-III, and pygidial area as well; usually more numerous near spiracles and in submarginal areas of basal segments.

**Setae (fig. H).** Very few slender and hair-like, scattered on cephalic region, thoracic and abdominal segments, 7.56-10.8 long; marginal setae a little longer and stouter; 5-6 on cephalic margins; 1 on each margin of thoracic segments, or frequently absent; and 1 on each of abdominal segments I-VII, 6.83-15.8 long; the longest ones on V or VI; becoming larger posteriorly.

**Vulvar area.** Vulvar opening situated about the middle of pygidium; perivulvar pore (fig. Q) groups: median, 13-24; anteriolateral, 13-38; posteriolateral, 15-28.

**Type material studied.** Cotypes from *Cornus paniculata*, MA, Reading, no date, coll. CKL, 1(4) USNM; no date, coll. A.H. Kirkland, 2(25) USNM; no date, coll. CKL, 1(3) USNM.

**Other material studied.** *Cornus amomum*, NY, Savannah, Feb. 28, 1927, coll. C.R. Crosby, 1(4) USNM; OH, Sandusky, Aug. 12, 1902, coll. H. Osborn, 1(8) USNM; Erie Co., Cedar Point, June 30, 1903, coll. JGS, 3(7) BM. PA, Presque Is. Erie, Oct. 5, 1922, coll. FMT, 1(6) USNM. *Cornus asperifolius*, IN, Lake Everitt, May 28, 1920, coll. C.C. Deam, 1(4) USNM. *Cornus obliqua*, IN, Monticello, at Frye Nursery, Oct. 5, 1926, coll. D.R. Erbaugh, 1(4) USNM. *Cornus paniculata*, IL, Chicago, Sept. 23, 1896, coll. Jas. Jensen, 2(2) USNM. *Cornus racemosa*, OH, Castalia, Resthaven Wildlife Area, Sept. 2, 1960, coll. MK, 1(3) VPI; Shenandoah National Park, Visitors Center, Mar. 3, 1981, coll. Keith Langdon, 3(4) VPI; WI, Albion, June 23, 1964, coll. R.D. Goeden, 2(6) CDA. *Cornus stolonifera*, NY, Rochester, Nov. 16, 1908, let. fr. Gec. G. Atwood, Albany, NY, 1(4) USNM. *Cornus* sp., CA, Placer Co., Pilot's Hill, June 12, 1938, coll. J. Steinweden, 1(4) CDA; Shasta Co., Castle Crag, May, 14, 1952, coll. R.P. Allen, 2(7) CDA; Alpine Co., 3 Mi. West of Woodfords, Sept. 9, 1960, coll. RFW, 3(14); Butte Co., Paradise, Aug. 30, 1939, coll. H.H. Keifer, 3(20) CDA; MI, Lansing, no date, coll. GFF, 1(7) BM; NY, Ithaca, Feb. 17, 1926, coll. R.D. Harwood, 2(12) USNM; OH, Flint, May 30, 1917, coll. PRL, 4(15) USNM; coll. W.S. Fields, 1(5) VPI; VA, Craig

Co., Sinking Creek, Apr. 8, 1963, coll. MK, 1(2) VPI. *Ribes* sp., CA, Madera Co., Bass Lake, July 13, 1942, coll. J. Wilson, 1(5) CDA.

**Host and distribution.** This species was originally described from *Cornus paniculata* and *C. alternifolia*, Reading, MA. It has so far been collected and recorded from several other species of *Cornus* (family Cornaceae), including: *C. amomum*, *C. asperifolius*, *C. obliqua*, *C. racemosa* and *C. stolonifera*, and *Cornus* sp. in several localities. It was also collected on *Ribes* of the family Saxifragaceae. It has been found in 17 states: CA, CT, ID, IL, KS, LA, MA, MD, MI, MS, NJ, NY, OH, PA, UT, VA, and WI, and in Ontario, Canada. This species is widely distributed in North America where its hosts are available.

**Affinity and discussion.** Among the North American species in the genus, this species is very close to *C. ortholobis* in several respects such as the arrangement and number of dorsal macroducts. However, it is easy to distinguish this species from others as soon as the most distinctive character is recognized, namely, the appearance of the median lobes. In *C. corni* their inner margins are parallel about half of their length, and then separated, and the strongly divergent margins are long and straight in typical specimens.

*Chionaspis etrusca* Leonardi

Plate 6

**Suggested common name.** Tamarix scurfy scale

**Literature.** *Chionaspis etrusca* -- Leonardi, 1908a:184; 1908b: 88; Sanderson, 1909: 58; Lindinger, 1910: 155, 330; 1912: 318; Leonardi, 1918: 212; 1920: 234; Vayssiere, 1920: 258; Ferris, 1921: 93; MacGillivray, 1921: 332; Vayssiere, 1921: 360; Archangelskaya, 1923: 263; Hall, 1926: 108; Balachowsky, 1927: 182; Gavalov, 1927: 211; Kuwana, 1928: 24; O'Dell, 1929: 29; O'Dell, 1931: 38; Lebert, 1931: 58, 63; de Lepiney and Mimeur: 1931: 249; Gavalov, 1932: 138; Balachowsky, 1933: 41; Stickney, 1934: 155; Bodenheimer, 1935: 271; Lindinger, 1935: 131; Burgess, 1936 (1935): 53; Balachowsky, 1936: 339; Archangelskaya, 1937: 88; Borchsenius, 1937: 177, 179; Ferris, 1937: SI-17; Gomez-Menor, 1937: 222; Fleury, 1938: 72; Lupo, 1938: 272; Essig, 1941: 590; Ferris, 1942: SIV-387, SIV-446; Hewitt, 1943: 269; Borchsenius, 1950: 194; Takahashi, 1952: 10; Bodenheimer, 1953: 12; Balachowsky, 1954: 320, 330, 334; Gomez-Menor, 1954: 134; Hopkins and Carruth, 1954: 1128; Gomez-Menor, 1957: 50; McKenzie, 1957: 97; Balachowsky, 1958: 43, 48; Gomez-Menor, 1959: 7; Bibby, 1961: 330; Gomez-Menor, 1967: 127; Balachowsky, 1970: 1083; Bazarov, 1971: 129; Herting and Simmonds, 1972: 178; Nakahara,

1975: 201; Monaco, 1977: 159; Nakahara, 1982: 17; Hadzibejli, 1983: 180, 181, 274; Takagi, 1985: 39.

*C. sassceri*-Considered as misidentification, Ferris, 1937; SI-17.

**Test of adult female (fig. A).** Osytershell- or pear-shaped, broadened posteriorly; flat and of moderately firm texture; about 1.8-2.5 mm long; white to dirty white; exuviae terminal, yellowish brown, occupying about one third of total length of test. Ventral test white and thin, it remains on surface of host when female is removed.

#### GENERAL DESCRIPTION

Body of adult female spindle-shaped, moderately lobed laterally, and widened posteriorly, broadest at abdominal segment I; on slides, 582-1040 long and 365-532 wide; derm membranous except for sclerotized pygidium (fig. B).

**Pygidial margin (fig. C).** Broadly triangular, 173-223 long and 340-507 wide at base; Median lobes well-developed, short and broad, 13.4-19.8 long and 12.4-15.3 wide; rounded apically, or with 3-5 distinct notches on apex, mesal and outer margins; base of lobes connected by a short and rather indistinct internal zygotis. Second pair of lobes bilobed, heavily sclerotized;

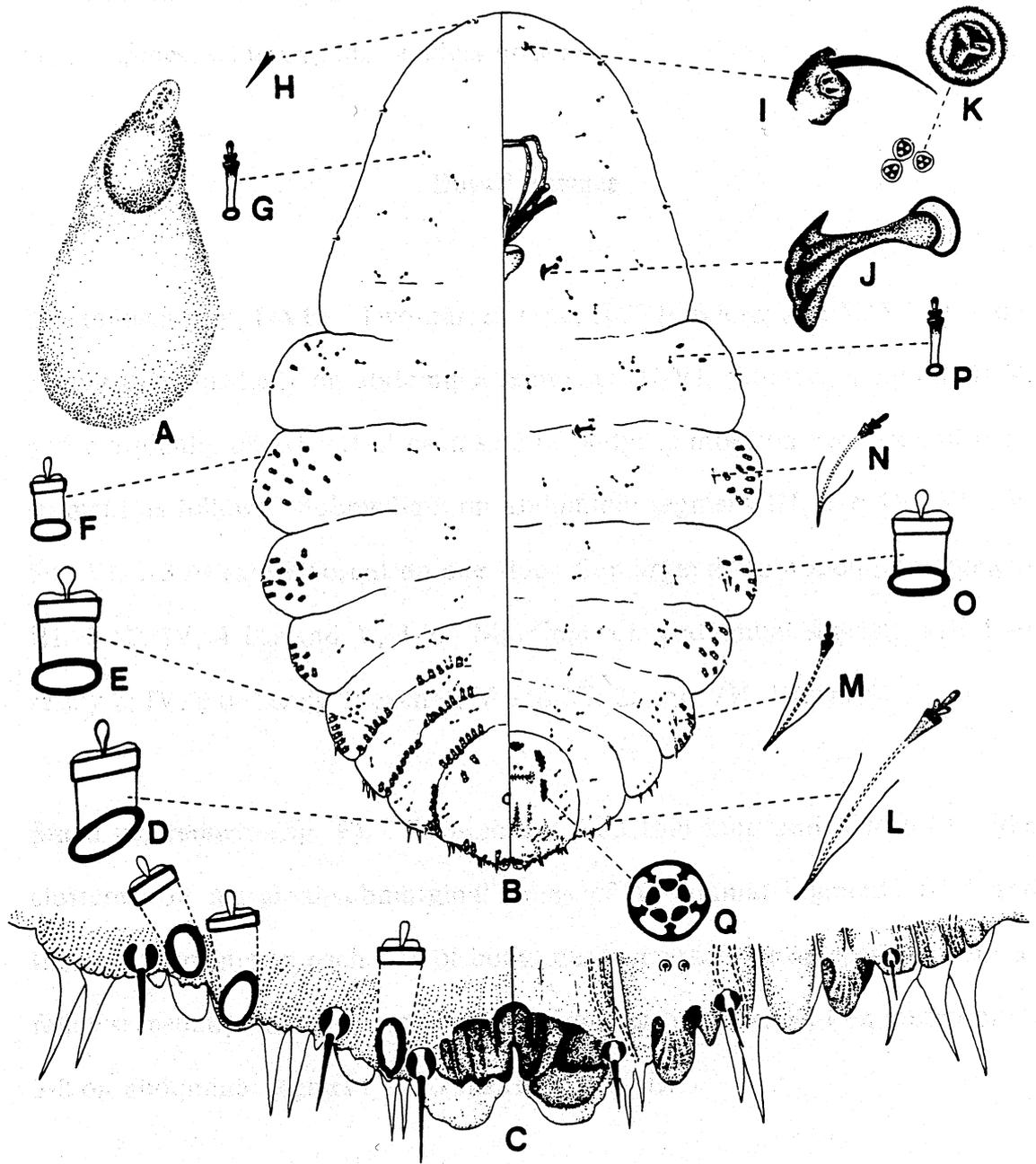


Plate 6. - *Chionaspis etrusca* Leonardi

inner lobule elongate and rounded at apex, much larger than outer one; outer lobule much reduced, pointed, tooth-like. Third pair of lobes partly-developed. Gland spines, setae and macroducts present.

### **Dorsal Surface**

**Macroducts (figs. D&E).** Two-barred type, 10.7-16.6 long and 5.85-7.81 wide, arranged submedially on abdominal segments III-VI, submarginally on III-V, and marginally on III-VII of each side of body; number on each side of each segment as follows. Submedian: on abdominal segment III, 2-9; IV, 5-11; V, 5-8; VI, 1-3 or rarely absent on one side. Sumarginal: on abdominal segment III, 7-12; IV, 4-11; and V, 3-9. Marginal: on abdominal segment III, 1 or rarely 2; IV, 2 or rarely 1; each of V and VI, 2; and VII, 1 always.

**Small macroducts (fig. F).** Two-barred, 6.83-15.6 long and 3.90-6.83 wide, clustered on marginal-submarginal areas of abdominal segments I-III and thoracic segments on each side of body; number arranged on each segment as follows: usually absent on prothorax, 2-6 on mesothorax, 5-14 on metathorax, 3-8 on abdominal segment I, 4-7 on II, 2-6 on III.

**Microducts (fig. G).** One-barred, 7.81-11.7 long and 1.95-2.44 wide at orifice, scattered on each side of body; usually very few scattered on cephalic region and 3-8 on each thoracic segment; sometimes on abdominal segments I-V and

usually on submedian areas, often mixed with or located anterior to macroducts on same segments, usually very few on I, 2-7 on II, 2-8 on III, 2-5 in IV, and 2-4 on V; but occasionally absent on IV and V; also 5-10 on pygidium.

**Setae (fig. H).** Very few, short, slender, and hair-like, 4.88-9.88 long, scattered on and along margin or submargin of cephalic region; 1 on each margin or very few on thoracic segments and basal 3 abdominal segments; 1 or rarely 2 on each margin of abdominal segments IV-VII and laterad of median lobes, slightly longer and stouter, some as long as 14.8.

**Anal area.** Anal opening circular, diameter 7.41-12.4, situated posterior to middle, or about posterior one third to two fifths of pygidium, much nearer to apex of pygidium than in any other species in the genus; distance from anterior margin of anus to midpoint of line between abdominal segments V and VI, 91.4-116; distance from posterior margin of anus to base of median lobes, 56.8-71.6.

#### Ventral Surface

**Antennae (fig. I).** Much reduced to small tubercles, 4.88-9.76 long and 4.88-9.76 wide at base, each with 1 long and slender fleshy seta, 9.78-22.2 long, usually curved; and with 2 very short and stout terminal sensory setae, 1.95-2.93 long. Distance between antennal bases, 26.0- 66.7.

**Clypeolabral shield.** Length, 118-148; width, 86.6-105; shape typical of the genus.

**Labium.** Cup- or shield-shaped, length 37.1-49.4, width 43.3-54.3.

**Spiracles.** Well-developed, with narrow bar supporting the opening; anterior spiracles (fig. J), 19.5-25.4 long and atrium 7.6-10.5 wide, each with 0-5 associated trilocular pores (fig. K), each pore 2.92-4.20 in diameter; posterior spiracles same shape as anterior ones, but slightly smaller, 17.3-27.2 long, each with 0-3 associated trilocular pores. The few trilocular pores present near each spiracle, especially near the anterior ones, is one of the main characters in which *C. etrusca* differs from others in the genus.

**Gland spines (fig. L).** Small and poorly-developed, 9.76-16.6 long and 3.95-4.88 wide at base, marginally situated on abdominal segments VI-VII and laterad of median lobes; number arranged as follows: 2-5 on abdominal segment IV, 2-4 on V, 2 or rarely 3 on VI, 2 on VII, and 1 or 2 laterad of median lobes.

**Gland tubercles (figs. M&N).** Very small, basally conical and distally spinelike, 5.86-10.7 long and 2.92-3.90 wide at base, clustered on submarginal areas of abdominal segments I-III and thoracic segments of each half of body;

lacking on prothorax; mesothorax, absent or rarely 1; metathorax, 1-4; on abdominal segment I, 1-6; II, 0-5; III, 1-4.

**Small macroducts (fig. O).** Two-barred, same size and location as those on dorsal surface, but slightly different in number on each segment on each side of body; absent on prothorax; 2-8 on each of mesothorax and metathorax; usually 4-12 on abdominal segment I, 3-10 on II, 2-7 on III.

**Microducts (fig. P).** Same size as those on dorsal surface but slightly more numerous; very few scattered on cephalic region, 3-7 on each of thoracic and abdominal segments, but 5-11 on pygidium.

**Setae (fig. H).** Short and hair-like, of same length as those on dorsal surface of each half of body; very few scattered on and along submargin of cephalic region, 1 or occasionally none on each margin of thoracic and basal 3 abdominal segments; 1 or rarely 2 on each margin of abdominal segments IV-VII and laterad of median lobes much shorter than that on dorsal surface.

**Vulvar area.** Vulvar opening situated in middle of pygidium. Perivulvar pore (fig. Q) groups: median, 9-18; anteriolateral, 16-31; posteriolateral, 8-16; each pore 4.39-4.88 in diameter.

**Type material studied.** Types from *Tamarix* sp., ITALY, Cecina, (Toscana), 1908, coll. Leonardi?, 10(10) Chermoteca Italica, Fasc. IV, No. 88. Cotypes from *Tamarix* sp., ITALY, Cecina, Toscana, Sept. 26, 1923, Let. F. Silvestri, 1(2) USNM; Tuscany, coll. unknown, 1(3) USNM.

**Other material studied.** *Salix* sp. AZ, Phoenix, Mar. 9, 1935, coll. R.H. Coldwell Jr., 1(6) USNM. *Tamarix aphylla*, AZ, Scanton at D.C., Nov. 22, 1944, coll. H.Y. Gouldman, 1(3) USNM; Dec. 13, 1945, coll. Wood, 1(3) USNM; CA, Coachella, Near High School, Jan. 7, 1924, coll. Harry Bloom, 7(30) USNM. "*Tamarix articulata*", AZ, Tucson, April 20, 1929, 5(9) UCD; Tucson, Feb. 7, 1925, coll. LPW, 5(51) UCD; 1923, coll. unknown, 1(7) USNM; Phoenix, Oct. 11, 1925, coll. A.A. Nichol, 2(8) UCD; Tucson, Feb. 27, 1924, coll. A.A. Nichol, 1(1) UCD; Pima Co., Tucson, July 2, 1930, coll. Jala Jaastad, 3(8) UCD; Tucson, Feb. 7, 1925, coll. GFF, 1(18) UCD; Tucson, Feb. 7, 1925, coll. A.A. Nichols, 1(6) UCD; Salt River Valley, Phoenix, Aug. 8, 1933, coll. Perry Glick, 2(4) USNM, Phoenix, Salt River Valley, Aug 8, 1923, coll. Perry Glick, 1(3) USNM; CA, Calexico, Mar. 9, 1931, coll. O.A. Pratt, 1(3) USNM; Coachella Valley, April 15, 1927, coll. L.E.M., 3(4) UCD; Indio, Oct. 22, 1946, coll. H.Y. Gouldman, 1(3) USNM. "*Tamarix odesseyana*", AZ, Tucson, Jan. 16, 1917, Let. Fr. A.W. Morrill, 2(5) USNM. *Tamarix pariflora*, AZ, Yavapai Co., Clarkdale, Mar. 3, 1936, coll. LPW, 6(9) UCD. *Tamarix pentandra*, Avondale, Nov. 23, 1953, coll. F.F. Bibby, 1(4) USNM. *Tamarix* sp., AZ, Maricopa Co., Glendale, Aug. 1, 1932, coll. E.

Draper, 2(7) UCD; Clarkdale, Mar. 3, 1936, coll. LPW, 3(38) UCD; Douglas, May 15, 1940, coll. LPW, 1(18) UCD; Douglas, 1960, coll. unknown, 1(5) USNM; Graham Co., Safford, June 1, 1936, coll. W.T. Mendenhall, 3(17) UCD; Arcadia District, Phoenix, Mar. 15, 1935, coll. C.D. Lebert, 2(20) UCD; Maricopa Co., W. Madison St., Phoenix, Oct. 11, 1925, coll. unknown, 2(6) UCD; Naco, June 25, 1942, coll. W.F. Maner, 1(4) USNM; Phoenix, 1331 N. Alvarado, Jan. 4, 1935, coll. Crismon, 2(16) UCD; Maricopa Co., Arcadia NE., Phoenix, March 15, 1935, coll. unknown, 2(5) UCD; Tucson, Feb. 16, 1937, coll. LPW, 1(3) UCD; Tucson, Dec. 10, 1941, coll. V. Potter, 1(1) UCD; Tucson, Pima Co., Feb. 7, 1925, coll. A.A. Nichol, 3(4) UCD; Tucson, Pima Co., 956 N. 6th. Avenue, Oct. 15, 1934, coll. LPW, 3(10) UCD; Tucson at D.C., April 11, 1929, coll. W.B. Wood, 1(2) USNM; Cochise Co., Willcox, Aug. 21 or 22, 1939, coll. Mr. Swenson, 2(2) UCD; CA, Kern Co., Arvin, Dec. 14, 1955, coll. E. Remmers, 1(2) UCD; Coachella Valley, coll. unknown, 19(219) USNM; Coachella Valley, April 26, 1923, coll. unknown, 1(1) CDA; Coachella Valley, April 15, 1927, coll. L.E.M., 3(4) UCD; Coachella Valley, coll. unknown, 3(13) UCD; Coachella, 1921, coll. R.C. Fleury, 1(5) USNM; Coachella, May 15, 1919, coll. Sharp and GFW, 2(4) UCD; Coachella, April 18, 1919, coll. Bruce Drummond, 1(3) USNM; San Balo Co., Athol Barstow Area, Feb. 22, 1943, coll. Chas. J. Hayward, 1(5) CDA; Calexico, Dec. 20, 1944, coll. A.J. Hansen and C.G. Anderson, 2(4) CDA; San Diego Co., Borrego Valley, June 20, 1952, coll. Les Hayworth, 1(2) CDA; Stanislaus Co., Modesto, Dec. 4, 1943, coll. W.M. Daniel, 1(2) UCD; San Bernardino Co.,

Trona, July 17, 1940, coll. John P. Coy, 1(8) CDA; Tulare Co., Jan. 22, 1941, coll. Hemphill, 1(9) CDA; Indio, Sept. 10, 1956, coll. Dean Halsey, 1(4) UCD; Riverside Co., Banning, Aug. 28, 1942, coll. Tower, 1(2) CDA; Riverside, May 29, 1936, coll. unknown, 1(5) UCD; Stanis Co., 115 Virginia Ave., Modesto, April 22, 1940, coll. H.E. Wallace, 1(7) CDA; Visalia, June 25, 1941, coll. E.O. Essig, 1(10) USNM; Morongo Valley, July 1, 1971, coll. H.H. Tippins, 1(1) UGAES; Tulare Co. Visalia, Feb. 13, 1975, coll. Akana and Thomas, 2(9) CDA; NM, Hildago Co., 5.3 min. Cotton City, July 26, 1969, coll. D.R. Liesner, 1(1) CDA; TX, Vinton, Aug. 7, 1939, coll. Joe Chrisler, 1(3) USNM, Indio River Co., Feb. 5, 1963, coll. M.K. Hess, 1(5) CDA,

**Host and distribution.** This species was first described from *Tamarix* sp. (family Tamaricaceae) in Italy. Since then it has been collected and recorded from several countries of the world including France, Japan, Mexico, Spain, and the United States. In this country, it has only been found on *Tamarix* including: *T. aphylla* (= *T. articulata*), *T. gallica*, *T. parviflora*, *T. pentandra* and *T. ramosissima* (= *T. odesseyana*), in AZ, CA, NM, and TX. It appears that this species is specific to *Tamarix*, and its distribution is limited to the southwestern states and Mexico in North America. It is common in desert regions where its host occurs.

**Affinity and discussion.** This species is thought to be closely related to *C. ortholobis*, but it differs mainly in its distinctly separated median lobes that

have lateral notches on their margins. The median lobes of *C. ortholobis* are set closely together, are smoothly rounded, and without lateral notches.

According to Bodenheimer (1953: 12) and Balachowsky (1954: 320), this species is also somewhat similar to *C. salicis*, but differs from it by having distinctly different median and second pair of lobes. It also approaches *C. engeddensis* Bodenheimer which feeds on the same host, but the much reduced number of perivulvar pores and other minor differences can be used to distinguish *C. engeddensis* from this.

While checking the specimens from CA, AZ and Mexico, I found that some of them had very different median lobes. In order to make sure if these differences were associated with feeding sites or localities, and to find more detailed characters, we mounted many slides by using the dry material on both leaves and bark from several localities. Both individuals with typical median lobes of this species and unusual median lobes have been found among the specimens feeding on leaves, and only the ones with typical median lobes have been found in all specimens collected from bark. When these were compared with the slide-mounted specimens from the type material from Italy, the author concluded that they were not different forms associated with feeding sites and localities but members of a new species. See separate description under *C. gilli*.

## *Chionaspis floridensis* Takagi

### Plate 7

**Suggested common name.** Florida scurfy, scale

**Literature.** *Chionaspis floridensis* - Takagi, 1969:269; 1985:39; Willoughby and Kosztarab, 1974:5; Nakahara, 1975:201; 1982:18.

**Test of Adult Female (fig. A).** Oystershell-shaped, white or dirty white, frequently covered by some extraneous material; about 2.0-2.5 mm long and 0.7-1.5 mm wide, posterior end broader; first exuviae pale yellow; second exuviae brown or dark brown, occupying about one fourth to one third of total length of test. Ventral scale white and thin, it remains on host when removed.

### General Description

Body spindle-shaped, margins laterally lobed; broadest at first abdominal segment, or sometimes at second; length on slides 984- 1207, width 520-631 (fig. B).

**Pygidial margin (fig. C).** Broadly triangular, 217-266 long and 427-501 wide at base, sclerotized apically. Median lobes well- developed, and prominent, 22.2-28.4 long and 13.6-17.3 wide; closely appressed together mesally, and deeply incised laterally; rounded at apex, notched obviously on lateral

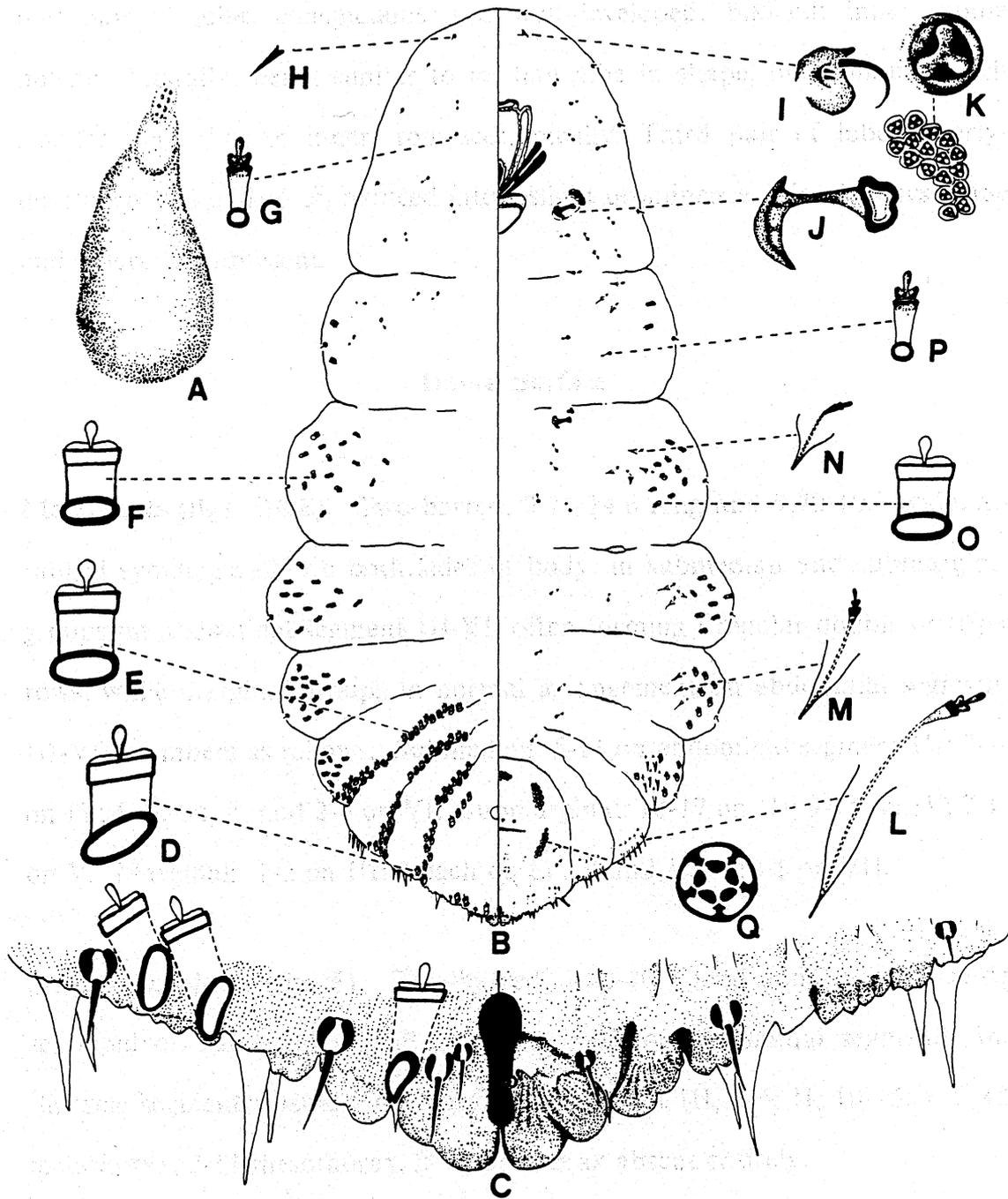


Plate 7. - *Chionaspis floridensis* Takagi

margins; basal zygotis elongate and narrow, much produced anteriorly. Second pair of lobes conspicuous and well-developed, bilobed; inner lobule notched laterally, being similar to median lobe in shape; outer lobule much smaller than that of inner, rounded apically. Third pair of lobes poorly developed and indistinct, reduced into a slight prominence. Gland spines, setae and macroducts present.

### **Dorsal Surface**

**Macroducts (figs. D&E).** Two-barred, 9.76-14.6 long and 9.70-10.7 wide, arranged symmetrically on both sides of body, in submedian and submarginal groups on abdominal segment III-VI, often forming irregular double or triple rows, while marginal groups in normal arrangement on abdominal segments III-VII; numbers as follows: Submedian: 5-11 on abdominal segment III; 7-14 on IV; 5-10 on V, and 2-6 on VI. Submarginal: 10-17 on III; 9-15 on IV; 7-11 on V. Marginal: 1-2 on III; 2 each on IV, V and VI; and 1 on VII.

**Small macroducts (fig. F).** Two-barred, 7.80-10.7 long and 3.90-6.93 wide; scattered on submarginal and marginal areas on abdominal segments and thoracic segments; usually on abdominal segment III, 2-5; II, 10-15; I, 8-12; metathorax, 7-11 mesothorax, 2-4; prothorax absent entirely.

**Microducts (fig. G).** Only very few irregularly scattered on the entire dorsal surface.

**Setae (fig. H).** Few small and slender hair-like setae scattered on or along the margins of cephalic region, 7.80-9.76 long; 1 or rarely 2 slender and longer setae on each segment of abdominal segments III-VII, becoming longer toward posterior segments.

**Anal area.** Anal opening circular, small, 12.45-14.8 in diameter, situated at about basal third of pygidium; distance from the anterior edge of the anus to mid-point of the line of abdominal segments V and VI, 51.87-83.98; distance from the posterior edge of anus to the base of median lobes, 121.03-153.15.

#### **Ventral Surface.**

**Antennae (fig. I).** Reduced into small sclerotized tubercles, 6.83-9.88 long and 5.85-10.4 wide at base; each antenna with 1 short and curved seta, about 14.6-19.5 long, and with 2 short and stout sensory setae, 2.68-3.92 long. Distance between the antennal bases 61.5-87.8.

**Clypeolabral Shield.** About 135.9-160.6 long and 101.27-118.56 wide; typical shape and structure of the genus.

**Labium:** 37.1-69.2 long and 54.3-69.2 wide; cup or shield-shaped.

**Spiracles.** Anterior spiracles (fig. J), 26.4-29.3 long and atrium 9.5-11.4 wide, with a large compact cluster of associated trilocular pores (fig. K), about 15-30. Posterior spiracle similar in shape and size to the anterior, 25.4-28.3 long; each with a range of 2-9 associated trilocular pores, but most of them each with 2-4.

**Gland spines (fig. L).** Well-developed and more numerous on margins of abdominal segments III-VII, or occasionally on submarginal area of abdominal segment III; their numbers as follows: III, 4-7; IV, 5-8; V, 2-4, mostly 3; VI, 2-3; and VII, 1 or 2.

**Gland tubercles (figs. M&N).** Conical on submarginal regions of abdominal segments I and II, metathorax and mesothorax, rarely prothorax near the posterior edge, 19.3-15.4 long and 5.15-9.27 wide at base; usually 4-6 on abdominal segment II, 1-4 on I, 2-6 on metathorax, 2-5 on mesothorax, or 1-2 on prothorax.

**Small macroducts (fig. O).** Situated marginally and submarginally, two-barred, about 7.80-10.7 long and 3.90-6.83 wide, on abdominal segments I-III, meso- and metathorax on both sides of body; numbers vary on each segment, 2-5 on abdominal segment III, 6-10 on II, 5-8 on I, 4-7 on metathorax and 2-4 on mesothorax.

**Microducts (fig. P).** One-barred, scattered irregularly on cephalic region; numerous near anterior and posterior spiracles and around the groups of gland tubercles, and more or less scattered on other segments; 10.0-12.4 long, 1.54-2.36 wide at orifice.

**Setae (fig. H).** Very few, small and slender, hair-like, along margins and scattered on cephalic region, 7.80-9.76 long; 1 on each margin of thoracic segments and abdominal segments I-III; stouter and longer setae on margins of abdominal segments IV-VII, the ones on V and VI longer than any others.

**Vulvar area.** Vulvar opening in middle of pygidium; perivulvar pores (fig. Q) quinquelocular, more numerous, and arranged in 5 groups: median, 16-30; anteriolateral, 32-42; posteriolateral, 23-41.

**Type material studied.** From *Fraxinus* sp., FL, O'leno St. Park, July 19, 1961, coll. GWD, 3(3) FDA.

**Other material studied.** *Betula nigra* FL, Cracker Bend, April 10, 1969, coll. AEG, 6(6) USNM; Columbia Co., Santa Fe River, Nov. 23, 1969, coll. AEG, 4(4) USNM.

**Host and distribution.** So far this species has only been found on *Fraxinus* in Florida.



*Chionaspis furfura* (Fitch)

Plate 8

**Common name.** Scurfy scale

**Selected literature and synonymy.** *Aspidiotus furfurus*-Fitch, 1856: 356; 1859: 54; Uhler, 1860: 313, 314; Howard, 1894: 5; Essig, 1931: 862; Ferris, 1937: SI-18; 1941: 43; Fulmek, 1943: 11, 23.

"Approaches *Coccus cryptogamus* Dalman" - Harris, 1841: 202.

*Aspidiotus cerasi* - Fitch, 1856: 358; Signoret, 1870: 107; Saunders, 1883: 204; Osborn, 1884: 2; Comstock, 1888: 151; Lintner, 1888: 208; Saunders, 1889: 204; Riley, 1889: 324; Tryon, 1889: 89; Packard, 1890: 538.

*Aspidiotus harrisii* - Walsh, 1867: 119; 1868: 36, 53; Riley, 1869: 7; 1870: 110, 181; Bethune, 1870: 303; Glover, 1871: 88; Bessey, 1875: 232; Packard, 1883: 530.

*Chionaspis furfura* - Comstock, 1880: 315; Lintner, 1882: 331; 1889: 300; 1893 (1891): 293, 299; 1893 (1892): 440; Osborn, 1883: 211; 1893: 122; Saunders, 1883: 44; Weed, 1890: 128; 1891: 16, 66; Gillette, 1891: 259; Townsend, 1891: 12; Troop, 1891-1892: 75; Smith, 1892: 217; Webster, 1892: 208; Cockerell, 1894: 33; 1899: 398; Howard, 1894: 354; Brick, 1899: 13; Cooley, 1899: 23; 1899: 88; 1900: 88; Newell, 1899: 150; Frank and Kruger, 1900: 100; Leonardi, 1901: 561; Banks, 1902: 14; Felt, 1901: 300, 360; 1905: 214; Forbes, 1901: 22; Hunter, 1902: 119; Reh, 1902: 48; 1902: 253; Rumsey,

1907: 32; Burgess, 1908: 213; Taylor, 1908: 81; Folsom, 1913: 130; Essig, 1915: 158; Blackman, 1916: 100; Lawson, 1917: 268; Houser, 1918: 288; Weiss, 1919: 12; Britton, 1920a, 64; 1923: 364; Hollinger, 1923: 23; Fraser, 1924: 176, 382; Patch, 1925, 531; Trimble, 1925: 9; Sheaffer, 25; Quaintance and Siegler, 1931a: 5, 64; 1931b: 74; Barrett, 1932: 283; Amos, 1933: 207; Ferris, 1937: SI-18; 1941: 43; 1942: SIV-386; Hewitt, 1939: 590; McDaniel, 1939: 3, 8; 1971: 285; Flint and Farrar, 1940: 11, 18; Chambers and Thompson, 1940: 21; de Santis, 1940: 35; 446; Slesman, 1945: 46; Lindinger, 1949: 211; Balachowsky, 1954: 321; Milliron, 1958: 12, 47; Kosztarab, 1963: 68, 69; Dekle, 1965: 10, 34; Takagi and Kawai, 1967: 30, 38; McComb and Davidson, 1969: 1; Schread, 1970: 22; Herting and Simmond, 1972: 178; Saker, 1972, 108, 109; Swan and Papp, 1972: 165; Beshear, Tippins and Howell, 1973: 9; Bobb, 1973: 16; Westcott, 1973: 421; Willoughby and Kosztarab, 1974: 2; Nakahara, 1975: 20;; 1882: 18; Schuder, 1975: 1; English, 1976: 26; Konstantinova, 1976: 43; Howell and Tippins, 1976: 179; Howell and Williams, 1976: 188; Johnson and Lyon, 1976: 322; Schuder, 1979: 1; Knight, Heikkenen, 1980: 281; Lambdin and Watson, 1980: 80; Takagi, 1985: 39.

*Chionaspis furfura var. fulvus* - King, 1899a: 334; 1899b: 886; Cockerell, 1899: 398; Marlatt, 1899: 836; 1901: 384; Britton, 1923: 364; Ferris, 1937: SI-18.

**Other synonymy.** *Diaspis harrisii*, Signoret, 1876: 604; Riley, 1881: 487.

Before 1910's this species was sometimes spelled as *C. furfurus*. Lindinger (1908: 87, 94; 1958: 366.) proposed changing the spelling of the species name from *C. furfura* to *C. furfurea*, but the latter name was not accepted.

**Test of adult female (fig. A).** Rather irregular or pear-shaped, rounded at one end and often abruptly bending to right or left immediately posterior to second exuvium; about 2.0-3.2 mm long, flat and thin, delicate in texture; if large number massed together, they appear just like a layer of dandruff; color normally pure white, but often dirty gray and sometimes resembling the bark on which it feeds; exuviae small, the first exuvium gray, and the second one yellowish brown but often grayish; usually occupying about one third of the entire length of the test; ventral test very thin, white.

### GENERAL DESCRIPTION

**Body of the adult female (fig. B).** Spindle-shaped, laterally lobed and broadened posteriorly; length on slide 866-1620, long and 408-755 wide.

**Pygidial margin (fig. C).** Triangular and quite large, sclerotized apically; about 210-260 long and 316-476 wide at base. Median lobes well-developed, short and broad, shell-like, apically rounded and set close together, 12.4-17.3 long and 14.9-17.3 wide; base of median lobes yoked by an elongated conspicuous zygotis; a distinct and very narrow transverse sclerotic bar at the base of each

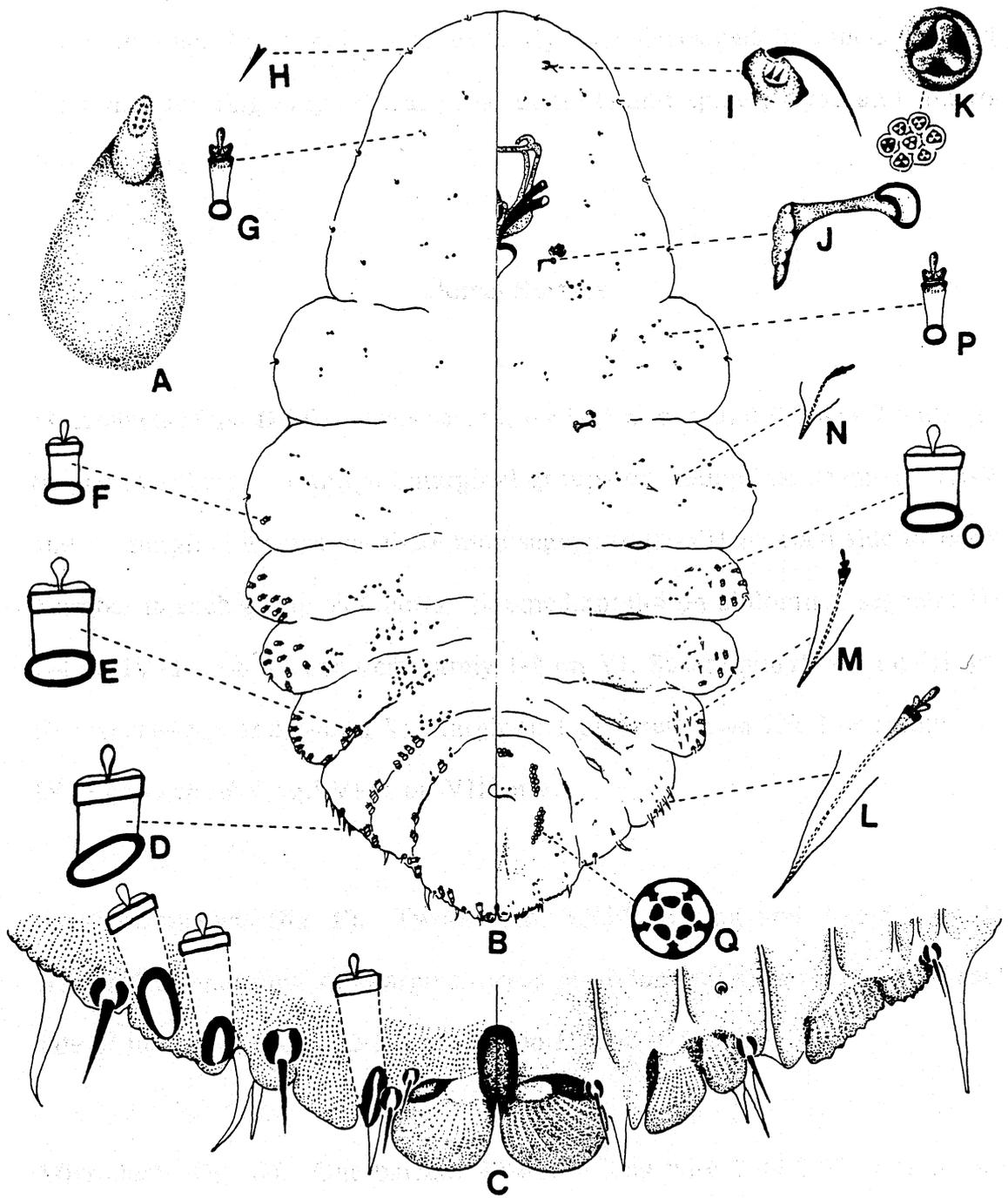


Plate 8. - *Chionaspis furfura* (Fitch)

lobe, sometimes the bar oblique. Second pair of lobes well-developed, bilobed, low and broad; each lobule rounded apically; inner lobule much larger than the outer one. Third pair of lobes fairly well developed or much reduced, sometimes forming only several projections. Gland spines, setae and macroducts present.

### **Dorsal Surface**

**Macroducts (figs. D&E).** Two-barred, 6.83-16.6 long and 9.76-11.7 wide, arranged in submedian and submarginal groups on abdominal segments III-V, and in marginal groups on abdominal segments III-VII on each side of body. Number in each group as follows: Submedian: 0-4 on abdominal segment III, 1-4 on IV, 1-3 on V, and very rarely 1-2 on VI; Submarginal: 2-6 on III and IV respectively, and 1-4 on V; Marginal: 1 or rarely 2 on III, 2 or rarely 3 on IV, 2 on each of V and VI, 1 on VII only.

**Small macroducts (fig. F).** Two-barred, 3.85-9.88 long and 2.85-8.76 wide, clustered on marginal-submarginal areas of abdominal segments I-III of each side of the body; usually 2-5 on I, 3-6 on II, and 3-5 on III.

**Microducts (fig. G).** One-barred, 7.84-9.76 long with 2.44-2.93 wide orifice, scattered irregularly on cephalic region, thoracic and abdominal segments on each half of the body; usually 4-6 on cephalic region, 3-5 on each thoracic

segments, 3-6 on each of abdominal segments I, II and III; sometimes more numerous, from 6 to 25, occupying the position of submedian macroducts on abdominal segments III, IV, or on II; in some individuals, 1-5 microducts mixed with or in lieu of submedian macroducts on abdominal segment V.

**Anal area.** Anal opening circular, 9.88-12.4 in diameter, situated about basal one third of pygidium; distance from anterior edge of anus to mid-point of line between abdominal segments V and VI, 61.8-86.5; distance from posterior edge of anus to base of median lobes, 109-148.

**Setae (fig. H).** Slender and hair-like, 6.83-7.81 long, about 8-12 arranged along margins of and on cephalic region; 1 or rarely 2 on each margin of thoracic segments, 4.94-7.41 long; ones on each margin of abdominal segments I-III, nearly the same length as anterior ones, but ones on each margin of abdominal segments IV-VII more or less longer, 9.88-17.29; ones on pygidial margin located laterad of each pair of lobes.

### Ventral Surface

**Antennae (fig. I).** Reduced to very small and sclerotized tubercles, 5.86-9.76 long and 5.86-8.78 wide at base, each with 1 slender and fleshy seta, 11.71-17.29 long, and 2 very stout and short sensory terminal setae, about 1.95-2.93 long; distance between antennal bases, 56.81-108.68.

**Clypeolabral shield.** Shape typical of genus, 98.6-124 long and 80.4-119 wide.

**Labium.** Cup- or oval-shaped. Length, 32.80-54.34; width, 43.32-56.81.

**Spiracles.** Anterior, (fig. J) 19.8-22.2 long and atrium 12.4-17.3, each with 5-10 associated trilocular pores (fig. K), each pore with a diameter of 2.44-3.12. Posterior spiracles resemble the anterior ones both in shape and in size, 19.76-22.23 long, each with only 1-2, or rarely none or 3 associated trilocular pores.

**Gland spines (fig. L).** Marginal, well-developed, 14.6-26.4 long, on margins of abdominal segments VI, V and laterad of each pair of lobes on pygidial margin of each side of body; usually 3-7 on abdominal segment IV, and 1 on each of abdominal segments V, VI and laterad of VII and of median lobes.

**Gland tubercles (figs. M&N).** Spine-like or basally conical and distally spinelike, clustered submarginally on abdominal segments I-III on each side of body; size greatly variable, becoming smaller anteriorly, with the range of about 1.96-9.76 long and 1.98-4.39 wide at base; on abdominal segment I, 0-6; II, 2-10; III, 5-11.

**Small macroducts (fig. O).** Two-barred, with same shape and size as ones on dorsal surface, but the number slightly fewer; about 2-6 on each of abdominal segment I-III.

**Microducts (fig. P).** One-barred, of same size as those on dorsal surface, more or less scattered on cephalic region, and on each segment of thorax and abdomen; usually 4-8 on cephalic region, 3-5 on each thoracic segment, 1-3 on abdominal segments, and 4-7 on pygidial area.

**Setae (fig. H).** Length and location nearly the same as for dorsal surface.

**Vulvar Area.** Vulvar opening located about middle of pygidium; perivulvar pore (fig. Q) groups: median, 6-12; anterolateral, 20-32; posteriolateral, 13-35; each pore 3.90-4.49 in diameter.

**Material studied.** *Amelanchier canadensis*, MA, Springfield, Mar. 15, 1900, coll. M. Dimmock, 1(3) USNM; Reading, July 26, 1910, coll. ERS, 1(3) USNM. *Aronia arbutifolia*, MA, East Boxford, Sept. 13, 1928, coll. H.R. Francis, 1(6) USNM; NJ, Whitesbog, Oct. 16, 1913, coll. H.B. Scammel, 1(2) USNM. *Aronia atropurpurea*, IN, Near Mill Creek, Aug. 25, 1920, coll. C.C. Deam, 1(2) USNM. *Aylmer* sp., Canada, Ontario, Rec'd May 7, 1914, coll. L.A. Hamkirso, 1(4) USNM. *Betula alba*, CA, San Diego, Johnson Nursery, Dec. 17, 1953, coll. G.W. Schwegel, 1(1) CDA. *Betula* sp., CA, San Diego,

Johnson Nursery, Dec. 29 1953, 1(2) CDA. *Chaenomeles japonica*, MD, Elkridge, July 9, 1958, coll. MK, 5(12) VPI; MO, St. Louis, Jan. 19, 1942, coll. Howard Baker, 1(5) USNM. *Crataegus agerulus*, MD, Yarrow, Jan. 3, 1921, coll. F.H.B., 1(3) USNM. *Crataegus oxyacantha*, DC, Botanical Gardens, July 16, 1909, coll. ERS, 1(4) USNM. *Crataegus pinnatifida*, MD, Yarrow, Dec. 17, 1921, coll. F.H.B., 1(1) USNM. *Crataegus pyracantha*, MD, Yarrow, Dec. 18, 1921, coll. F.H.B., 1(2) USNM. *Crataegus* sp., NY, Medina, N.Y. Insecticide Co. Inc., Let. July 31, 1926, coll. unknown, 1(4) USNM; CN, New Haven, Jan. 27, 1919, coll. PRL, 2(8) USNM; GA, Richmond Co., May 18, 1972, coll. RB, 2(3) UGAES; Eatonton, May 26, 1975, coll. S. Smith, 1(1) UGAES; Macon Co., April 10, 1976, coll. RB, 1(1) UGAES; LA, Baton Rouge, coll. GFF, 1(6) UCD; MD, Yarrow, Jan. 11, 1921, coll. H.Y. Gouldman, 1(7) USNM; OH, East Harbor State Park, Lot # A-7, Sept. 6, 1960, coll. MK, 1(4) VPI; Tuscarawas Co., Near Newcomb, Sept. 5, 1961, coll. MK, 1(2) VPI; TX, coll. Marshall, T-856, 2(4) UCD; Dekalb, April 30, 1970, coll. Sue Smith, HHT-190-70, 1(1) UGAES; College Station, July 6, 1916, coll. unk., #T311-13, 1(1) UCD; College Station, 1921, coll. GFF, #T220, 1(2) UCD; DC, July 16, 1909, coll. ERS, 1(3) USNM. *Cotoneaster* sp., CA, Fresno, Henderson's Exp. Gar., Mar. 17, 1939, coll. J.W. Dixon, 2(3) CDA; Fresno, Henderson's Exp. Gar., April 13, 1939, coll. J.W. Dixon, 1(4) CDA; IN, Vincennes, Old Cathedral, Let. Nov. 3 1941, coll. Paul T. Ulman, 1(6) USNM; OH, Lake Co., Sept. 27, 1967, coll. P. Kohankie, 7(8) CDA. *Cydonia* sp., MD, Baltimore, Greenmount Ave. Cemetery, March 10, 1943, coll.

Spessardr Vinzant, 1(5) USNM. *Juglans cinerea*, OH, Wooster, Aug. 13, 1929, coll. PRL, 1(1) USNM; PA, Rockville, Jan. 7, 1921, coll. F.M. Trimble, 1(3) USNM; WI, Madison, coll. JGS, 1(5) USNM. *Juglans nigra*, IN, W. Lafayette, Mar. 1, 1932, #69, coll. JMA, 2(6) USNM; OH, S. of Piketon, Pike Co., July 16, 1961, #0182, coll. MK, 2(2) VPI. *Malus pumila*, OH, Hocking Co., Neotoma, April 16, 1960, coll. MK and P. Freytag, #02, 1(4) VPI; VA, James Madison College, Harrisonburg, May 8, 1975, coll. MK, VA 12920, 2(4) VPI; OH, Logan Co., July 9, 1961, coll. MK, #0221, 1(2) VPI; New California, Union Co., July 9, 1961, coll. MK, #0216, 1(2) VPI; Cuyahoga Co., March 5, 1961, coll. MK, 1(4) VPI. *Malus* sp., CT, New Canaan, 1902, coll. unknown, 4(25) UCD; GA, Spalding Co., June 16, 1969, coll. RB, 1(1) UGAES; Ellijay, Oct. 26, 1923, Let., John D. Moore, HHT-198-69, 1(2) USNM; IL, Lagrange, Let. rec Sept. 9, 1911, coll. W.H. Moore, #225, 1(2) USNM; Olney, Let. June 11, 1909, coll. Bryant Higgins, #225, 1(1) USNM; Kirkwood, Let. June 4, 1921, coll. Mrs. H.T. Ricketts, 1(2) USNM; IN, Indianapolis, Let. Aug. 9, 1910, coll. Bly W. Douglas, #225, 1(1) USNM; coll. H. Morrison, 1(2) UCD; Vincennes, memo Jan. 30, 1953, coll. D.W. Hamilton, #53-374, 1(5) USNM; Indianapolis, St. Capitol, Mar. 29, 1979, coll. Bruce Cummings, 1(2) USNM; KY, Oldham Co., Dec. 3, 1961, coll. MK, #KY-237, 1(3) VPI; Lexington, Let. Aug. 25, 1921, coll. Prof. H. Gorman, 1(3) USNM; Bowling Green, Let. Dec. 26, 1908, coll. W.E. Campbell, #225, 1(3) USNM; MD Flintstone, Let. April 15, 1921, coll. T.D. Horstock, 1(1) USNM; Westminster, Sept. 9, 1897, coll. unk., #ACC.3169, B-5 No.-6, 1(1)

USNM; Westminster, Sept. 8, 1897, coll. unk., #225 ACC-3169 B-3 No.-1, 1(2) USNM; North East, April 23, 1918, coll. C.B. Nickels, #ACC 3169, 1(1) USNM; Hyattsville, June 21, 1965, coll. E. Dudik, 1(2) USNM; MS, Jamaica Plains, July 29, 1910, coll. ERS, #225, 2(4) USNM; Lawrence, coll. E.R. King, #8292, 1(1) USNM; MO, St. Louis, Dec. 4, 1942, coll. N. Stahler, #P.C.S. No.53, 2(9) USNM; Louisiana, Nov. 1899, coll. Stark Bros., #225, 2(9) USNM; NC, Randolph Co., June 17, 1959, coll. M.H. Farrier, #NC-5938, 1(6) USNM; NJ, Near Penville, Aug. 28, 1917, coll. R.V. Deane, 1(2) UCD; NY, Staten Id., 1918, coll. R.W. Deane, 1(2) UCD; OH, Cuyahoga Co., Mar. 5, 1961, coll. MK, #O214, 1(2) VPI; Hamilton, Let. Jan. 6, 1915, coll. Henry H. Gushes, 1(4) USNM; Wooster, Aug. 24, 1917, coll. PRL, 2(11) USNM; VA, Raven, Let. May 11, 1965, coll. Mr. Leo Lawson, VA 266, 1(3) VPI; Blacksburg, VPI Plot 63/k, March 28, 1969, coll. M.L. Williams, Va 881, 2(4) VPI; Fairfax Co., May 5, 1969, coll. J.L. Gugino Jr., VA 666, 4(8) VPI; Richmond, Feb. 5, 1979, coll. T. Roth, VA 1490, 1(2) VPI; Mabry Mill, Blue Ridge Pkwy., May 25, 1978, coll. MK, VA 1483, 3(6) VPI; Waynesboro, March 1939, coll. A.M.W., VA 68, 1(1) VPI; Floyd Co., Aug. 17, 1963, coll. MK and D.V., 1(3) VPI; Clintwood, May 30, 1964, coll. T.E. Dinwiddie, VA 132, 2(5) VPI; DC, Oct. 13, 1908, coll. ERS, 1(1) USNM; June 25, 1936, coll. LPW, 9(129) UCD; WV, Shepherdstown, Let. Mar. 17, 1921, coll. C. Wysong, 1(7) USNM; Charleston, Kanawha Co., May 11, 1980, coll. C.C. Coffmen, 1(1) USNM; Reedsville, Preston Co., May 29, 1982, coll. G.W. Gibson, 82-5465, 2(4) USNM. "Mayhaw", GA, Clinch Co., April 12, 1970, coll. RB,

HHT-63-70, 1(1) UGAES. *Prunus caroliniana*, FL, Plymouth, Jan. 26, 1979, coll. G.T. Smith, K-967, 2(2) FDA. *Prunus domestica*, GA, Marshallville, April 12, 1900, coll. W.M. Scott, CA 18, 1(1) VPI. *Prunus maritima*, MA, Newburyport, Rec'd Aug. 31, 1939, coll. J.M. Batchelor, 1(5) USNM. *Prunus* sp., GA, Ft. Valley, Feb. 15, 1906, coll. A.L. Quaintance, 2(12) USNM; GA, Taylor Co., July 23, 1980, coll. RB, HHT-19-80, 1(1) UGAES; Albany, Nov. 27, 1898, coll. T.S. Williams, 381, 1(5) USNM; MO, Louisiana, Nov. 1899, coll. Stark Bros., 1(4) USNM; OH, Columbus, July 2, 1917, coll. PRL, 1(6) USNM. *Pyracantha coccinea*, OH, Secor Park Arboretum, Lucas Co., July 9, 1961, coll. MK, 0222, 1(3) VPI. *Pyracantha* sp., MD, Ellicott City, April 23, 1959, coll. MK, MD 5, 1(2) VPI; Elkton, Jan. 1963, coll. L.V. Howard, 1(5) UCD; MO, Tow. Gr. Park, St. Louis, Dec. 1, 1941, coll. B.O. Brayton, VII-42, 1(12) USNM. *Pyrus communis*, VA, Montgomery Co., Aug. 22, 1973, coll. MK, VA 1289, 3(5) VPI. *Pyrus japonica*, PA, Philadelphia, Let. Mar. 14, 1906, coll. H.A. Surface, 5211a, 1(6) USNM. *Pyrus pyrifolia*, MD, Bell Station, Nov. 22, 1928, coll. H.L. Sanford, 1(3) USNM. *Pyrus* sp., FL, Chattahoochee, Apr. 10, 1933, coll. W.L. Kersey, 45203, 2(3) FDA; GA, Henry Co., May 19, 1969, coll. RB, HHT-187-69, 2(2) UGAES; Henry Co., Feb. 11, 1968, coll. RB, HHT-40-68, 2(2) UGAES; IN, Paxton, Let. Jan. 14, 1907, coll. F.D. Roberts, 1(3) USNM. MD, Baltimore, Jan. 2, 1920, coll. H.W. Fogg, 5(10) FDA; Bell. Sta., Sept. 31, 1921, coll. W.B. Wood, 1(2) USNM; Curtis Bay, Sept. 6, 1943, coll. M. Mohr, 1(7) USNM; Bell, Sept. 8 1921, coll. H.Y. Gouldman, 1(3) USNM; MA, N. Abington, Sept. 11 1921,

coll. G.B. Merrill, 16766, 6(12) FDA; VA, Abingdon, Yard, Ext. Bldg., July 8, 1980, coll. MK, VA 1536, 2(4) VPI. *Ribes* sp., IN, Indianola, March. 11, 1922, coll. Mowry and Thos., 11370, 3(6) FDA; Mechanicsville, March 22, 1921, coll. Gist and Mowry, 8816, 4(8) FDA; PA, Trevorton, Let. May 13, 1919, coll. Matthew Fitzpatrick, 1(3) USNM; Pinegrove, Nov. 16, 1899, coll. W.H. Stout, 1(3) USNM. *Sorbus americana*, NC, Busick, Aug. 22, 1951, coll. H.S. McConnell, 1(4) USNM. *Sorbus acuparia*, PA, Rickerts Nursery, Morrisville, Aug. 26, 1943, coll. G.B. Slesman, PA-471, 2(9) VPI; IN, Madison Co., Aug. 28, 1975, coll. V. Knapp, 3(9) USNM; MI, Manistee, Let. July 18, 1908, coll. D.J. Murphy, 1(2) USNM. *Sorbus* sp., NC, Top of Mt. Leconte, Grt. Smoky Mtns, July 2, 1968, coll. MK, NC 52, 1(3) VPI. *Xanithoxylon americanum*, PA, Dreshertown, Jan. 13, 1908, Let. Fr. H.A. Surface, 1(4) USNM. Host unknown, MD, near Baltimore, coll. T. Riernay, 1(2) USNM; NY, Tivoli, Oct. 4, 1943, coll. J. Brann, 1(5) USNM; PA, Pillston, Let. April 1, 1918, coll. W.C. Sutherland, 1(5) USNM; Va, Plot 53I, c, Blacksburg, May 13, 1969, coll. M. Williams, VA 1319, 1(3) VPI.

**Host and distribution.** This species was originally described from apple trees in New York. Since then it has been collected throughout the United States and Canada including: CA, CT, DC, FL, GA, IA, ID, IL, IN, KY, LA, MA, MD, MO, NC, NJ, NY, OH, PA, TX, VA, WI, WV. It also has a wide range of hosts belonging to several plant families including: *Betula papyrifera* (*B. alba*); *Juglans cinerea* and *J. nigra*; *Eucalyptus regnans*, *E. fraxinoides*,

*Fraxinus americana*; *Aesculus hippocastanum*, *Amelanchier canadensis*, *Aronia arbutifolia*, *A. melanocarpa*, *Chaenomeles sp.*, *Cotoneaster japonica*, *C. sp.*, *Crataegus crus-galli*, *C. laevigata (C. oxyacantha)*, *C. pininatifida*, *C. azarolus*, *Cydonia speciosa*; *Malus pumila*, *M. spp.*, *Prunus avium*, *P. caroliniana*, *P. cerasus*, *P. ilicifolia*, *P. maritima*, *P. pennsylvanica*, *P. serotina*, *P. virginiana*, *Sorbus aucuparia* and *S. americana*; *Zanthoxylum americanum*; *Ribes rubrum*. In the early literature it was also recorded from *Cornus sp.*.

**Affinities and discussion.** This species is unique in the genus in that the zygotis at the base of the median lobes is greatly elongated, each median lobe has transverse, wide and well sclerotized bar, and the dorsal macroducts are much fewer than in other species. The above characters make it obviously different from the closely related species, *C. caryae*.

*Chionaspis gilli*, Liu and Kosztarab

Plate 9

**Suggested common name.** Tamarix scurfy scale

**Test of adult female (fig. A).** Very similar to that of *C. etrusca*, appears indistinguishable from it. Oystershell-shaped or pear-shaped; white or dirty white; about 1.6-2.5 long; terminal exuviae yellowish brown, occupying about one-third of total length of test; ventral test thin, adheres to surface of host when female is removed.

**GENERAL DESCRIPTION**

**Adult female (fig. B).** Spindle-shaped; posterior of body slightly widened and lobed, broadest at abdominal segment I or II; on slide, 1034 (507-1049) long and 574 (397-628) wide.

**Pygidial margin (fig. C).** Quite small in proportion to entire body, 191 (156-177) long and 387 (338-441) wide at base, somewhat triangular or oval. Median lobes relatively small, poorly-developed, elongated and narrow, rounded apically, deeply sunken into pygidium, and strongly divergent, 21.7 (19.6-19.8) long and 5.9 (5.9-8.2) wide; both inner and outer margins mostly

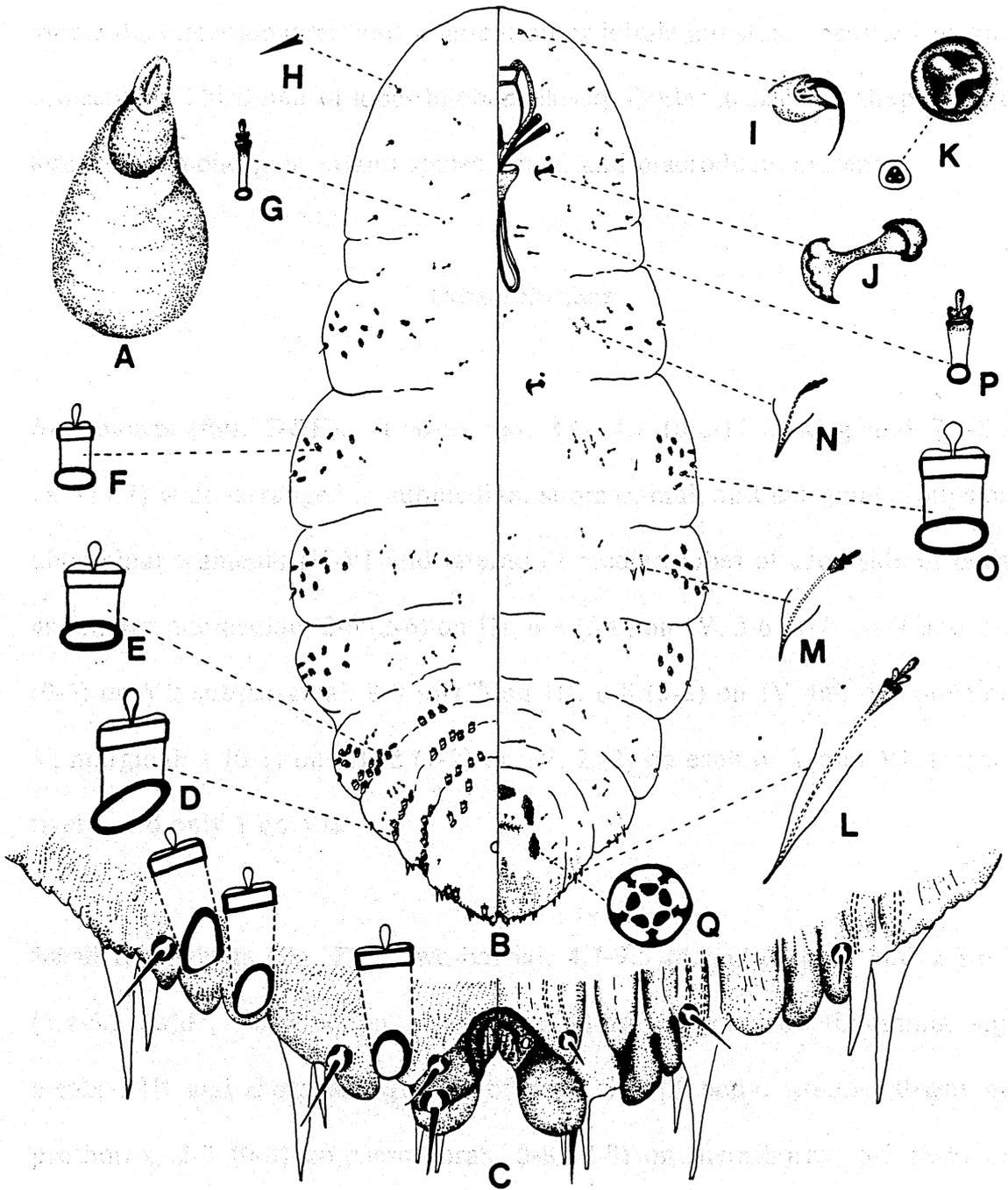


Plate 9. - *Chionaspis gilli* Liu & Kosztarab

without, or rarely with, irregular notches; base of lobes connected by a short, broad, and well-developed zygois. Second pair of lobes bilobed, only inner lobule distinct, elongated and pointed; outer lobule indistinct, reduced to tiny projections. Third pair of lobes bilobed, closely similar in size and shape to two lobules of second pair. Gland spines, setae, and macroducts present.

### **Dorsal Surface**

**Macroducts (figs. D&E).** Two-barred, 8.6-17.1 (6.2-17.1) long and 7.1-8.7 (3.7-11.2) wide, arranged in submedian, submarginal, and marginal groups on abdominal segments III-VI and laterad of median lobes of each side of body as follows: submedian: 2-6 (2-6) on III, 6-8 (5-8) on IV, 5-6 (4-7) on V and 2-3 (0-3) on VI; submarginal: 8-9 (5-12) on III, 6-8 (5-8) on IV and 4-6 (4-6) on V; marginal: 1 (0-1) on III, 2 (1-2) on IV, 2 (2) on each of V and VI, respectively, and only 1 on VII.

**Small macroducts (fig. F).** Two-barred, 4.7-9.5 (4.9-12.3) long and 2.8-6.7 (3.4-6.2) wide, clustered on marginal-submarginal areas of abdominal segments I-III and thoracic segments of each side of body: usually absent on prothorax, 2-3 (0-3) on mesothorax, 5-8 (2-9) on metathorax, 5-9 (2-6) on abdominal segment I, 3-8 (6-8) on II, 4-5 (2-7) on III.

**Microducts (fig. G).** One-barred, small, 9.3-9.7 long and 2.0-2.6 wide at orifice, scattered on cephalic region, thoracic and abdominal segments and on pygidium, between 3-5 on each of thoracic segments and abdominal segments I-II, few or absent on abdominal segments III-V and pygidium.

**Setae (fig. H).** Few hair-like setae scattered on cephalic region and 1 on margin of thoracic segments and abdominal segments I-III, length 2.2-6.1; 1 on margin of posterior segments and laterad on pygidial lobes, these larger and longer, 4.7-9.5 long.

**Anal area.** Opening circular or somewhat oval, 10.6 (7.9-11.9) in diameter, much closer to base of median lobes than in any other species of this genus, except for *C. etrusca*; distance from anterior margin of anus to mid-point of line between abdominal segments V and VI, 92.8 (79.0-90.9), and from posterior margin to base of median lobes, 65.2 (56.9-67.2).

### Ventral Surface

**Antennae (fig. I).** Reduced to small tubercles, 6.3 (5.4-7.9) long and 6.3 (4.7-9.9) wide at base, each with 1 long, often curved and slender fleshy seta, 11.8 (11.8-19.8) long, with 2 very short and stout terminal sensory setae, each 1.4 (1.4-3.1) long. Distance between two antennal bases, 53.4 (47.4-63.2).

**Clypeolabral shield.** Similar in general shape to other species of the genus, 113 (118-134) long and 93 (83-93) wide.

**Labium.** Cup-shaped, 39 (34-44) long and 44 (39-53) wide.

**Spiracles.** Anterior (fig. J) 19.5 (19.8-28.1) long, atrium 7.6-10.5 in diameter, each with 1-2 (0-4) associated trilocular pores (fig. K), each pore 3.7-4.6 in diameter; posterior ones same shape as the anterior but slightly smaller, 20.3 (17.8-21.7) long, each with 1 (0-1) associated trilocular pore.

**Gland spines (fig. L).** Quite small and poorly developed, 9.5-20.9 (8.7-21.8) long, each with an associated one-barred microduct, situated on marginal areas of abdominal segments III-VIII of each side of body; 0-2 on abdominal segment III, 1-2 on each of IV to VII; usually 2 on abdominal segment VIII just underneath of median lobe, protruding beyond apex of lobe, these last two gland spines give the species a distinct appearance.

**Gland tubercles (figs. M&N).** Conical basally and spinelike distally, small, 6.6-7.6 long and 1.9-3.0 wide at base, each with an associated microduct, clustered on submarginal areas in group of 0-4 on abdominal segments I-II and on thoracic segments of each side on body, or sometimes absent on prothorax.

**Small macroducts (fig. O).** Two-barred, same size, shape, location and number on each segment as those on dorsal surface.

**Microducts (fig. P).** Same size, shape and location as those on dorsal surface except for being more numerous on each region or segment.

**Setae (fig. H).** Length and location nearly same as for those on dorsal surface, except for being slightly more numerous on cephalic region, and with 1 long seta on abdominal segment VIII which is overlapped by median lobes and extends beyond apex of these lobes between or close to two gland spines located in the same area, this arrangement provides a distinct character for identification.

**Vulvar area.** Opening slit-like, arched in shape, extremely distinct, located in middle of pygidium. Perivulvar pores quinquelocular (fig. Q), in 5 groups: median, 15 (6-13); anterolateral, 23-26 (21-28); and posterolateral, 14-16 (10-16); each pore 3.8-4.8 (3.9-4.7) in diameter.

**Holotype.** 1 adult female on 1 slide, Las Cruces, New Mexico, August 12, 1975, collected by J. G. Watts on *Tamarix sp.*, deposited in USNM.

**Paratypes.** On *Tamarix chinensis*, AZ, 5 on 4 slides, Grand Canyon Natl. Pk., Colorado River, Coconino Co., July 23, 1984, coll. L. E. Stevens, 4(5)

USNM. *Tamarix* sp., AZ, Phoenix, Sep. 21, 1953, coll. F. F. Bibby et al., 1(5) USNM; Safford, Sep. 13, 1943 from L. P. Wehrle Collection, (about 20 specimens on these slides are considered to be *C. etrusca*), 6(80) UCD; CA, Holtville, Imperial Co., Jul. 22, 1986, coll. R. A. Flock, et al., 4(15) USNM; Winterhaven, Imperial Co., Oct. 26, 1967, coll. R. A. Waeger, 2(4) CDA; NM, Albuquerque, Bernalillo Co., Nov. 20, 1979, coll. by D. C. Heninger, 3(6) UGAES; 1 on 1 slide, N. Cotton City, Hidalgo, Aug. 26, 1969, coll. D. R. Liesher, FSCA; Dona Ana Co., New Mexico State Univ. campus, Jul. 30, 1968, coll. D. R. Liesher, 2(4) VPI.

The accompanying illustration is based on the holotype, and supplemented by several paratypes.

**Remarks.** This new species is very similar to *C. etrusca* (Leonardi, 1908), but the combination of morphological characters of pygidial margin can be used to distinguish it from *C. etrusca* as follows: in *C. gilli*, the median lobes are elongate and narrow, strongly divergent, poorly-sclerotized, without or rarely with irregular notches on both mesal and outer margins, and with 2 gland spines and 1 long seta just overlapping with the median lobes, and protruding distinctly beyond the apex of pygidium; further, in the second pair of lobes only the inner lobule is distinct and elongate, and the outer lobule is reduced to very small projections; while in *C. etrusca*, the median lobes are well-developed, short and broad, conspicuous, notched on both inner and outer

margins, straight and rounded apically, and the gland spines and setae besides the median lobes are not as long as those in the new species.

We compared this species with the type material of *C. etrusca* from Italy, and found that it is not the same. Both *C. gilli* and *C. etrusca* have similar ecological and host preference, and are somewhat similar in their external morphology. In few cases they were found feeding on the same branch of the same host. Microscope slide preparations are needed to separate the two.

**Etymology.** This species was named in honor of Mr. Raymond Gill, who supplied us with needed new samples for this description, and assisted this research in many ways.

*Chionaspis gleditsiae* Sanders

Plates 10, 11

**Common name.** Honey-locust scurfy scale

**Literature and synonymy.** *Chionaspis gleditsiae* - Sanders, 1903: 403; 1904: 48; Herrich, 1911: 26; Dietz and Morrison, 1916 (1914-1915): 271; Hartman, 1916: 102; Lawson, 1917: 266; Houser, 1918: 293; McGillivray, 1921: 328; Hollinger, 1923: 19, 24, 69 (This species associated with *Phenacaspis spinicola*.); Perssois, 1927: 82; Ferison, 1927: 158; Amos 1933: 207; Couch, 1935: 6, 7, 38, 53, 57, 58; Herrick, 1935: 169; Ferris, 1937: SI-14, SI- 19, SI-23; Couch, 1938: 40, 57, 86, 87, 115, 165; Ferris, 1942: SI-446; Slesman, 1945: 46; McKenzie, 1956: 99; Kosztarab, 1963: 70; Dekle, 1965: 265; Takagi and Kawai, 1967: 29-43; McComb and Davidson, 1969: 6; Tippins and Beshear, 1970: 1023; McDaniel, 1971: 275-308; Willoughby and Kosztarab, 1974: 83; Nakahara, 1975: 201; Knipscher, 1976: 90; Howell, 1980: 92; Lambdin and Watson, 1980: 80; Nakahara, 1982: 18; Takagi, 1985: 39.

*Phenacaspis spinicola* - Dietz and Morrison, 1916: 101-102; Hollinger, 1923: 36; Amos, 1933: 207; Lindinger, 1933: 166 (= *Trichomytilus*); Ferris, 1937: SI-91, SI-95; 1942: SI-446; 1956: 72, 74; Kosztarab, 1963: 94, 97, 98; Takagi and Kawai, 1967: 34; McDaniel, 1972: 340; Lambdin and Watson, 1980: 80.

## GENERAL DESCRIPTION

There are two different forms: bark form feeding on the bark of branches of the host, and leaf form feeding on the leaves. The latter was originally described under the name of *C. spinicola*. Because of their different morphological characters, they will be described and illustrated separately as follows.

### Bark Form

#### Plate 10

**Test of adult female (fig. A).** Oystershell-shaped, or irregular, usually very broad posteriorly, somewhat convex, about 1.5-2.0 mm in length; dirty white or slightly gray, or inconspicuously blackened and with a sooty material covering the epidermis on the host; exuviae obvious at one end, occupying about one fourth to one third of length of test. Ventral scale white and thin, it is left on surface when female is removed.

**Body of adult female (fig. B).** spindle-shaped, segments prominent and laterally lobed, 498-935 long and 268-521 wide; broad toward posterior end, and broadest at first abdominal segment or at metathorax; derm membranous except for sclerotized pygidial area.

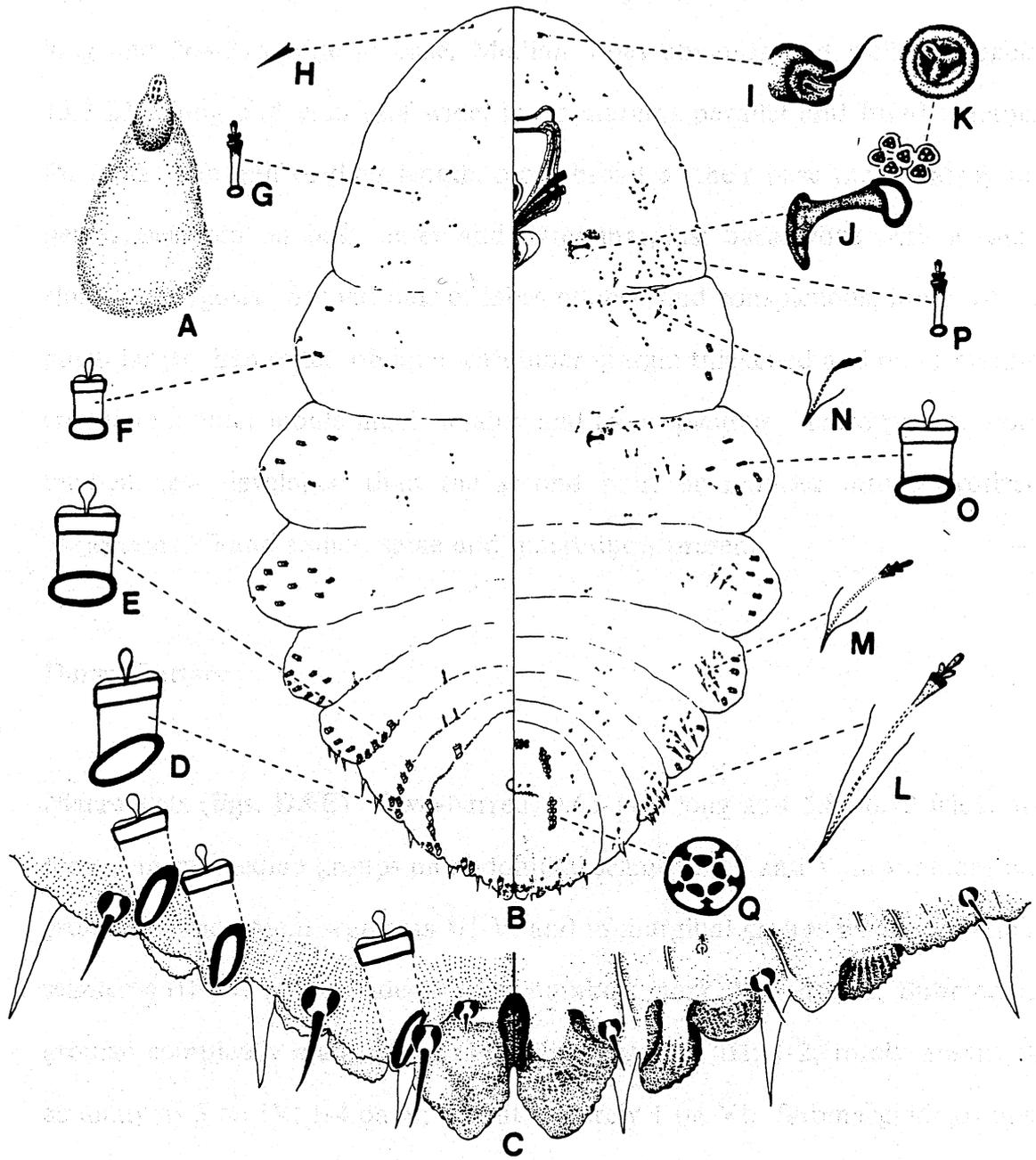


Plate 10. - *Chionaspis gleditsiae* Sanders, bark form

**Pygidial margin (fig. C).** More or less triangular, rounded at apex, 165-192 long and 264-375 wide at base. Median lobes obvious and well-developed, 15.3-23.2 long and 9.26-12.4 wide; inner margins parallel and fused together for more than half of their length; lobes broad at their base then sharply tapering, serrated on both inner and outer margins; basal yoke with a small elongated zygotis. Second pair of lobes bilobed and conspicuous, inner lobule much larger than outer, oblique with inner margin thickened and outer margin crenulated; outer lobule much smaller and inconspicuous. Third pair of lobes bilobed, less developed than the second pair, or reduced into sclerotized projections. Gland spines, setae and macroducts present.

### **Dorsal Surface**

**Macroducts (figs. D&E).** Two-barred, 9.65-11.1 long and 5.85-6.72 wide, arranged in submedian groups on abdominal segments IV and V, in submarginal groups on abdominal segments III-V, and in marginal groups from abdominal segments III-VII of each side of body; numbers markedly reduced. Submedian groups: completely wanting on abdominal segment III; 1-2, rarely absent or as many as 3 on IV; 1-4 on V; absent or rarely 1 on VI. Submarginal groups: 1-4, mostly 3-4 on III; 2-5 on IV; 2-4 on V. Marginal groups: 1 or 2 on each of III and IV; 2 on V and VI, respectively, and only 1 on VII.

**Small macroducts (fig. F).** Two-barred, 6.15-10.1 long and 3.83-5.56 wide, submarginally and marginally scattered on abdominal segments I-III, metathorax and mesothorax of each side of the body; the numbers vary greatly on each segment as follows: on mesothorax, 5-18; on metathorax, 1-8, rarely as many as 21; on abdominal segment I, 7-16; II, 5-15; III, 2-6.

**Microducts (fig. G).** One-barred, 8.50-9.88 long and 3.71-4.32 wide at orifice, arranged on each side of body; 0-2 on submedian regions of abdominal segment III or IV, or mixed with macroducts there; about 6-18 on cephalic region and frequently 10-12 on prothorax; only very few on other two thoracic segments, 2-5 on each of abdominal segments I-III and the posterior segments or sometimes lacking completely.

**Setae (fig. H).** Few, very small hair-like, 6.18-8.65 long scattered on and along the margins of cephalic region; a similar kind of seta, 1 each on margins of thoracic segments and basal three abdominal segments; longer and stouter setae, one of each or rarely 2 on each margin of abdominal segments IV-VI, and laterad of each pair of pygidial lobes; longest ones, 15.5 -19.8, on V and VI.

**Anal area.** Anal opening circular, 7.66-11.5 in diameter, situated at posterior of median group of perivulvar pores. Distance from anterior edge of anus to

mid-point of line between abdominal segments V and VI, 38.6-61.3; distance from the posterior edge of anus to the base of median lobes, 95.8-114.

### **Ventral Surface**

**Antennae (fig. I).** Small sclerotized tubercles, 6.18-7.72 long and 5.88- 8.42 wide at base; each with a fleshy and curved seta, about 9.26-19.2 long. Distance between bases of antennae, 37.1-54.0.

**Clypeolabral shield.** About 97.3-111 in length and 61.8-92.6 in width; shape typical of the genus.

**Labium.** Shield- or cup-shaped, 32.4-42.1 long and 38.6-47.9 in wide.

**Spiracles.** Anterior spiracles (fig. J), 19.2-24.7 long and atrium 6.6-8.6 wide; each with 4-13 associated trilocular pores (fig. K). Posterior spiracles nearly same shape as anterior, but a little stouter and smaller, 17.0-23.2 long; each with 1-3 associated trilocular pores, rarely absent completely.

**Gland spines (fig. L).** Large and well-developed, 7.66-27.8 long, arranged on marginal region of each segment of abdominal segments III-VII on each side of body as follows: 3-6 on III, 3-4 on IV, 1 or rarely 2 on each of V, VI and VII; each with an associated one-barred microduct.

**Gland tubercles (figs. M&N).** Conical basally and spine-like distally, 5.44-12.8 long and 5.86-7.89 wide at base, with one associated one-barred microduct projecting in each tubercle, located sumarginally on abdominal segments I-II and thoracic segments of each side of the body; arrangement on each segment as follows: prothorax, 0-3; mesothorax, 1-3; metathorax, 1-4; on abdominal segment I, 1-6; II, 2-6;

**Small macroducts (fig. O).** Two-barred, 6.18-10.1 long and 3.83-5.56 wide, clustered on basal three abdominal segments and distal two thoracic segments of each side of the body as follows: sometimes 1 or 2 on prothorax; mesothorax, 0-3; metathorax, 0-5; on abdominal segment I, 0-4; II, 0-3; III, 1-3; in some specimens the small macroducts entirely wanting on mesothorax and prothorax.

**Microducts (fig. P).** One-barred, 8.54-9.88 long and 3.71-4.32 wide at orifice, scattered on each side of body. Two groups of clustered microducts on prosoma, around anterior spiracles: anterolateral, 3-15; posterolateral, 6-24. On mesothorax and metathorax, each with a transverse row of microducts anterior to previous segment, about 7-16 on each row, and also several on posterior of the submarginal region of these two segments; in the typical material, 15-20 on submarginal area of mesothorax. About 2-5 on each of abdominal segments and 4-9 on pygidial area.

**Setae (figs. H).** Few very small and slender, hair-like, 3.95-8.65 long, scattered on and around the margins of cephalic region; one on each thoracic segment and abdominal segments I-III, being similar in shape and size to those on cephalic region; stouter and longer setae, 8.65-14.8 long, one of each on margins of abdominal segments IV, V and laterad of pygidial lobes as well.

**Vulvar area.** Vulvar opening located in middle of pygidium; perivulvar pore (fig. Q) groups: median, 8-13; anteriolateral, 10-18; and posteriolateral, 9-15.

## Leaf Form

### (Plate 11)

**Test of adult female (fig. A).** Irregular, oystershell-shaped, about 1.5-2.0 mm long, strongly broadened at posterior end, broadest behind middle, and apex broad-rounded; rather flat and slightly convex; white, dirty white or grayish; exuviae larger, occupying about one third of length of test; first exuviae pale brown and shiny, while second light yellow. Ventral test well-developed along margins, very thin or wanting in center, often remaining attached to dorsal test when female removed.

Body of adult female (Fig. B), spindle-shaped, distinctly segmented and laterally lobed, 632-1110 long and 299-494 wide on slide; broadest at abdominal segment I or II; cephalic apex rounded and sclerotized.

**Pygidial margin (fig. C).** Rather large, triangular, deeply incised at apex by median lobes. Median lobes 23.2-27.8 long and 9.26-13.4 wide at base, sunken deeply into pygidium, forming an acute notch; inner margins close together and parallel for a short distance and then strongly divergent and curved from base to apex, with 8-12 distinct serrations; outer margins nearly straight or angularly curved. Second pair of lobes bilobed and distinct, rounded apically; inner lobule as long as length of median lobe; outer lobule much smaller. Third pair of lobes poorly-developed, reduced into slightly sclerotized projections;

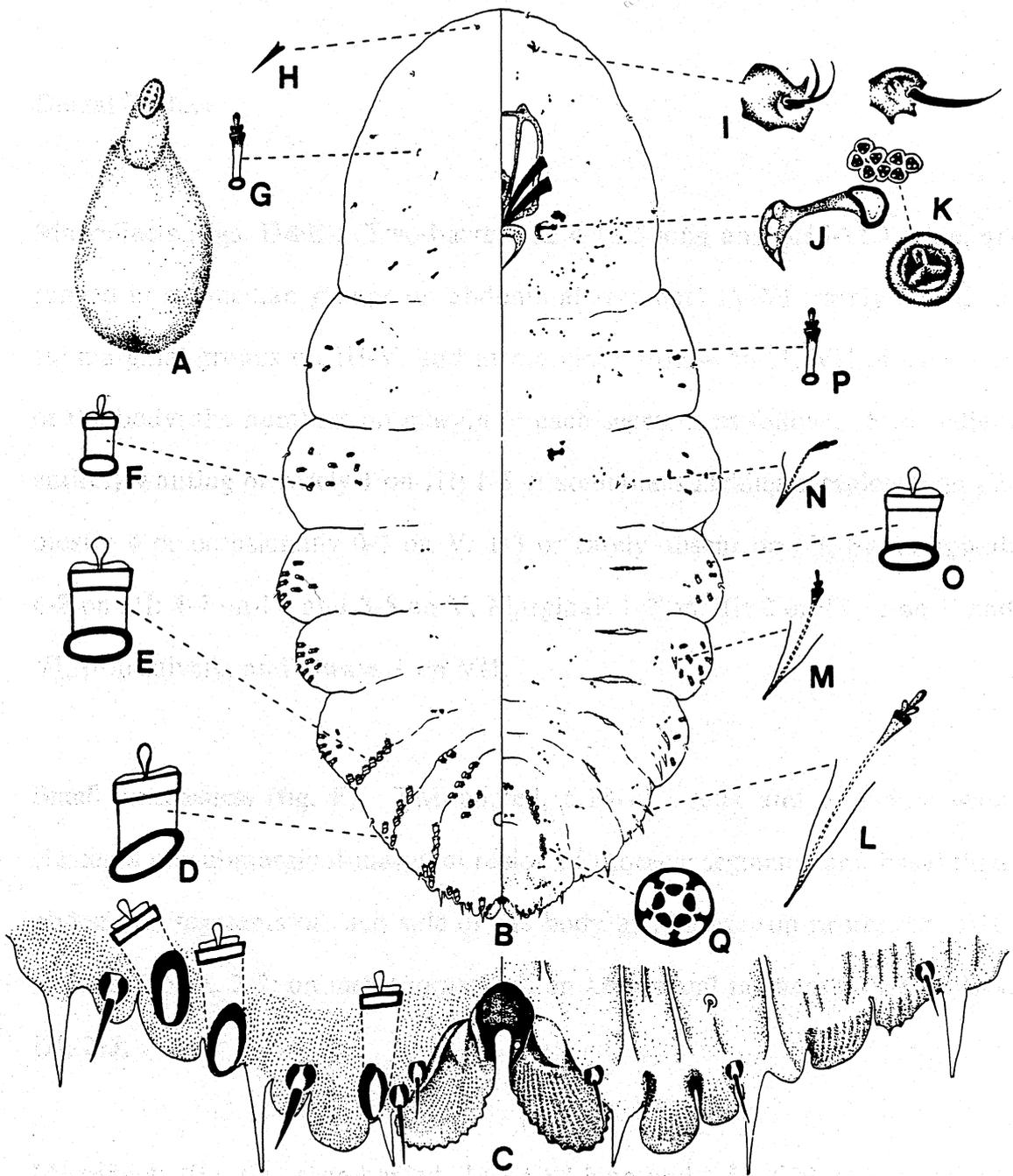


Plate 11. - *Chionaspis gleditsiae* Sanders, leaf form

inner lobule more or less triangular and rounded at apex; outer lobule wide, with serrated margin. Gland spines, setae and macroducts present.

### **Dorsal Surface**

**Macroducts (figs. D&E).** Two-barred, 12.4-18.5 long and 8.65-11.1 wide, arranged in submedian groups on abdominal segments IV-VI, rarely on III, in submarginal groups on III-V, and in marginal groups on III-VII of each side of the body; the numbers on margin of each segment as follows: Submedian: entirely wanting or rarely 1 on III; 1-5 or sometimes lacking completely on IV; mostly 4 or occasionally 0-3 on V; 1-3 or rarely absent on VI; Submarginal: 4-8 on III; 4-7 on IV and 3-5 on V; Marginal: 1-2 on III; 2 on IV; 2 on V and VI, respectively; and always 1 on VII.

**Small macroducts (fig. F).** Two-barred, 6.18-11.1 long and 3.71-4.32 wide, clustered on submarginal-marginal region of thoracic segments and basal three abdominal segments of each side of the body as follows: on prothorax, 5-10; on mesothorax, 3-7; on metathorax, 5-9; on abdominal segment I, 5-9; II, 4-8; III, 2-5;

**Microducts (fig. G).** One-barred, 4.63-6.88 long and 1.54-3.09 wide at orifice, very few scattered on entire surface of each side from anterior segments to pygidium. Frequently 1-5 on submedian region, in lieu of macroducts on same

region; in some individuals, several (1-6) on submedian area, mixed with or anterior to macroducts.

**Anal area.** Anal opening located at posterior of median group of perivulvar pores, circular, 7.72-10.8 in diameter; distance from the anterior edge of anus to mid-point of line between abdominal segments V and VI, 49.4-66.4; distance from the posterior edge of the anus to base of median lobes, 69.5-92.6.

**Setae (fig. H).** Few small, and slender hair-like, along margins and on cephalic region, 1 of each on thoracic segments and abdominal segments I-III of each side of body, 1.50-6.18 long; stouter and longer setae on abdominal segments IV-VII, 9.26-12.4 long, 1 on each margin of these segments or laterad of pygidial lobes.

#### **Ventral Surface**

**Antennae (fig. I).** Reduced to small tubercles, 6.18-7.72 long and 4.94-8.35 wide at base; usually each with 1 long and slender seta, 12.4- 18.5 long, in one specimen, 2 little short and slender setae present, and with 2 or 3 very stout and short terminal sensory setae, about one sixth to one fifth of length of long one. Distance between the antennal bases 38.6-63.3.

**Clypeolabral shield.** Length 100-136; width 71.0-95.8; shape typical of genus.

**Labium.** Length 23.2-43.2; width 30.9-46.3; cup-shaped.

**Spiracles.** Anterior (fig. J), slightly larger than posterior, 18.5-21.6 long and atrium 7.6-8.6 wide; each with 5-10 associated trilocular pores, and each pore 2.16-2.62 in diameter; posterior the same shape as the anterior but slightly smaller, 17.0-20.1 long; each with 0-5, mostly 1-3, associated trilocular pores.

**Gland spines (fig. L).** Well-developed, 7.72-12.4 long, each with an associated one-barred microducts; marginally arranged on abdominal segments III-VII on each side of the body as follows: 3-4 on III, 2-4 on IV, 1 on each of V, VI and VII, the posteriormost ones usually laterad of pygidial lobes.

**Gland tubercles (figs M&N).** Basally conical and distally spine-like, 6.75-11.1 long and 3.75-7.35 wide at base, arranged on submarginal region with none or 1-2 on prothorax and mesothorax; 1-4 on metathorax; none or only 1 on abdominal segment I, 2-5 on segment II.

**Small macroducts (fig. O).** Two-barred, 5.66-11.1 long and 3.45-4.32 wide, clustered on submarginal-marginal region of abdominal segments I-III and thoracic segments of each side of body; number greatly variable, several or none on prothorax; 0-5 on mesothorax; 0-3 on metathorax; 1-8 on abdominal segment I, 2-5 on II, 1-3 on III.

**Microducts (fig. P).** One-barred, 4.50-9.34 long and 1.64-3.23 wide at orifice, scattered on cephalic region, thoracic segments and abdominal segments of each side of body. Numbers remarkably variable; 12-30 on cephalic region, sometimes divided into two groups around anterior spiracles, and also several scattered on other areas of cephalic regions; about 5-15 on mesothorax, 4-14 on metathorax, sometimes ones on these two segments forming a transverse row at anterior of segment; 2-6 on abdominal segment I, 0-8 on II, and sometimes 2-3 on III, and very few on other posterior segments.

**Setae (fig. H).** Length and distribution similar to that on dorsal surface.

**Vulvar area.** Vulvar opening in the middle of pygidium; perivulvar pore (fig. Q) groups: median, 7-9; anterolateral, 11-18; posterolateral, 7-12.

**Type material studied.** *Gleditsia triacanthos*, Columbus, OH, Jan. 21, Feb. 28, 1902, coll. JGS, 3(13) (some are not in good condition.) USNM; May 30, 1903, coll. JGS, 1(5) USNM; Oct. 10, 1902, coll. unknown, 4(8) UCD.

**Other material studied.** *Carpinus caroliniana*, FL, Ft. Green, Sept. 19, 1986, coll. G. Johnson and ZM, 3(3) FSAC. *Carpinus americana*, MA, Preists Bridge, Mau 21, 1939, coll. NSM, 14(14) (only few specimens are good.), USNM. *Fraxinus americana*, NC, Chapel Hill, Nov. 11, 1928, coll. JNC, 1(2)

USNM, by Bookers Creek, Chapel Hill, Raleigh Road, March 14, 1929, coll. Rhodes & JNC, 1(5) USNM; Chapel Hill, Jan. 10, 1929, JHC, 1(4) USNM. *Fraxinus* sp., VA, VPI campus, Blacksburg, Montgomery Co., May 13, 1969, coll. JH, 2(3) VPI. *Gleditsia aquatica*, FL, Limestons W., Oct. 9, 1981, coll. J. Felty, 3(3) FSAC; Sandy Point, May 12, 1977, coll. 6(6) FSAC. *Gleditsia triacanthos*, IL, Midlothian, August 6, 1938, coll. G. L. Pierce, 1(2) USNM; KS, Lawrence, Feb. 16, 1934, coll. L. R. Penner, 3(9) VPI; IN, Bluffton, Wells Co., Sept. 20, 1973, RFW, 7(20) USNM; Battleground, July 18, 1956, coll. DLS, 2(5) VPI; MO, Snow Bot. Garden, St. Louis, August, 1921, coll. 1(2) USNM; NY, Manhattan, Collegiate School, Feb., 1981, coll. A. Freundel, 4(11) VPI; OH, Columbus, Jan. 20, 1902, coll. JGS, 3(15) USNM, Feb. 9, 1961, coll. MK, 1(1) VPI; South of Findlay, Hancock Co., July 9, 1961, coll. MK, 3(3) CDFA; Hocking Co., June 11, 1961, coll. MK, 1(3) VPI; Hamilton Co., July 1, 1961, coll. MK, 1(2) VPI; East Harbor State Park, Sept. 6, 1960, coll. MK, 1(3) VPI; Tuscarawas Co., Sept. 5, 1961, coll. MK, 1(4) VPI; TX, Dallas, date & coll. unknown, 1(1) UCD; Brazas Co., July 28, 1932, coll. F. F. Bibb, 2(5) UCD; College Station, date & coll. unknown, 1(2) UCD. *Gleditsia* sp., CA, Los Angeles, Dec. 1, 1954, coll. K. C. Stephens, 3(9) CDFA; KS, Lawrence, May 7, 1934, coll. LBP, 2(8) VPI, Feb. 15, 1947, coll. E. L. Todd, 1(3) USNM; IN, Whitewater St. Park, Liberty, Oct. 10, 1983, coll. RFW, 2(3) VPI; Indianapolis, Sept. 24, 1915, coll. HM & HFD, 1(1) BM; Vincennes, August 31, 1915, coll. HM & UFD, 2(2) UCD; MO, St. Louis, Nov. 21, 1941, from Howard Baker, 3(11) USNM; Columbia, July 27, 1973,

coll. J. Franaka, 3(5) USNM; MS, Columbus, July 5, 1931, coll. LEM, 4(5) UCD; Agri. College, March 16, 1908, coll. Cooley, 1(1) USNM, August 16, 1908, coll. R. W. Harned, 1(3) USNM; OH, Columbus, May 22, 1917, coll. PRL, 2(6) USNM; Dayton, April 27, 1950, coll. R. B. Keiswander, 2(4) USNM; TX, Bryan, April 19, 1919, coll. unknown, 5(9) UCD, August, 1918, coll. Hollinger, 1(2) UCD; Dallas, Feb. 1, 1918, coll. unknown, 2(3) UCD; Fort Mouth, May 5, 1918, coll. unknown, 1(1) UCD; Wallace, August 31, 1919, coll. Hollinger, 1(1) UCD; McKinney, August 15, 1927, coll. F. F. Bibby, 1(5) USNM. *Ostrya virginiana*, NC, West of Wilmington, Dec. 30, 1921, coll. JNC, 3(10) BM. *Rubus* sp., MD, Patapsco State Pk., Ellicott City, May 10, 1959, coll. MK, 3(7) VPI. *Robinia pseudoacacia*, TN, Faye Hesville, May 2, 1918, coll. Cooley, 1(5) USNM. *Robinia* sp., TN, Knoxville, Jan 27, 1898, coll. uncertain, 1(7) USNM.

**Host and distribution.** This species was originally collected on honey locust, *Gleditsia triacanthos* in Ohio. Since then, it has been found and collected on several species of hosts belonging to 5 families: *Carpinus caroliniana* and *Ostrya virginiana* (Corylaceae); *Fraxinus americana*, *F. nigra* and *Fraxinus* sp. (Oleaceae); *Gleditsia aquatica*, *G. triacanthos* and *Robinia pseudoacacia* (Leguminosae); *Liquidambar styraciflua* (Hamamelidaceae); *Magnolia virginiana* (Magnoliaceae); and *Rubus* sp. (Rosaceae). It has been found in 15 states: CA, FL, IL, KS, MD, ME, MO, MS, NC, NY, OH, SC, TN, TX

and VA. Therefore, this species has a wide distribution ranging from the far northern U.S. to Florida and to the west coast.

**Affinity and discussion.** This species is very similar to several species in the genus both in morphological characters and in host preferences.

The bark form of this species resembles *C. kosztarabi* more than any other within the genus, and they sometimes feed on the same host. According to Takagi and Kawai (1967: 35), the following main characters of *C. gleditsiae* are different from *C. kosztarabi*: ventral microducts on prosoma of cephalic region are numerous and in two groups around anterior spiracle; basal zygotis on the base of median lobes is not prominent and dorsal submedian macroducts on abdominal segment IV are usually absent. The last character is not reliable because we found 1 or 2 dorsal submedian macroducts (as in figure); these are rarely absent on abdominal segment IV.

The combination of the following characters present in *C. gleditsiae* can be used to distinguish the bark-form of this species from *C. acericola* and the bark form of *C. platani*: median lobes appear to be fused for about half of their length; basal zygotis is weakly developed and fewer dorsal macroducts are present.

The leaf-form of this species is very close to the leaf-form of *C. triformis*, but in *C. gleditsiae* the total number of dorsal macroducts is more than 20, whereas in the latter it is less. In addition, in *C. gleditsiae* the inner lobule of the second pair of lobes is remarkably enlarged, as long as the length



*Chionaspis hamoni*, Liu and Kosztarab

Plate 12

**Suggested common name.** Florida willow scale

**Test of adult female (fig. A).** Elongate oystershell-shaped; white or dirty white, sometimes of same color as bark, thus difficult to detect; rather small, about 1.5-2.0 mm long, with moderately concave. Exuviae terminal, occupying about one third of total length of test, yellowish brown. Ventral test very thin, white.

**GENERAL DESCRIPTION**

**Body of adult female (fig. B).** Spindle-shaped, produced laterally and broadened posteriorly, widest at abdominal segment I or II. On microscopic slide, 1577 (715-1177) long and 686 (445-637) wide.

**Pygidial margin (fig. C).** Oval or somewhat triangular, 255 (211-250) long and 539 (402-471) wide at base, with sclerotized apex. Median lobes well-developed, broad and stout, with very fine serrations on the rounded margins, base of each lobe wider than or nearly equal to its length; two lobes contiguous or with a very narrow separation at mesal base; a more or less sclerotized sigmoid or crescentlike bar at base of each lobe; median yoke distinct, stout and well-sclerotized, connecting the two lobes. Second pair of lobes bilobed,

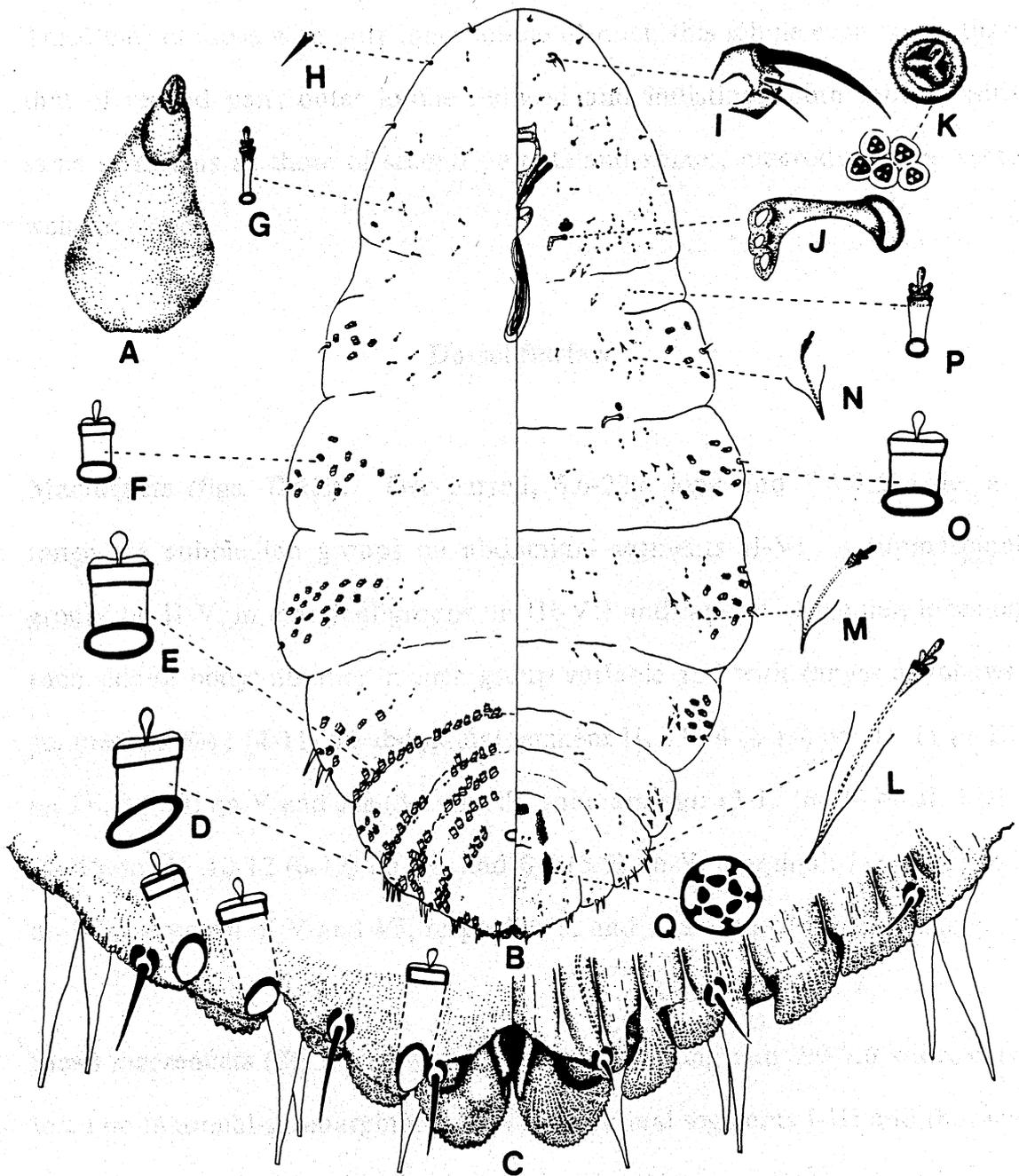


Plate 12. - *Chionaspis hamoni* Liu & Kosztarab

conspicuous; inner lobule elongate, close to median lobe, somewhat oblique; outer lobule shorter and smaller; both lobules with fine marginal serrations. Third pair of lobes with only inner lobule distinct, this lobule even larger than that of second pair; outer lobule reduced and indistinct; both lobules with same serrations as those of second pair. Gland spines, macroducts and setae well-developed.

### Dorsal Surface

**Macroducts (figs. D&E).** Two-barred, 6.6-22.8 long and 7.6-9.5 wide, arranged in submedian groups on abdominal segments II-VI, in submarginal groups on II-V, in marginal groups on III-VII and laterad of median lobes on each side of body; number in each group variable and with ranges as follows: submedian: 8-11 (4-11) on abdominal segment II, 13-14 (6-14) on III, 11 (4-12) on IV, 8 (4-8) on V and 5-8 (3-7) on VI; submarginal: 13-17 (6-16) on II, 12-13 (5-13) on III, 10-12 (6-12) on IV, and 6-7 (5-9) on V; marginal: 1-2 on III, 2-3 on IV, 2 on each of V and VI, respectively, and 1 laterad of median lobe.

**Small macroducts (fig. F).** Two-barred, 6.7-14.3 long and 2.9-7.6 wide, clustered on marginal-submarginal areas of abdominal segments I-III and thoracic segments of each side of body; number varies widely with ranges as follows: 1-2 on prothorax, 2-7 on mesothorax, 6-12 on metathorax, 4-7 on abdominal segment I, 4-10 on II, and 2-5 on III.

**Microducts (fig. G).** One-barred, 7.6-9.5 long and 1.4-2.0 wide at orifice, scattered on dorsal surface from cephalic region to pygidium; number on each body region or segment as follows: 5-8 on cephalic region, 3-6 on prothorax, 2-5 on each of mesothorax and metathorax, 2-6 on each of abdominal segments I-II, and few or absent on abdominal segments III-V and pygidium.

**Setae (fig. H).** Hairlike, long and slender, 3.8-11.4 long; 5-8 scattered on cephalic region, 1 on each margin of thoracic segments and abdominal segments I-III; also 1 on each margin of abdominal segments IV-VI and laterad on pygidial lobes, these latter much longer and thicker than those on anterior part of body, 11.4-19.0 long.

**Anal area:** Anal opening circular or slightly oval, 11.9 (11.9-13.8) in diameter, located about one fourth anterior on pygidium, opposite to median group of perivulvar pores of ventral derm under microscope. Distance from anterior margin of anus to mid-point of line of abdominal segments V and VI, 73 (67-89), and from posterior margin to base of median lobes, 158 (122-148).

### Ventral Surface

**Antennae (fig. I).** Reduced to small tubercles, 8.9 (7.9-9.9) long, 9.9 (7.9-11.9) wide at base, each with 1 long, usually curved and slender fleshy seta, 19.8

(15.8-21.7) long, with 2 short and stout sensory terminal setae, 2.9-3.8 long. Distance between antennal bases, 106.7 (49.4-106.7).

**Clypeolabral shield.** Similar in general appearance to rest of species in this genus, 168 (105-160) long and 120 (98-119) wide.

**Labium.** Cuplike, 49.0 (34.3-47.4) long and 58.3 (43.5-63.7) wide.

**Spiracles.** Anterior spiracle (fig. J), 27.7 (23.7-29.6) long and atrium 8.5-9.5 in diameter, each with 6-8 (3-9) associated trilocular pores (fig. K), each pore 2.3-3.1 in diameter; posterior spiracles similar in shape to anterior ones but slightly smaller, 27.7 (15.8-23.7) long, each with 2 (1-5) associated trilocular pores; sometimes trilocular pores in cluster, especially those near anterior spiracles; this clustering makes difficult to count their number.

**Gland spines (fig. L).** Marginal, well-developed, 20.0-38.0 long, each with an associated one-barred microduct, arranged on abdominal segments IV-VII and laterad of median lobe on each side of body; usually 4 (2-5) on IV, 2 (1-2) on V, 2 (1-2) on VI and VII, respectively, and 1 laterad on median lobe.

**Gland tubercles (figs. M&N).** Conical basally and spinelike distally, 9.5-15.2 long and 2.9-4.8 wide at base, each with an associated one-barred microduct, located submarginally on thoracic segments and abdominal segments I-III,

and becoming gradually smaller anteriorly; usually 2-3 (0-3) on prothorax, 2 (0-2) on mesothorax, 1-2 (0-3) on metathorax, 2-3 (0-4) on abdominal segment I, 4-6 (2-6) on II, 5 (2-7) on III.

**Small macroducts (fig. O).** Same shape, size and location and nearly same number as or slightly more numerous than those on dorsal surface.

**Microducts (fig. P).** Shape, size and location about same as for those on dorsal surface except for being more numerous on cephalic region, prepygidial segments and pygidial area.

**Setae (fig. H).** Same as those on dorsal surface except for their number being somewhat different.

**Vulvar area.** Vulvar opening situated about middle of pygidium; perivulvar pores quinquelocular (fig. Q), clustered in 5 groups: median: 25 (15-24); anterolateral: 26-27 (15-35); and posterolateral: 13-16 (10-23). Diameter of pore, 3.9-5.5.

**Type material studied.** Holotype, 1 adult female on 1 slide, Steinhatchee, Florida. XII-2-1981 by F. McHenry on *Salix nigra*. Holotype and most paratypes are deposited in the Florida State Collection of Arthropods unless indicated otherwise in parenthesis.

All specimens listed below are paratypes. Seven on 7 slides, same data as holotype; *S. babylonica*, FL, Pembroke Pines, Mar 6, 1980, coll. P. Phillips, 4(4); *S. caroliniana*, FL, Everglades Natl. Pk., Royal Palm Center, Mar. 28, 1987, coll. M. and M. Kosztarab, 3(6) VPI; DeBary, Feb. 12, 1980, coll. C. R. Roberts, et al., 4(4); Ft. Lauderdale, Mar. 7, 1984, coll. M. McDonald, 4(4); Plant City, Nov. 27, 1981, coll. C. H. Ray, Jr., 7(7) USNM; Port St. John, Feb. 3, 1983, coll. R. Burns, 4(4); *S. discolor*, FL, North of Cross City, coll. A. E. Graham 2(2); Orange Lake, Dec. 15, 1961, coll. A. E. Graham, 3(3); *S. nigra*, FL, Horseshoe Beach, Aug. 12, 1982 coll. F. McHenry, 3(3); Leigh Acres, Dec. 17, 1986, coll. Z. Smith, 3(3); Moore Haven, Dec. 16, 1982, coll. Z. Smith, 4(4); Palatka, June 17, 1980, coll. K. Elliott, 4(4); Steihatchee, Dec. 2, 1981, coll. F. McHenry, 5(5); Weaver's Sta., Collier Co., no date, coll. Z. Smith, 1(1); *Salix* sp., FL, Gainesville, July 30, 1965, coll. G. W. Dekle, 8(8); Homeland, Apr. 11, 1968, coll. G. W. Dekle, 4(4); Micranopy, Mar. 30, 1965 coll. G. W. Dekle, 3(3); Miramar, Apr. 12, 1967 coll. K. Hickman, 6(6) UGAES; N. Port, Dec. 20, 1982, coll. J. Felty, 3(3); Orange Lake, Jan. 26, 1962, coll. G. W. Dekle, 2(2) BM; Palatka, Jul. 29, 1980, coll. K. Elliott, 3(3) UCD; 2, Stuart, Feb. 28, 1978, coll. E. W. Campbell, 2( ); Welaka, May 6, 1961, coll. G. W. Dekle, 2(2) CDA.

The accompanying illustration is based on the holotype.

**Remarks.** The new species is very similar to *Chionaspis longiloba* (Cooley, 1899), therefore all specimens collected earlier from Florida were identified

and confirmed as *C. longiloba* by previous workers. The new species differs from *C. longiloba*, chiefly in having dorsal submedian and submarginal macroducts on abdominal segment II, while in the latter these macroducts are absent; also the median lobes are not as long and as acutely pointed, with more or less sclerotized base on each lobe in the new species, whereas *C. longiloba* is characterized by the elongated and acutely pointed median lobes. On the other hand, these two species are closely related because of the similarities in the general appearance of the median lobes and of the body of adult females.

**Etymology:** We named this species in honor of Dr. Avas B. Hamon, who lent us most of the specimens used for this description and provided much help with this and other research projects for our Coccidology Laboratory.

*Chionaspis heterophyllae* (Cooley)

Plates 13, 14

**Suggested common name.** Pine scurfy scale

**Literature and synonymy.** *Chionaspis pinifoliae heterophyllae* - Cooley, 1897: 281; Wilson, 1917: 48; Brotton, 1923: 365; Felt and Morrison, 1928: 198; Ferris, 1942: SIV-406; 1956: 70, 73.

*Chionaspis heterophyllae* - Takagi and Kawai, 1967: 30, 38; Tippins and Beshear, 1970: 8; Luck and Dahlsten, 1974: 310; Nakahara, 1975: 201; Dekle, 1976: 49; Kosztarab, 1977: 184; Nakahara, 1982: 18; Howard and Oliver, 1985: 49; Takagi, 1985: 40.

*Phenacaspis heterophyllae* - MacGillivray, 1921: 347; Ferris, 1937: SI-93; 1942: SIV-406, SIV-446; 1956: 70, 73; Andersen, 1957: 81; Kosztarab, 1963: 91; Dekle, 1965: 13, 109; McDaniel, 1972: 337; Johnson, 1982: 119.

**Test of adult female (fig. A).** Elongate to pyriform or ostershell-shaped, with practically parallel sides or slightly broadened posteriorly; strongly or moderately convex, firm in texture; about 1.7-4.0 mm long; white to dirty white; exuviae at anterior extremity yellow or light yellow, occupying taken about one third to one fourth of whole length of test. Ventral test white and very thin.

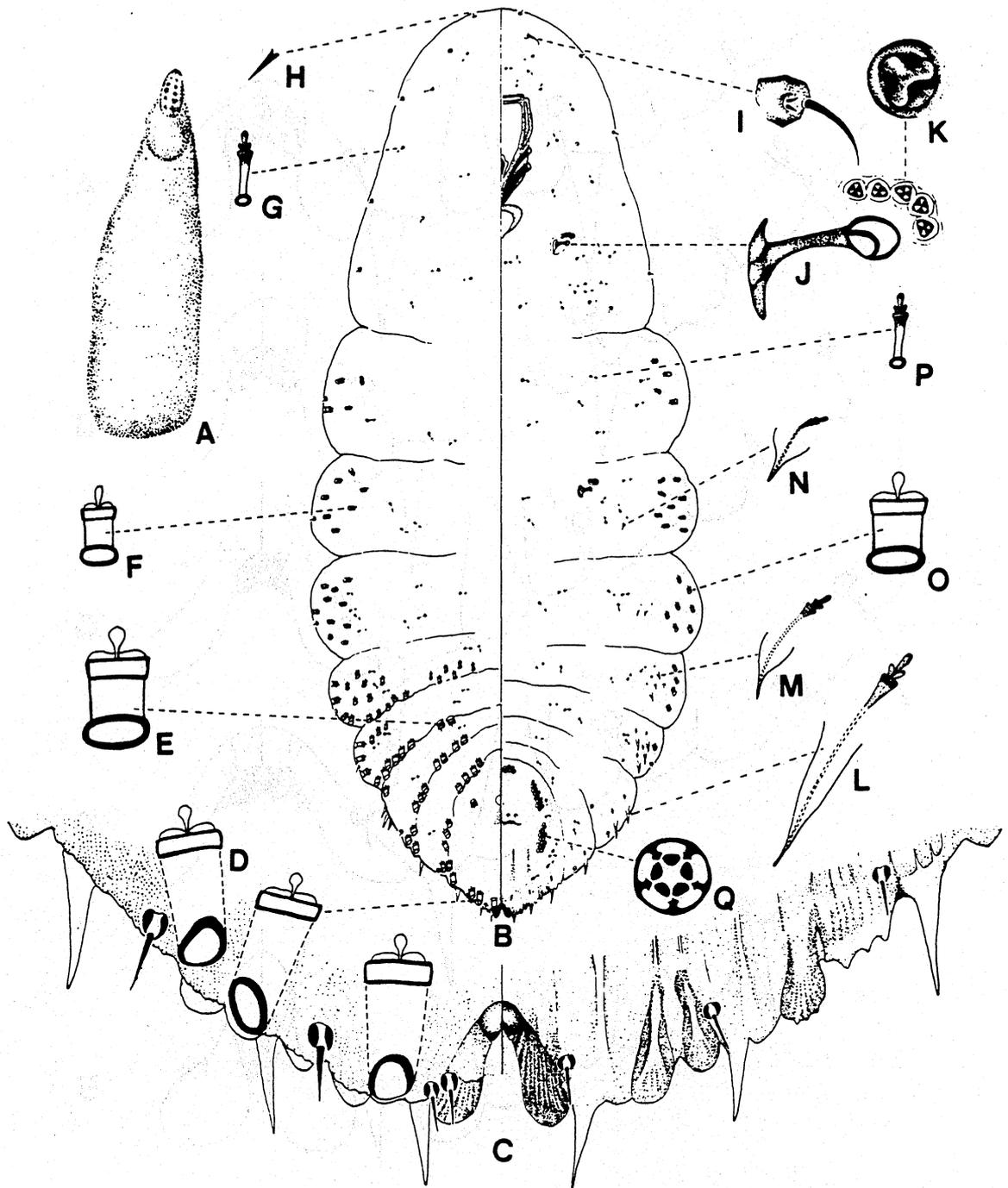
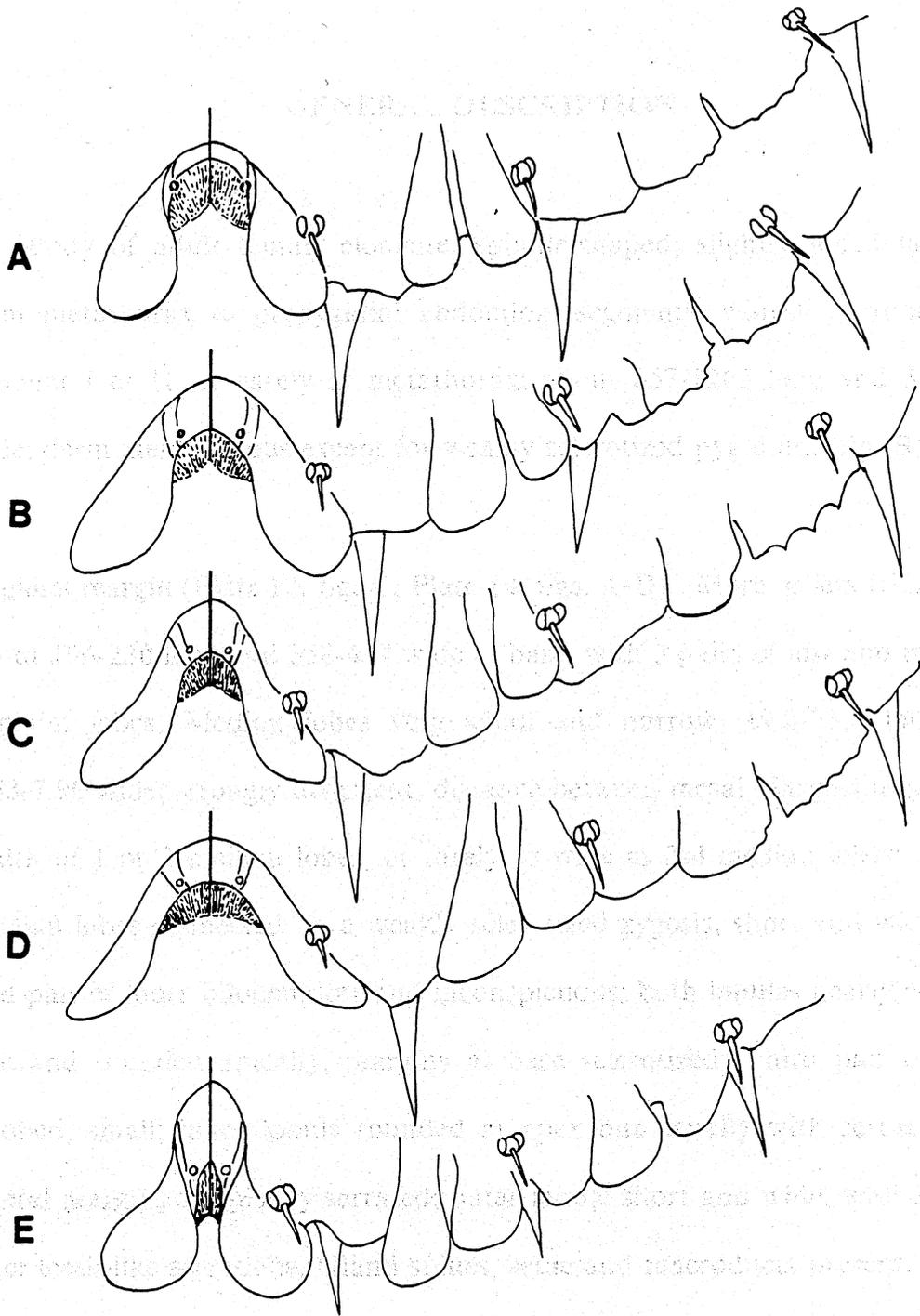


Plate 13. - *Chionaspis heterophyllae* Cooley



**Plate 14. - *Chionaspis heterophyllae* Cooley (A-D),  
*Chionaspis pinifoliae* (E), variation of median lobes**

## GENERAL DESCRIPTION

Body of adult female elongate, spindle-shaped, slightly lobed laterally from metathorax to prepygidial abdominal segments; widest at abdominal segment I or II, or rarely at metathorax; about 657-1265 long and 373-539 wide; derm membranous except for weakly sclerotized pygidium (fig. B).

**Pygidial margin (Plate 13, fig. C; Plate 14, figs. A-D).** More or less triangular, about 196-230 long and 358-417 wide at base, with 3 pairs of low and recessed pygidial lobes. Median lobes very small and narrow, 19.8-23.7 long and 5.53-7.90 wide; strongly divergent, distance between mesal margins more than width of 1 or 2 median lobes, or rarely as wide as 3-4 median lobes; base of median lobes connected by a weakly sclerotized zygois, short and wide. Second pair of lobes bilobed, low and inconspicuous; both lobules nearly equal in size and rounded apically; margins at base sclerotized. Third pair of lobes bilobed, small; inner lobule rounded at apex but usually with serrations at lateral margin, or apically serrated; outer lobule short and wide, with 3-6 distinct teeth-like serrations. Gland spines, setae and macroducts present.

### Dorsal Surface

**Macroducts (figs. D&E).** Two-barred, well developed, 5.93-15.8 long and 7.64-9.88 wide, arranged in submedian groups on abdominal segments III-VI, in submarginal groups on abdominal segments II or III-V, and in marginal groups on abdominal segments II-VII of each side of body; number on each segment variable and present as follows: submedian: on abdominal segment III, 1-8, sometimes these ducts much smaller, or mixed with microducts; IV, 3-9 or in very few specimens much reduced in size; V, 3-7; and VI, 1-4; submarginal: on abdominal segment II, 4-12, or sometimes much small in size; III, 4-10; IV, 4-8; and V, 3-5; marginal: on abdominal segment III, 1 or rarely 2; IV, 2 or rarely 3; V, 2 or rarely 3, VI, 2; and VII, 1 only.

**Small macroducts (fig. F).** Two-barred, very small; about 5.92-11.9 long and 3.95-7.90 wide, scattered on marginal-submarginal areas of meso- and metathorax, and abdominal segments I-III, or arranged on submedian areas and submarginal areas of abdominal segments II or III or IV; number on each segment on each side of body as follows: Marginal and submarginal: completely wanting on cephalic region; 1-7 or rarely absent on mesothorax; 2-8 on metathorax; 4-10 on abdominal segment I, 5-13 on II, 2-8 on III. Submedian: frequently 4-7 on II, but sometimes only microducts; sometimes several on abdominal segments III or IV, mingled with macroducts.

**Microducts (fig. G).** One-barred, 11.9-15.8 long and 1.97-4.35 wide at orifice, scattered or clustered on cephalic region and all segments of each half of body,

but numbers much fewer than those on ventral surface; usually very few on cephalic region and prepygidial segments, 4-13 on each of meso- and metathorax, and 4-11 on abdominal segment I, 2-13 on II, 0-12 on III; usually few or absent on pygidium.

**Setae (fig. H).** Very short, slender, hair-like, 3.55-5.93 long, scattered on or along margin of each side of body; usually 5-8 on cephalic area, 1 or rarely 2 on each margin of meso- and metathorax, and each of abdominal segments I-IV; 1 or 2 on each margin of abdominal segment V, VI and laterad of each pair of pygidial lobes, slightly longer and stouter, 5.34-7.90 long.

**Anal area.** Anal opening circular, 11.9-15.8 in diameter, situated about basal one-third of pygidium; distance from anterior margin of anus to mid-point of line between abdominal segments V and VI, 55.3-81.0; distance from posterior margin to base of median lobes, 83.0-138.

### **Ventral Surface**

**Antennae (fig. I).** Reduced to small tubercles, 4.69-7.90 long and 3.90-7.90 wide at base, each with 1 long and slender seta, 13.8-21.7 long, usually laterally curved, and with 1 or 2 short and stout terminal sensory setae, 1.56-2.31 long. Distance between two antennal bases, 59.3-83.0.

**Clypeolabral shield.** Shape typical of genus; length, 137-158; width, 88.2-103.

**Labium.** Cup- or shield-shaped; length, 31.6-49.4; and width, 45.5-59.3.

**Spiracles.** A very narrow bar supports spiracular opening; anterior spiracles (fig. J), 21.7-25.7 long and atrium 8.5-9.5 wide, each with 4-7 associated trilocular pores, and each pore 3.12-3.91 in diameter; posterior spiracles with a similar shape to the anterior ones, and slightly smaller or rarely larger than anterior ones, 19.8-25.7 long, each with 1-4 associated trilocular pores (fig. K).

**Gland spines (fig. L).** Poorly-developed, 9.88-19.8 long and 3.04-4.23 wide, arranged on margin of abdominal segments IV-VII, and laterad of median lobes on each side of body; usually 1-3 on abdominal segment IV, 1 on each of V, VI, VII, and laterad of median lobes, respectively. The one laterad of each median lobe distinctly protrudes posteriorly, exceeding apex of lobe in length.

**Gland tubercles (figs. M&N).** Very few and small, 7.90-9.88 long and 1.98-3.95 wide, submarginally clustered on thoracic segments and abdominal segments I-III on each side of body as follows: usually absent or rarely 1 on prothorax; 0-2 on mesothorax; 0-2 on metathorax, 0-3 on abdominal segment I, 2-4 on II, and 2-5 on III,

**Small macroducts (fig. O).** One-barred, with same size as those on dorsal surface, clustered on marginal-submarginal areas of meso- and metathorax and abdominal segments I-III of each side of body; number on each segment greatly variable; completely absent on prothorax; 4-8 on mesothorax; 4-10 on metathorax, 2-13 on abdominal segment I, 4-9 on II, usually 0-5 on III.

**Microducts (fig. P).** One-barred, of same size as those on dorsal surface, but more numerous on each side of body; on cephalic region, 4-8 clustered on anterior of clypeolabral shield and near antennae, and 6-16 posteriolaterally of anterior spiracle; 5-10 on each of meso- and metathorax, and abdominal segments I-III, and fewer on IV and V; about 5-8 scattered on pygidium.

**Setae (fig H).** Few short and hair-like, of same length as those on dorsal surface, scattered on cephalic region and margin of each segment on each half of body; usually 4-8 along margins of cephalic area, 1 on each margin and 1 or 2 on submargin of mesothorax and metathorax, and abdominal segments I-V; a few longer and stouter setae, 5.96-8.45 long, 1 or 2 on each margin of posterior abdominal segments, namely, laterad of each pair of pygidial lobes.

**Vulvar area.** Vulvar opening located about middle of pygidium; perivulvar pore (fig. Q) groups: median, 6-15; anteriolateral, 13-18; posteriolateral, 13-20; each pore 3.91-5.47 in diameter.

**Material studied.** See Appendix A.

**Host and distribution.** This species was originally described from *Pinus heterophyllae* in Florida as a subspecies of *C. pinifoliae*. Since then, it has been collected from 18 species of *Pinus* and two other genera all in the family Pinaceae including: *Abies balsamea*; *Picea abies* and *P. pungens*; *Pinus banksiana*, *P. caribaea*, *P. clausa*, *P. densiflora*, *P. echinata*, *P. elliotii*, *P. glabra*, *P. mugo*, *P. nigra*, *P. occidentalis*, *P. palustris*, *P. resinosa*, *P. rigida*, *P. strobus*, *P. sylvestris*, *P. taeda*, *P. thunbergiana*, and *P. virginiana*. It has been collected from AL, CA, CT, DC, DE, FL, GA, IN, KY, LA, MA, MD, MO, MS, NC, NJ, NY, OH, PA, RI, SC, TN, TX, VA, and WV in the United States, as well as Canada and Mexico.

**Affinities and discussion.** This species resembles *C. pinifoliae* more than any other species in the genus, but differs in having the following characters: (1) median lobes separated from each other much wider than the width of 1 to 2 lobes, or even 3 lobes (Plate 14, figs. C&D); (2) each lobe very narrow from base to end, usually expanding very slightly at posterior half, but never wider than 8.0; (3) the 3 pairs of pygidial lobes deeply recessed, so gland spines laterad to median lobes and those of other 2 pairs of lobes protrude posteriorly to exceed the apex of median lobe for a long distance; (4) inner lobule of third pair of lobes rounded apically, or laterally serrated with several indistinct serrations, and the outer lobule serrate apically, forming 3-6 conspicuous

teeth-like serrations; while in *C. pinifoliae* (Plate 14, fig. E): (1) median lobes are not widely separated from each other; (2) median lobes wider at posterior half than at anterior; (3). all 3 pairs of pygidial lobes are more protruding, so gland spines only slightly longer than median lobes; (4). both lobules of third pair of lobes rounded.

Because the tests of adult females of these two species are indistinguishable from each other and the adult females on slides are very similar, many misidentifications have been found during this study, therefore, some specific records of hosts and distribution in early literature are certainly doubtful. It is hoped that the above description together with the description of *C. pinifoliae* can offer help to identify and clarify the confusion that existed with the two related species.

*Chalcidius pinifoliae* was first described by Ashmead (1870) as *Chalcidius pinifoliae* from the pygidium of a female. The pygidium of the female is not shown, but the pygidium of the male is shown. The pygidium of the male is recorded. This species was first collected with specimens of *Fraxinus* and *Quercus virginiana* (Shuckard, 1882). The accompanying description was written from Willoughby and Karsgaard (1944).

*Chionaspis kosztarabi* Takagi and Kawai

Plate 15

**Suggested common name.** Ash scurfy scale.

This species was recognized as a separate taxa from the bark form of *Chionaspis gleditsiae* by Takagi and Kawai (1967). They found morphological differences between the two species in both adult females and second instar males.

The most important morphological characters of adult females present in *C. kosztarabi* are: (1) lack of a ventral cluster of microducts on prosoma, (2) distinct basal zygotis that protrudes anteriorly beyond the base of median lobes; while in the bark form of *C. gleditsiae*, two groups of microducts are present on prosoma, and the zygotis between the median lobes is not prominent. So far as recorded, this species has been collected only on species of *Fraxinus* and *Ostrya virginiana* (Nakahara, 1982). The accompanying illustration was selected from Willoughby and Kosztarab (1974).

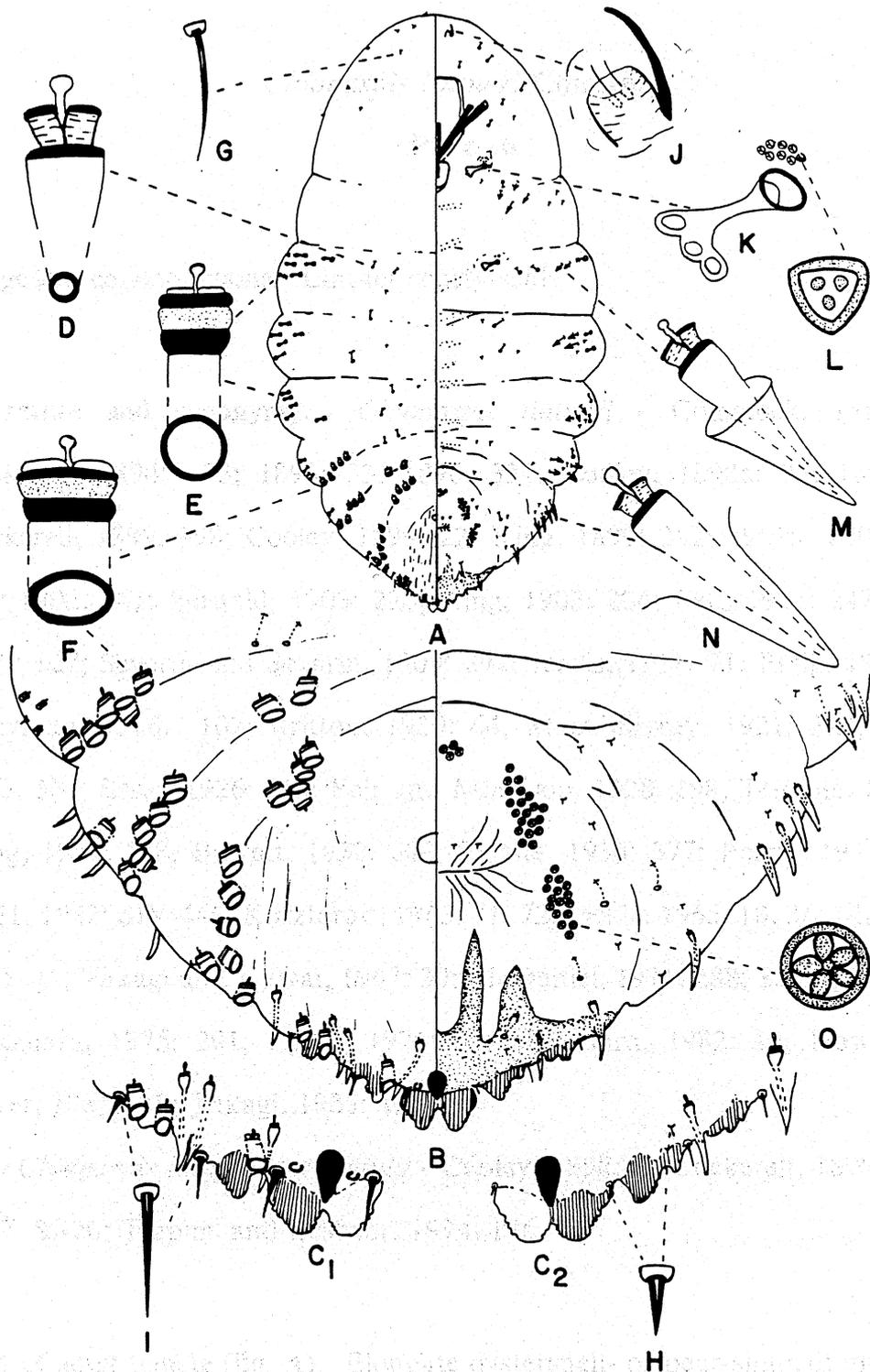


Plate 15. - *Chionaspis kosztarabi* Takagi & Kawai

*Chionaspis lintneri* Comstock

Plate 16

**Suggested common name.** Lintner scurfy scale

**Literature and synonymy.** *Chionaspis lintneri* - Comstock, 1883: 103; Cockerell, 1894: 33; 1895: 33; 1896: 337; Cooley, 1898a: 85; 1898b: 89; Cockerell, 1899: 398; Cooley, 1899: 22; King, 1899: 252; 1901a: 200; 1901b: 333; 1902: 161; Fernald, 1903: 220; King, 1903: 204; Felt, 1905: 247; Smith, 1909: 127; Severin and Severin, 1909: 297; Jarvis, 1911: 71; Essig, 1915: 159; Haryman, 1916: 102; Britton, 1920: 64; MacGillivray, 1921: 328; Britton, 1923: 364; Essig, 1926: 310; Felt and Morrison, 1928: 198; Trimble, 1928: 45; Essig, 1931: 578; Barrett, 1932: 283; Doane, 1936: 377; Ferris, 1937: SI-20, SI-21; 1942: SIV-446; Kosztarab, 1963: 71, 72; Dekle, 1965: 10, 36; Martineau, 1965: 46; Takagi and Kawai, 1967: 30; McDaniel, 1971: 288; Saker, 1972: 109; Nakahara, 1975: 201; Dekle, 1976: 52; Nakahara, 1982: 19; Howard and Oliver, 1985: 50; Takagi, 1985: 40.

*Chionaspis lintneri* var. *betula* - Cooley, 1898:85; Cockerell, 1899: Ferris, 1937: SI-20; Tippins and Beshear, 1974: 146.

**Test of adult female (fig. A).** Elongate oystershell- or pear-shaped; much widened near posterior end; about 2.5-3.2 mm long; somewhat flattened; snow-

white or dirty white to grayish white; exuviae yellowish brown, located at terminal end; occupying about one third of length of test. Ventral test white and very thin.

## GENERAL DESCRIPTION

Body of adult female spindle-shaped, laterally lobed and posteriorly widened, broadest at abdominal segment I, or sometimes at abdominal segment II or metathorax; length on slides 693-1516 and width 439-784 (fig. B).

**Pygidial margin (fig. C).** More or less triangular, about 147-260 long and 415-570 wide at base; sclerotized apically with well-developed and elongate pygidial lobes. Median lobes distinct and large; 19.8-24.7 long from apex to base of zygois, and 17.3-22.2 wide; lobes acutely pointed, rarely more or less rounded; mesal margins straight with very fine serrations, parallel and somewhat close together at base for about less than half of their length, then divergent widely with an acute angle; in very few specimens, both inner and outer margins of lobes with some irregular and distinct serrations; base of lobes yoked by a short median sclerosis. Second pair of lobes well-developed and bilobed; both lobules rounded apically; inner lobule much larger than the outer one. Third pair of lobes conspicuous, bilobed, rounded at apex; outer lobule much reduced. Gland spines, setae and macroducts present.

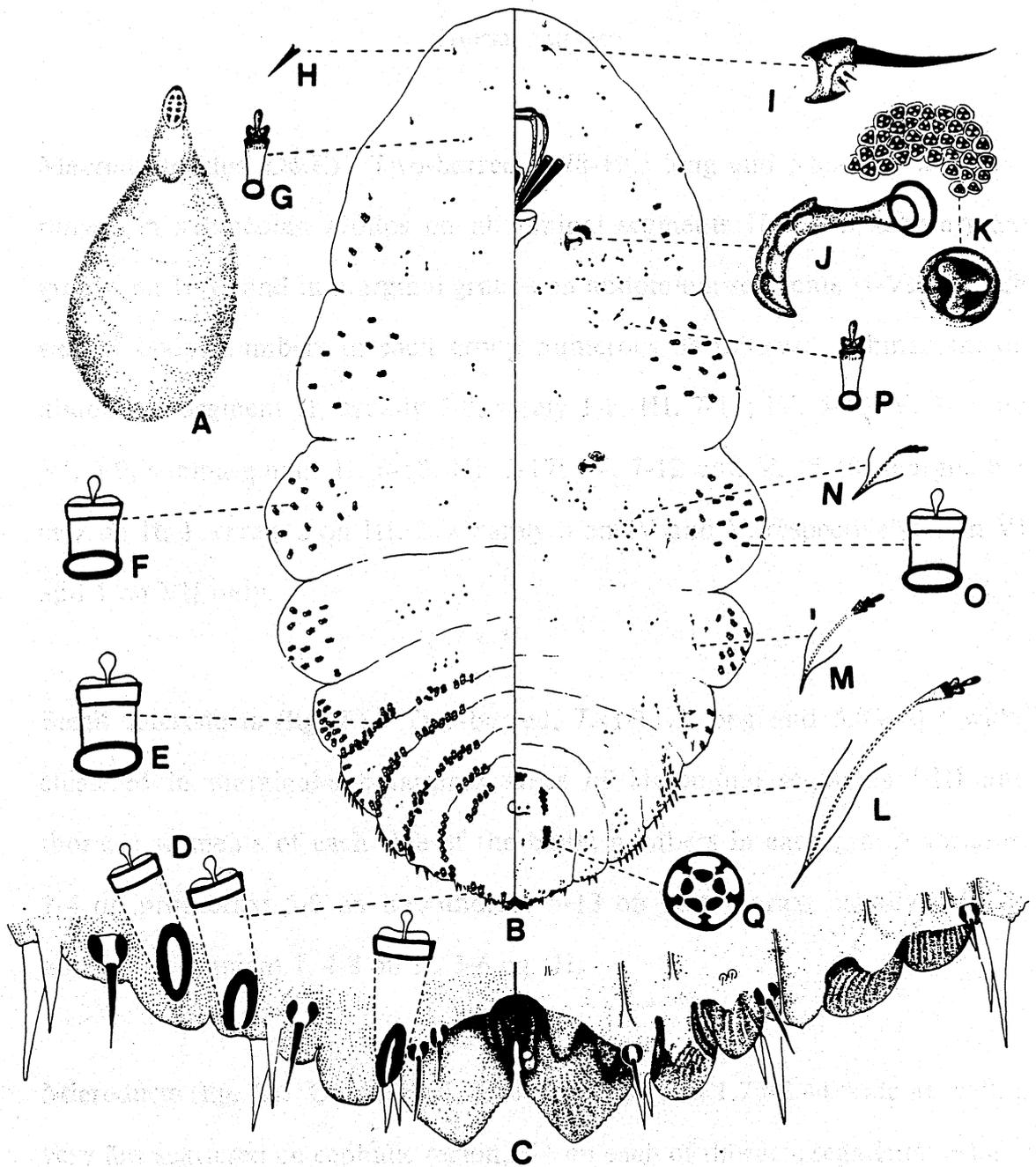


Plate 16. - *Chionaspis lintneri* Comstock

### Dorsal Surface

**Macroducts (figs. D&E).** Two-barred, 8.78-19.5 long and 5.86-10.7 wide, arranged in submedian groups on abdominal segments II-VI, in submarginal groups on II-V, and in marginal groups on abdominal segments II-VII of each side of body; numbers in each group numerous as follows: submedian: on abdominal segment II, usually 3-8, rarely 1-2; III, 7-11; IV, 5-10; V, 3-7 and VI, 3-9; submarginal: II, 6-15; III, 5-17; IV, 7-12 and V, 5-10; marginal: 1 or 2 on II; 1, rarely 2 on III; 2 or rarely 3 on IV and V, respectively; 2 on VI and 1 on VII only.

**Small macroducts (fig. F).** Two-barred, 7.41-11.7 long and 5.86-10.7 wide, clustered in marginal-submarginal areas of abdominal segments I-III and thoracic segments of each side of the body; numbers in each group variable, 2-4 on prothorax; 5-9 on mesothorax; 6-13 on metathorax; usually 4-10 on abdominal segment I, 4-8 on II, 3-6 on III.

**Microducts (fig. G).** One-barred, 7.84-11.7 long and 1.75-2.44 wide at orifice, very few scattered on cephalic region, 3-6 on each of thoracic segments; usually ones on abdominal segments I-V arranged in submedian areas, numbers remarkably variable from specimen to specimen: range from completely absent, to 2-3 or as many as 10-21 on abdominal segment I; wanting, or 1-3 or as

many as 7-36, mixed with macroducts or in lieu of macroducts on II; occasionally 1-3 or rarely as many as 20 on III, anterior of or mixed with macroducts; usually absent, but rarely several or as many as 7-13 occur on each of IV and V; and several on pygidial area.

**Anal area.** Anal opening circular, with diameter of 9.88-12.8, located about basal one-third of pygidium; distance from the anterior edge of anus to midpoint between abdominal segments V and VI, 59.3-79.0; distance from posterior edge of anus to base of median lobes, 141-166.

**Setae (fig. H).** Very short and slender, hair-like, 3.90-6.83 long; 4-6 scattered along margins of and on cephalic region, very few on thoracic segments, usually 1 on each margin of them; 1 on each margin of abdominal segments I-VI with same length as those on anterior segments; but 1 or 2 on each margin of posterior of abdominal segment IV, much longer and stouter, situated near gland spines on each side of body.

#### **Ventral Surface**

**Antennae (fig. I).** Reduced to small tubercles, 6.83-11.9 long and 6.83-11.7 wide at base, each with 1 long and slender fleshy seta, 9.88-24.7 long, usually curved; and 2 very short and stout terminal sensory setae, 1.95-2.92 long. Distance between antennal bases 49.4-86.5.

**Clypeolabral shield.** Length 141-161; width 105-121; shape typical of genus.

**Labium.** Length 37.1-51.9; width 49.0-61.8; shield- or cup-shaped.

**Spiracles.** Very narrow and thin bar supporting the opening of thoracic spiracles; anterior spiracles (fig. J), 23.7-27.2 long and atrium 13.7-17.8 wide, each with 14-36 associated trilocular pores, each pore 2.44-2.93 in diameter; posterior spiracles usually same shape as anterior ones, but slightly stouter and smaller, 19.5-25.9 long, each with 4-9 associated trilocular pores (fig. K). The pores in this species are very numerous and clustered closely together, therefore it is impossible to exactly count and measure them.

**Gland spines (fig. L).** Extremely well-developed, thin and long; numerous; 7.90-31.6 long, marginally arranged on abdominal segments III-VII, and laterad of median lobes of each side of body; usually 5-6 on III, 6-9 on IV, 1-3 on V, 2 on each of VI, VII and laterad of median lobes.

**Gland tubercles (figs. M&N).** Basally conical and distally spine-like, 5.93-11.9 long and 3.55-4.54 wide at base, submarginally arranged on thorax and abdominal segments I-III on each side of body; numbers in each group as follows: completely absent or rarely few on each of prothorax and mesothorax;

1-4 or sometimes absent on metathorax; 2-5 on abdominal segment I, 6-8 on II, 7-12 on III.

**Small macroducts (fig. O).** Two-barred, with the same size and locality on the ventral surface as the ones on dorsal surface, but slightly fewer on each side of body; 1-3 on prothorax; 4-12 on each of mesothorax and metathorax; usually 5-10 on abdominal segment I, 2-7 on II, 0-5 on III.

**Microducts (fig. P).** One-barred, same size as ones on dorsal surface; 15-27 scattered on cephalic region, 5-8 or sometimes more or less on each of thoracic segments, and basal 2 or 3 abdominal segments as well; few on abdominal segments IV and V, and 4-9 on pygidial area.

**Setae (fig. H).** Short and slender hair-like, nearly same length as ones on dorsal surface, scattered along margins of and on cephalic region, thoracic and abdominal segments of each side of body; usually 5-7 on cephalic region, 1 on each margin of thoracic segments, and 1 on each margin of abdominal segments I-III; ones on margins of posterior of abdominal segment IV, longer and stouter, 5.46-16.2 long, 1 each on segments IV to VII, or on laterad of each pair of lobes of pygidial margin of posterior three segments.

**Vulvar area.** Vulvar opening located about middle of pygidium; perivulvar pore (fig. Q) groups: median, 10-17; anterolateral, 23-38; posterolateral, 19-31; each pore with a diameter of 3.90-4.68.

**Type material studied.** No host, no date, no collector, No. 1071, 1(2) USNM. Type from *Betula papyrifera*, CANADA, Charlottetown, Prince Edward Island, date and coll. unknown, 2(6) USNM. Cotype specimens, no host, no date, Comstock Coll. No. 151, 1(3) USNM.

**Other material studied.** *Alnus glutinosa*, MA, Woburn, Let. Dec. 8, 1908, coll. D.M. Rogers, 1(4). *A. incana*, NH, Wheelwright Pond, Lee, Oct. 5, 1924, coll. PRL, 2(9) USNM. *A. rugosa*, PA, Enterline, July 4, 1920, coll. JGS, 1(6) USNM. *Alnus*, sp., NH, Bellamy River swamps, 1904, coll. Bridwell, 2(6) UCD. *Amelanchier canadensis*, MA, Andover, date and coll. unknown, 1(4) USNM; *Betula papyrifera*, ME, let. Mar. 31, 1930 fr. J.H. Faull. *Betula* sp., CANADA, Trura, Nova Scotia, Aug. 10, 1911, coll. L.B. Smith, 3(8) USNM; Charlottetown, Prince Edward Island, no date or coll., 1(4) BM; *Cornus alternifolia*, CANADA, Hull, Quebec, Sep. 1905, coll. Janice Fletcher, 1(5) USNM. *C. paniculata*, NY, Cayuga Heights, let. Mar. 28, 1927 fr. Glen W. Herrick, 1(4) USNM. *C. racemosa*, MA, Forest Hills, Boston, Let. Feb. 28, 1917, coll. D.M. Rogers, 1(4) USNM. *C. stolonifera*, CANADA, Ontario, Goulds, Oct. 2, 1899, coll. J. Dearness, 1(3) USNM; CANADA, Quebec, Chateaugay, coll. unknown, 2(2) USNM; Ontario, Guelph, let. July 15, 1907,

coll. T.D. Jarvis, 1(3) USNM; *Cornus* sp., DC (opp. Alexandria, VA), 1(1) USNM; IL, Urbana, Sep. 1895, coll. Johnson, 1(9) USNM; NY, Ithaca, 1904, coll. R.S. Woglum, 2(6) UCD; Ithaca, let. May 19, 1924, coll. G.W. Herrick, 1(6) USNM; Ithaca, apr. 1931, coll. G.W. Herrick, 1(4) USNM; Rochester, let. Nov. 21, 1908, coll. J.A. Thompson, 2(9) USNM; CANADA, British Columbia, Kaslo, let. Mar. 25, 1909, coll. J.W. Corkle, 2(4) USNM. *Corylus avellana*, MI, near Pettitt, Aug. 28, 1921, coll. unknown, 2(5) BM. *Corylus* sp., MA, Concord, May 1915, coll. J.B. Norton, 1(8) USNM; Methuen, 1898, coll. unknown, 1(3) AMNH; MI, 1915, coll. R.H. Petit, 1(5) USNM. *Dirca palustris*, CANADA, Ontario, London, May 18, 1899, coll. J. Dearness, 2(7) USNM. *Fraxinus* sp., TX, Edgewood, Aug. 23, 1918, coll. Hollinger, 3(6) UCD; Edgewood, Sep. 12, 1918, coll. Hollinger, 2(3) UCD; Houston, Sep. 9, 1918, coll. Hollinger, 1(5) UCD. *Juglans* sp., MI, E Lansing, 1914, coll. C.A. Reese, 1(1) VPI; OH, Wadsworth, June 1914, coll. C.A. Reese, 2(8) VPI. *Ostrya virginiana*, CANADA, Ontario, Oct. 1907, coll. T.D. Jarvis, 1(3) USNM. *Salix* sp., NY, Ithaca, coll. unknown, 1(1) USNM; Ithaca, coll. unknown, 1(6) USNM; OH, Flint, Sep. 22, 1917, coll. P.R. Lowry, 1(4) USNM; Flint, Sep. 22, 1917, coll. P.R. Lowry, 5(17) USNM; Flint, Oct. 22, 1917, coll. P.R. Lowry, 1(4) UCD; Flint, 1917, coll. P.R. Lowry, 5(7) UCD. *Syringa* sp., PA, Harrisburg, Mar. 9, 1918, coll. F.M. Trimble, 1(6) USNM. *Viburnum alnifolium*, NH, Nov. 18, 1967, coll. D.W.S. Sutherland, 2(2) CDA, 1(3) VPI.

**Host and distribution.** This species was originally described and collected from a species of "alder," *Viburnum lantanoides* (?), and from an unknown plant in New York. Now it has been collected from hosts belonging to 8 families including: *Alnus incana*, *Betula papyrifera*, *Betula* spp., *Corylus* spp. and *Ostrya virginiana* (Betulaceae); *Viburnum alnifolium* (Caprifoliaceae); *Cornus alternifolia*, *C. racemosa* (= *C. paniculata*), *C. sericea* (= *C. stolonifera*) in (Cornaceae); *Juglans cinerea* in the family Juglandaceae; *Fraxinus* spp. and *Syringa* sp., (Oleaceae); *Amelanchier canadensis* (Rosaceae); *Salix* spp. (Salicaceae); and *Dirca palustris* (Thymelaeaceae). Its distribution includes CT, DC, IL, MA, ME, MI, NC, NH, NY, OH, PA, and TX in the United States and Ontario, Quebec, and Prince Edward Islands in Canada.

**Affinities and discussion.** During this study, the author had an opportunity to check all specimens from nearly all the localities listed above including the type and co-type material.

It was found that the combination of the numbers and arrangement of dorsal macroducts, the fusion and divergence of mesal margins of median lobes and numbers and rate of development of gland spines, especially the numbers and length on the margin of abdominal segment IV, and gland tubercles on the margin of abdominal segment III, in this species are the most important characters to distinguish it from any other similar species.

*Chionaspis longiloba* Cooley

Plate 17

**Suggested common name.** Longiloba scurfy scale

**Literature.** *Chionaspis longiloba* -- Cooley, 1899: 16; Sanders, 1904: 47; Dean, 1909: 69; Barber, 1911: 450; Herrick, 1911: 27; Hartman, 1916: 102; Lawson, 1917: 272; MacGillivray, 1921: 329; Hollinger, 1923: 24; O'Dell, 1925: 61; Felt and Morrison, 1928: 198; Doane, 1936: 378; Ferris, 1937: SI-21; 1942: SI-387, SI-445, SI--446; Schuh and Mote, 1948: 46; Kosztarab, 1963: 72, 73; Dekle, 1965: 10, 37; Takagi and Kawai, 1967: 30, 38; McDaniel, 1971: 288; Nakahara, 1975: 202; Dekle, 1976: 53; Mead ed., 1983: 3; Nakahara, 1982: 19; Howard and Oliver, 1985: 50; Takagi, 1985: 40.

**Test of adult female (fig. A).** Elongate oystershell-shaped; rather small compared with others in the genus, about 1.5-2.0 mm long; white or dirty white, moderately stout in texture; exuviae yellowish brown, occupying about one third to one fourth of whole length of test. Ventral test white and thin.

**GENERAL DESCRIPTION**

**Body of adult female (fig. B).** Spindle-shaped, laterally produced and posteriorly widened; broadest at metathorax or abdominal segment I, rarely at II; on slides, 921-1238 long and 495-743 wide.

**Pygidial margin (fig. C).** More or less triangular, 192-247 long and 353-545 wide at base, with acutely pointed and sclerotized apex. Median lobes well-developed, elongated; acutely rounded and comparatively longer than in any other in the genus; each lobe 19.7-27.2 long and 12.4-17.3 wide, both mesal and outer margins with very fine serrations; mesal margin slightly more straight than outer; base of lobes yoked by a very short and stout zygotis. Second pair of lobes bilobed, conspicuous; inner lobule elongate and narrow, somewhat oblique, slightly pointed; both lobules with fine serrations. Third pair of lobes with only inner lobule distinct, pointed and with fine serrations; outer one reduced into small projection. Gland spines, setae and macroducts present.

### **Dorsal Surface**

**Macroducts (figs. D&E).** Two-barred type, 4.9-18.6 long, 6.8-8.7 wide; arranged in submedian groups on abdominal segments III-VI, in submarginal groups on II-V, and in marginal groups on III-VII and laterad of median lobes of each side of body; number in each group vary greatly; with an arrangement as follows: Submedian: on abdominal segment III, 1-10, usually over 5; IV,

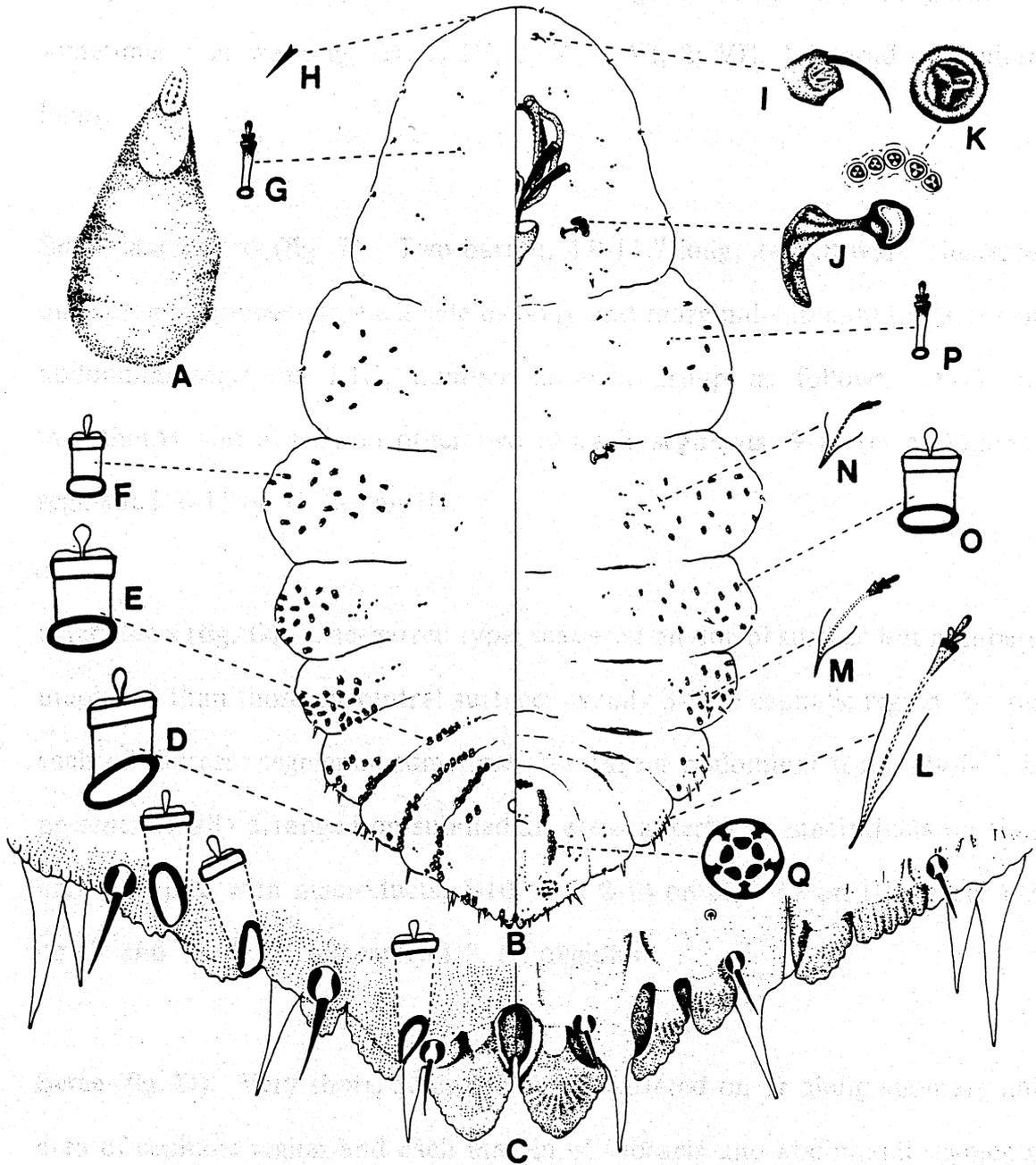


Plate 17. - *Chionaspis longiloba* Cooley

3-11; V, 3-12, VI, 2-6. Submarginal: on abdominal segment II, 4-13, or completely absent; III, 5-13; IV, 4-11; V, 3-7. Marginal: on abdominal segment II, sometimes 1 or wanting; III, 1; IV, 2; V, 2; VI, 2; VII, 1 laterad of median lobes.

**Small macroducts (fig. F).** Two-barred, 4.9-11.7 long, 2.0-7.8 wide; clustered on thoracic segments on each side of body and marginal-submarginal areas of abdominal segments I-III; number in each group as follows: 8-12 on metathorax and absent on other two thoracic segments; 9-14 on abdominal segment I, 6-11 on II, 2-4 on III.

**Microducts (fig. G).** One-barred type, scattered on dorsal surface but numbers much less than those on ventral surface; usually 3-8 on cephalic region, 3-5 on each of thoracic segments; sometimes several on abdominal segments I-V, if present, usually arranged on submedian areas anterior to macroducts on that area or mixed with macroducts, 5-10 on I, 2-14 on II, 1-12 on III, rarely 1-3 on IV and V; about 5-8, rarely 1-2, on pygidium.

**Setae (fig. H).** Very short, 5.66-7.32 long, scattered on or along submarginal area of cephalic region and each margin of thoracic and abdominal segments on each side of body; usually 5-8 on cephalic area, 1 or rarely 2 on each margin of thoracic segments and basal 3 abdominal segments. The ones on margins of posterior abdominal segment III or IV slightly longer and stouter,

6.02-15.58 long, 1 or rarely 2 on each margin of abdominal segments IV-VII, one each laterad of pygidial lobes.

**Anal area.** Anal opening circular, located about basal one third of pygidium, 12.4-14.8 in diameter; distance from anterior margin of anus to midpoint between abdominal segments V and VI, 49.4-76.6; distance from posterior margin of anus to base of median lobes, 106-141.

### **Ventral Surface**

**Antennae (fig. I).** Reduced to very small tubercles, 2.88-10.7 long and 4.88-9.76 wide at base; each with 1 slender fleshy seta, 11.7-17.6 long, usually curved; also with 2 very short and stout terminal sensory setae, 1.95-2.86 long. Distance between antennal bases, 39.0-81.5.

**Clypeolabral Shield.** Length, 117-154; width, 80.4-111; shape typical of the genus.

**Labium.** Length, 34.6-49.4, width, 43.3-55.7; cup- or shield-shaped.

**Spiracles.** Anterior spiracles (fig. J), 22.5-27.2 long, atrium 7.6-8.6 wide, each with 4-10 associated trilocular pores (fig. K); each pore 1.95-2.76 in diameter.

Posterior spiracles very similar in shape to the anterior ones, but slightly smaller, 19.8-25.4 long, each with 1-4 associated trilocular pores.

**Gland spines (fig. L).** Marginal, moderately developed, 14.6-34.1 long, arranged on abdominal segments IV-VI, and laterad of median lobes of each side of body; usually 3-7 on abdominal segment III; 2-5 on IV, 1 or 2 on V, 1 or rarely 2 on VI, 1 on each of VII and laterad of median lobes, the latter smaller than any other mentioned above.

**Gland tubercles (figs. M&N).** Submarginal, basally conical and distally spine-like; 5.86-15.6 long and 4.88-5.86 wide at base, usually smaller anteriorly; number in each group on each side of body as follows: 0-3 on each of prothorax and mesothorax, 1-3 or rarely completely wanting on metathorax, 0-3 on abdominal segment I, 2-5 on II.

**Small macroducts (fig. O).** Two-barred, 4.88-11.7 long and 1.99-7.80 wide, arranged on marginal-submarginal areas on each side of body; number markedly variable, a little more numerous than those on dorsal surface; usually absent on basal two thoracic segments; on abdominal segment I, 11-16; on II, 9-15; on III, 2-5, and sometimes 3-5 anterior of submarginal group of macroducts.

**Microducts (fig. P).** One-barred, similar in shape and in size to those on dorsal surface, but much more numerous on certain segments and regions; about 14-21 on cephalic region, more numerous beside anterior spiracles and anterior of clypeolabral shield; 5-10 on each of thoracic segments, most of them on submarginal areas; very few on each of abdominal segments I-V, about 7-9 on pygidium.

**Setae (fig. H).** Very short, slender, hairlike, 4-6 scattered on and along margins or submargins of cephalic region, 1 on each margin of thoracic segments and basal 3 abdominal segments, rarely very few scattered on submarginal areas of some segments, with same size as those on dorsal surface; 1 on each margin from abdominal segments IV-VI and laterad of each pair of pygidial lobes, usually much smaller than those on dorsal surface.

**Vulvar area** Vulvar opening situated about middle of pygidium. Perivulvar pores (fig. Q): median group, 7-21; anterolateral, 14-36; posterolateral, 11-23; each pore 3.90-4.86 in diameter.

**Type material studied.** Cotypes from *Populus* sp., TX, Alwin, Apr. 14, 1896, coll. H.H. Eldnyde, 6545, 1(7) USNM; Alwin, July 6, 1896, 6545, 2(10) USNM; Apr. 14, 1896, 6545, 4(4) USNM.

**Material studied.** *Populus canadensis*, OH, Painesville, Apr. 14, 1904, O.E. Bremner coll., 4(9) UCD; Columbus, Oct. 3, 1920, coll. PRL, 1(7) USNM. *Populus deltoides*, MI, Warren Dunes State Park, Aug. 20, 1960, coll. MK, 1(1) VPI; MS, Feb. 21, 1952, coll. H.Y. Gouldman, 52-597, 1(2) USNM; OH, Painesville, 1(5) BM; Painesville, Apr. 14, 1904, coll. O.H. Swezey, Cooley coll. 60, 1(3) USNM. *Populus* sp., LA, New Orleans, Sept. 26 1910, coll. T.C. Barker 2(5) USNM; MS, Mar. 26, 1951, coll. H.Y. . . Gouldman, 51-775, 1(7) USNM; NE, Hartington, Jan. 22, 1894, coll. Boyd, 6158, 1(10) USNM; OH, Painesville, Sept. 18, 1903, coll. G.H. Rumner, 2(7) USNM; TX, Sherman, coll. GFF, 2(3) UCD; Albany, 1917, coll. Hollinger, T41, 2(3) UCD. *Salix nigra* L., AL, Baldwin Co., Mobile Bay, Nov. 3, 1977, coll. C.H. Ray Jr. and M.L. Williams and I. Daniels, AL-280-77, 5(5) VPI; AR, at Washington, D.C., Jan. 31, 1967, coll. F.T. Kenworthy, 62 0116, 1(1) USNM. *Salix* sp., CA, Alameda (fr. IA), Feb. 8, 1954, coll. W.A. Kroger, 54B100, 2(2) CDA; Contra Costa Co.(fr. IA), Feb. 9, 1954, coll. J. Simmen, 193) UCD; LA, Baton Rouge, Jan. 1921, coll. T.H. Jones, 2(4) UCD; Port Sulphur, Mar. 9, 1944, coll. Plummer, Spec. Survey 12372, 1(2) USNM; Spanish Fort, New Orleans, Mar. 9, 1919, coll. ERS, 1(5) USNM; Buras, Mar. 10, 1944, coll. Plummer, Spec. survey 12334, 1(1) USNM; TX, Hidalgo, June 2, 1978, coll. S. Nakahara , N-7B-24, 2(10) USNM; Hidalgo Co., Rio Rico Rd., June 3, 1978, coll. S. Nakahara, N-7B-60, 1(9) USNM.

**Host and distribution.**

This species was originally described from cottonwood in Texas. It has so far been collected from willow, *Salix spp.*; poplar, *Populus spp.*; and some unknown hosts. Its distribution includes the following states: AL, AR, CA, IA, KS, LA, MI, MS, NE, TX in the United States, and Mexico.

#### **Affinities and discussion.**

It appears that this species is very similar in morphological characters to *C. lintneri*, but this species differs from the latter in having a more acute and pointed pygidium, comparatively longer and more pointed median lobes with both mesal and outer margins finely serrate, also fewer gland spines and gland tubercles on each margin of abdominal segments III and IV, usually less than 6.

This species is very closely related to the bark form of *C. wistariae* in appearance, but the following combination of characters present in *longiloba* can be used to separate it from *lintneri*. (1) zygotis at base of median lobes much shorter and stouter, (2) median lobes comparatively longer and narrower, also more pointed with both mesal and outer margins finely serrate, (3) either more or fewer dorsal microducts on submedian areas of abdominal segments I-III; may be mixed with macroducts.

According to Dekle (1965, 1976) and Nakahara (1982), this species is distributed in FL and MS. After having checked all slides from several localities of these two states and compared them with the type and cotype material,

I concluded all were misidentified. The material from FL is particularly distinctive and can be separated in having several dorsal submedian and submarginal macroducts on abdominal segment II and several different characters on the median lobes. There were enough differences to designate a new species (see *C. hamoni*). The materials from MS and OR have distinctly different median lobes and several other morphological characters that are different from *C. longiloba*.

The back lobe is similar to *C. americana* and *C. floricola* in having several macroducts on the dorsal surface of the second abdominal segment. The back lobe differs from *C. americana* in having (1) median macroducts along the dorsal margin, (2) dorsal margin of median lobe with four serrations, and (3) only 2-3 dorsal submedian macroducts on each of abdominal segments IV and V.

## *Chionaspis nyssae* Comstock

### Plates 18, 19

**Common name.** Sour-gum scurfy scale.

This species was originally described by Comstock (1881) as a member of *Chionaspis*. Based on the shape of median lobes, Cooley (1903) treated it as the species *sylvatica* in his new genus, *Phenacaspis*. After some disagreement among scientists who published on the status of the genera *Chionaspis* and *Phenacaspis*, Takagi and Kawai (1967) proposed that *P. sylvatica* is a leaf form of *C. nyssae* which feeds on bark. Knipscher et al. (1976) completed a study of the life history and on the morphology of all stages of both the leaf and bark form. They confirmed that these two forms belong to the same species, but are associated with the different feeding sites, and the morphological differences of these two distinct forms and some intermediate forms may be caused by the chemical components of bark and leaves on which they feed.

The bark form is similar to *C. americana* and *C. floridensis* in having median lobes fused for more than half of their length, except for a small apical notch, and it differs from these two species in having: (1) median lobes almost triangular toward the apex, (2) lateral margins of median lobes with fine serrations, and (3) only 1-3 dorsal submedian macroducts on each of abdominal segments IV and V.

The leaf form is characterized by having two dorsal submarginal macroducts on abdominal segment VI, which are lacking in other leaf forms of related species.

The two illustrations for this species are selected from Knipscher et al. (1976) in order to offer readers a complete treatment of all the species in North America and appropriate illustrations for use with the species key provided.

Plate III - *Chironomus* sp. larva, head form

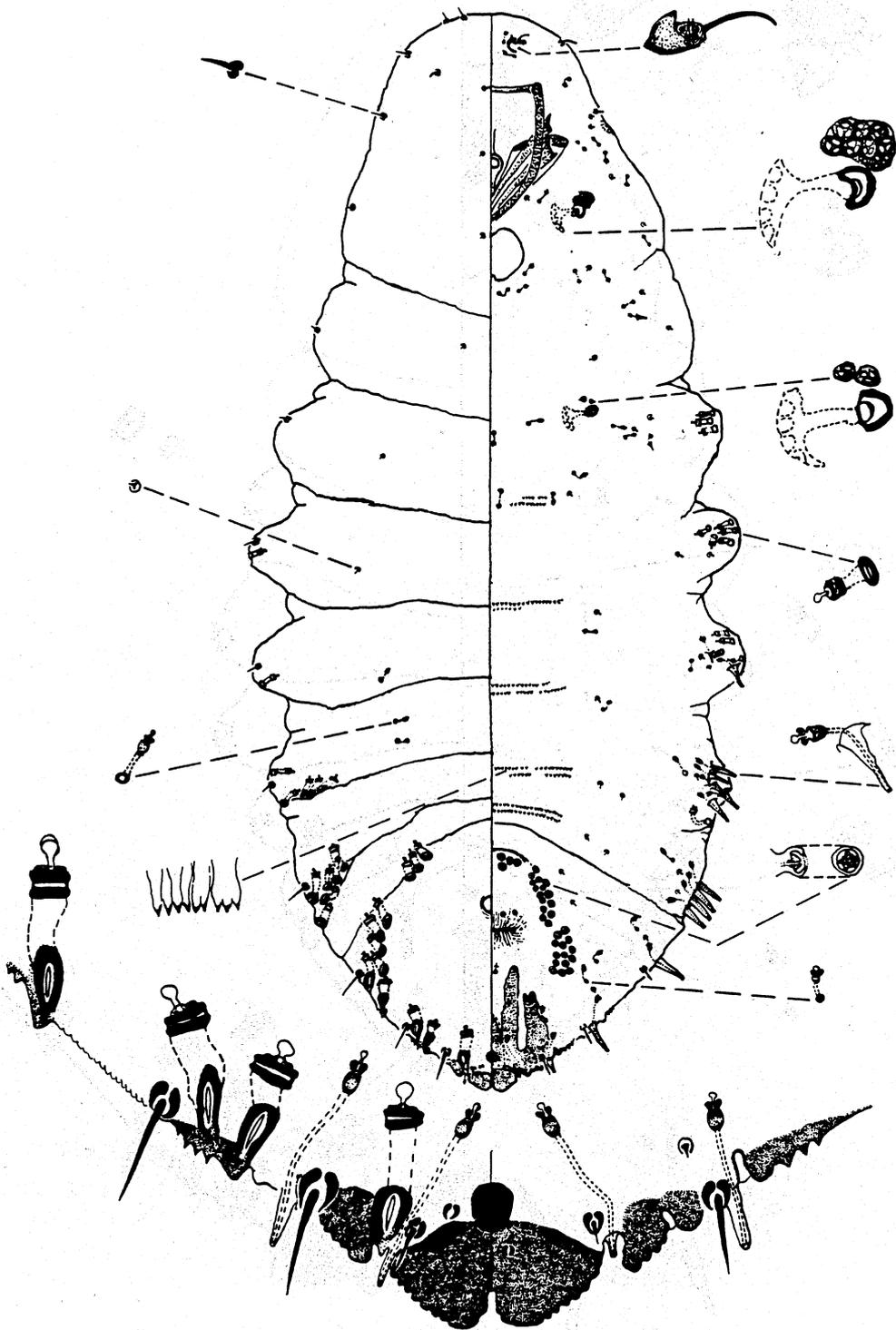


Plate 18. - *Chionaspis nyssae* Comstock, bark form

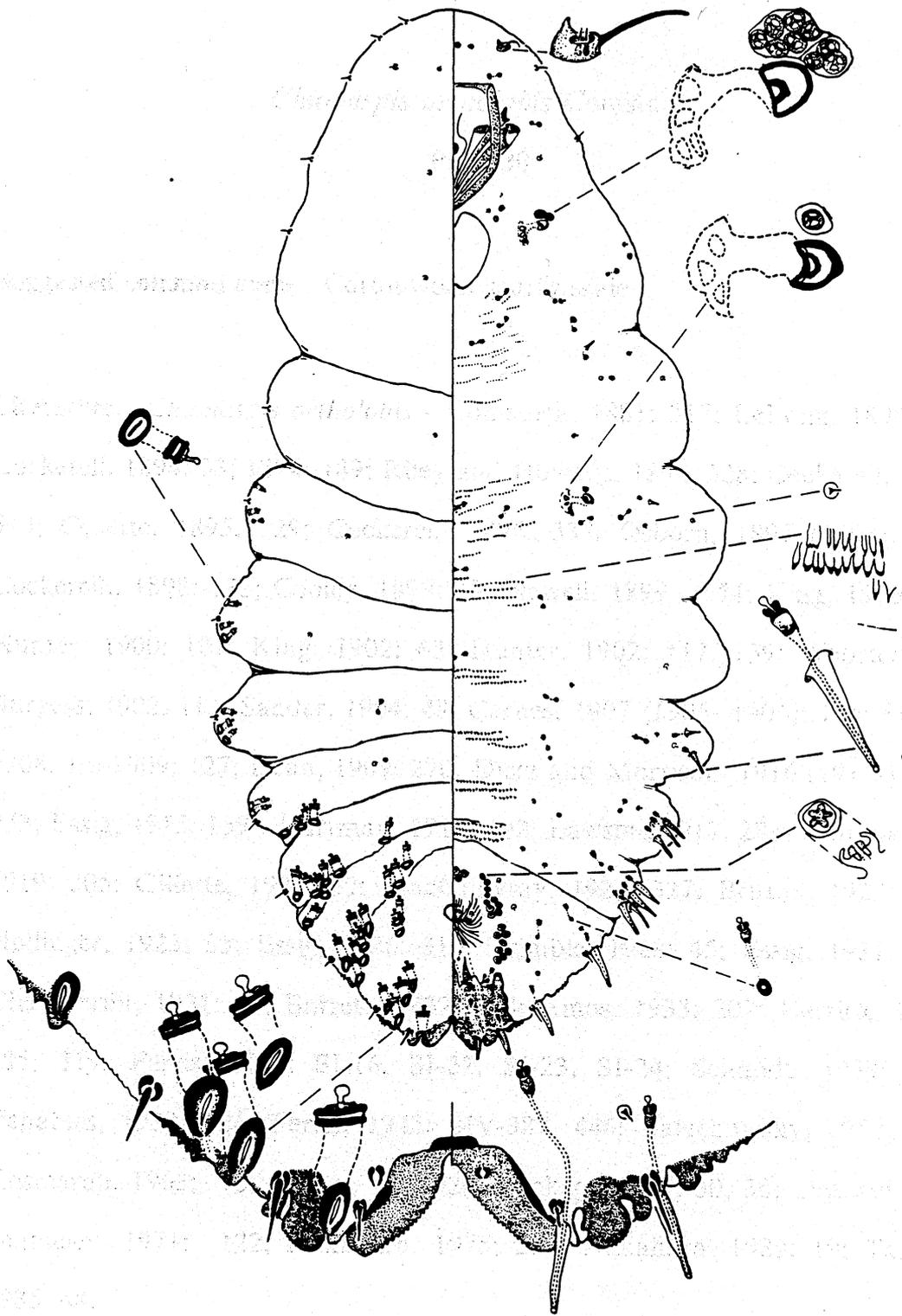


Plate 19. - *Chionaspis nyssae* Comstock, leaf form

*Chionaspis ortholobis* Comstock

Plate 20

**Suggested common name.** Cottonwood scurfy scale

**Literature.** *Chionaspis ortholobis* - Comstock, 1881: 317; LeLong, 1890: 77; Cockerell, 1894: 33; 1894: 189; Riley and Howard, 1894: 328; Cockerell, 1895: 513; Gillette, 1895: 129; Cockerell, 1896: 337; Osborn, 1897 (1898): 228; Cockerell, 1898: 133; Cooley, 1899: 17; Newell, 1899: 154; King, 1900:117; Hunter, 1900: 101; King, 1902: 62; Hunter, 1902: 117, 139; Webster and Burgess, 1902: 113; Sander, 1904: 48; Carnes, 1907 (1905- 1906): 195; Smith, 1908: 12; 1909: 127; Dean, 1909: 270; Dietz and Morrison, 1916 (1914-1915): 273; Essig, 1915: 159; Hartman, 1916: 102; Lawson, 1917: 273; Schumacher, 1919: 305; Gillette, 1921: 22; MacGillivray, 1921: 327; Britton, 1923: 364; Hollinger, 1923: 35; Essig, 1926: 310; Trimble, 1928: 45; Essig, 1931: 578; Chamberlin, 1931: 30; Barrett, 1932: 283; Amos, 1933: 207; Herrick, 1935: 285, 319; Ferris, 1937: SI-16, SI-22, SI-23, SI-24; Schmidt, 1939: 153; Venables, 1939: 24; Ferris, 1942: SIV-387, 446; Balachowsky, 1954: 348; Kosztarab, 1963: 73; Brown, 1965: 209; Takagi, 1967: 30, 38; Dazarov and Schmelev, 1971: 122; Nakahara, 1975: 202; Nakahara, 1982: 19; Takagi, 1985: 48.

**Test of adult female (fig. A).** Elongate and broad oval or irregularly shaped when crowded; white or dirty white, about 2.0-2.5 mm long. Exuviae brown or pale brown, distinct, about 0.8 mm long, occupying about one-third of the total length of the test. Ventral scale distinct, fairly heavy, thicker along the margins of the test.

### GENERAL DESCRIPTION

Body of adult female spindle-shaped, broadest at the first abdominal segment, or sometimes the second, and rarely at metathorax; 854-1572 long and 458-804 wide on slides; slightly larger than that of most species in this genus (fig. B).

**Pygidial margin (fig. C).** Apically sclerotized and triangular, 217-285 long and 464-557 wide at base. Median lobes large and distinct, parallel and close together but separate at a definite angle toward their more or less rounded apex; base of median lobes yoked by a stout sclerosis; inner margin and apex occasionally with several serrations. Second pair of lobes well or poorly developed, bilobed, broad and stout; inner lobule much larger than outer one, rounded apically. Third pair of lobes poorly developed, and indistinct, often reduced into slight prominences. Gland spines, setae and macroducts present.

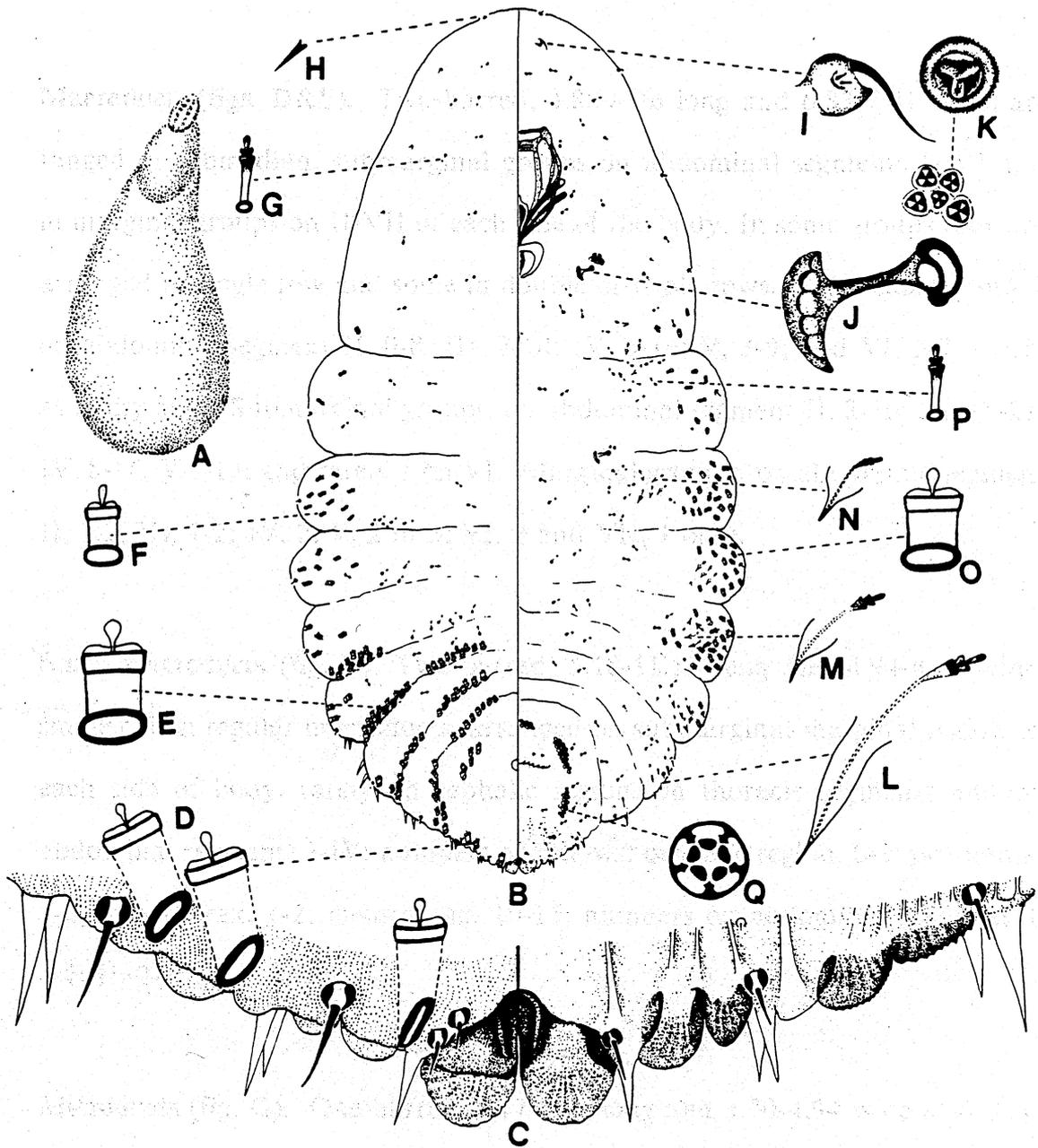


Plate 20. - *Chionaspis ortholobis* Comstock

## Dorsal Surface

**Macroducts (figs. D&E).** Two-barred, 4.88-9.76 long and 6.83-7.81 wide, arranged in submedian, submarginal groups on abdominal segments II-VI and in marginal groups on II-VII of each side of the body. In some groups they are arranged in single row and some in double or triple rows. Submedian groups: on abdominal segment II, 0-8; III, 7-14; IV, 5-16; V, 3-9; and VI, 3-7, rarely as many as 9. Submarginal groups: on abdominal segment II, 8-30; III, 12-21; IV, 8-16; V 6-13; and rarely 1 on VI. Marginal groups: on abdominal segment II, 1-2; III, 1-2; IV, 2; V, 2 or 3; VI, 2 and VII, 1 only.

**Small macroducts (fig. F).** Two-barred, 5.18-11.12 long and 4.94-6.18 wide, smaller than regular macroducts, arranged on submarginal-marginal region on each side of body, rarely on cephalic region, on thoracic segments and on abdominal segments I-IV; numbers as follows: cephalic region, 0-3; prothorax, 1-2; mesothorax, 1-2; metathorax, 10-15; numbers on abdominal segments I, 4-7; II, 2-4; III, 2-3; IV, 0-3.

**Microducts (fig. G).** One-barred, 5.17-8.65 long and 3.70-4.94 wide at orifice, scattered irregularly or arranged regularly on cephalic region, thoracic and abdominal segments of each half of the body; 5-8 on abdominal segment I, 7-14 on II, 3-14 on III, or 1-3 on IV, just occur among or in front of subme-

dian macroducts. Some scattered on submarginal and marginal areas of abdominal segments, but most of them dispersed on submedian and submarginal region of thoracic segments and cephalic region.

**Setae (fig. H).** Few very small hair-like setae, 6.17-7.14 long, along body margins and scattered on cephalic region; setae on margins of abdominal segments slender and long, 1 on each of abdominal segments I-VII, usually shortest ones on I-III, longest ones on V and VI, the ones on IV and VII slightly shorter than those on V and VI.

**Anal area.** Anal opening circular, diameter 10.6-14.8, situated in median area of pygidium. Distance from anterior edge of anus to mid-point of line between abdominal segments V and VI, 61.8-93.9; from posterior edge to base of median lobes, 111-143.

### Ventral Surface

**Antennae (fig. I).** Reduced into small sclerotized tubercles, 7.41-13.1 long and 4.94-10.4 wide at base; each with a fleshy, curved seta, about 12.4-19.8 long; distance between antennal bases, 51.9- 119.

**Clypeolabral shield.** Length, 136-167; width, 98.1-126.

**Labium.** Length, 37.1-56.8; width, 46.9-66.7; cup-shaped.

**Spiracles.** Anterior spiracle (fig. J), 22.2-34.6 long atrium 7.6-9.5 wide, slightly larger than those of other species in the genus; with 5-16 associated trilocular pores (fig. K). Posterior spiracle nearly same shape and slightly smaller than anterior, sometimes stouter, 22.2-27.2 long; each with 0-5 associated trilocular pores.

Gland spines (fig. L): Marginal, 6.08-19.8 long; more numerous than in other species of the genus; situated on each side of body, from abdominal segments III to VII, each with an associated one-barred microduct; III, 5-10; IV, 3-7; V, 1-3, (mostly 2), VI, 2; and VII, 1.

**Gland tubercles (figs. M&N).** Conical basally and spine-like distally, 8.00-9.94 long and 5.56-8.63 wide at base, located submarginally on basal two abdominal segments and three thoracic segments; the arrangement as follows: prothorax, 0-5; mesothorax, 0-5; metathorax, 0-4; abdominal segment I, 1-6; II, 4-9.

**Small macroducts (fig. O).** Numerous, scattered on submarginal and marginal areas of thoracic and abdominal segments I-III, 7.41-11.2 long and 4.74-6.18 wide; arranged as follows: prothorax, 2-5 mesothorax, 8-15; metathorax,

18-26; on abdominal segment I, 15-25; II, 20-31; III, 1-3; on each side of the body.

**Microducts (fig. P).** One-barred, 7.41-12.4 long and 1.24-1.85 wide at orifice, scattered irregularly on submedian, submarginal or marginal region of each side of the body; on cephalic region, 15-22; prothorax, 8-17; mesothorax, 5-9; metathorax, 11-16; on abdominal segment I, 3-4; II, 2-5; III, 2-4; IV, 3-5; V, 2-4 and 8-11 on the pygidial area.

**Setae (figs. H)** Few slender, hair-like, 3.70-4.94 long, on cephalic region; stouter marginal setae, 6.18-11.16 long, one on each abdominal segment from III to V and laterad of lobes of VI and VII, and laterad of median lobes as well.

**Vulvar area:** Vulvar opening in the middle of pygidium; perivulvar pore (fig. Q) groups: median, 11-25; anteriolateral, 21-37; posteriolateral, 16-26; each pore 4.32-4.94 in diameter.

**Type material studied.** Types from *Salix* sp., CA, San Bernadino, date and coll. unknown, 1(3) USNM, 2(7) VPI.

**Other material studied.** *Alnus* sp., CA, North Fork, other data unknown, 1(3) UCD. *Arbutus menziisii*, CA, Summit, 1907, coll. W. M. Gifford, 1(3) USNM.

*Arctistaphylos patula*, 1936, 3(6) UCD. *Arctistaphylos* sp., 1975, coll. L. Davis, 1(6) CDFA. *Ceanothus cordulatus*, CA, Silver City, Tulare Co., August 20, 1963, coll. DRM & JAF, 3(3) UCD; Sierra Nevada Mt., July 5, 1939, coll. C. R. Quick, 1(6) USNM; Chowchilla Mt., Monposa Co., August 13, 1940, coll. C. R. Buick, 1(5) USNM; El Dorado Co., August 1, 1944, coll. H. H. Keifer, 1(3) UCD. *Ceanothus integerrimus*, CA, Forest Hill, Nov. 21, 1913, coll. EOE, 1(4) USNM; Placer Co., Nov. 21, 1913, coll. EOE, 1(4) USNM. *Ceanothus martini*, NV, White Pine Co., August 9, 1972, coll. R. G. Krebill, 2(8) USNM. *Ceanothus sanguineus*, ID, Weippe, August, 1902, coll. Cooley, 1(6) USNM; WA, Yakima Co., July 26, 1920, coll. C. J. Newcomer, 1(3) USNM, Oct. 20, 1923, coll. C. J. Newcomer, 1(4). *Ceanothus velutinus*, CA, Sierra Co., July 15, 1966, coll. DRM, 2(4) UCD; Fallen Leaf Lake, El Dorado Co., August 1, 1944, coll. H. H. Keifer, 1(1) CDFA; 6 mi, E. Independence Lake, Sierra Co., July 15, 1966, coll. DRM, 1(2) USNM; ID, Smith's Ferry, date unknown, coll. A. C. Burrill, 1(5) USNM; UT, Cache Co., near Logan Canyon, Sept. 15, 1972, coll. R. G. Krebill, 3(8) USNM. *Ceanothus* sp., CA, Saddlebuck Mt., Santa Ceria Mts., Sept. 23, 1912, coll. R. K. Bishop, 1(8) USNM; Mariposa Co., Sept. 26, 1975, coll. Gibert & Griffin, 4(10) UCD; Big Pine Co., April 20, 1963, coll. W. Dyer, 1(2) USNM; Amedor Co., Sept. 18, 1978, coll. Paddock & Bingham, 1(3) UCD; Burney, 1923, coll. C. Bethel, 2(5), UCD; Kerrivill, Dec. 10, 1938, coll. L. E. Myers, 2(6) UCD; Lake Tahoe, El Dorado Co., Sept. 16, 1956, coll. G. Prole, 2(5) UCD; June 12, 1916, coll. H. G. Dyar, 3(8) USNM; Mt. Shasta, 1911, coll. H. J. Suayle, 1(1), USNM;

OR, Gold Beach, Nov. 26, 1938, coll. C. P. Reyser, 1(2) USNM; UT, Farmington Canyon, Davis Co., June 24, 1973, coll. G. F. Knowlton & G. E. Bohart, 5(13) USNM; 1(4) VPI; WA, north of Goldendale, July, 1962, coll. Tichenor, 2(5) UCD; near Yakima, Dec. 7, 1929, coll. E.J.N., 2(4) USNM; WI, Lincoln Co., August 4, 1967, coll. DRM & DSH, 3(5) UCD. *Cytisus scoparius*, CA, Grass Valley, April 27, 1959, coll. L. E. John & W. W. Wiard, 2(14) USNM. *Salix* sp., AZ, near S. W. Res. Sta., Portal, June 19, 1958, coll. SWB, 1(2) UCD; CA, Mono Lake, August 20, 1922, coll. R. Flartman, 1(2) UCD; San Bernadino, 1936, coll. H. McKenzie et al., 5(18) UCD; Ventura, April 23, 1938, coll. E. L. Smith, 4(16) CDFA; San Diego Co., Sept. 18, 1974, coll. Cramer & Koide, 3(10) CDFA; Chola Vista, San Diego Co., Sept. 8, 1980, coll. Kenyon & Anderson, 5(15) CDFA; San Diego, March 27, 1940, coll. J. W. Dixon, 1(3) CDFA; Leevining, April 15, 1960, coll. R. Rollins, 1(4) CDFA; San Fernando, Valley, March 16, 1927, coll. LEM, 1(4) UCD; San Diego, Sept. 13, 1959, coll. P. H. Jimberluke, 1(6) USNM; Orange Co., Jan. 10, 1940, coll. Bumgardner, 1(2) CDFA; Others: 3(9), data unknown, USNM. *Rhamnus purshiana*, CA, San Bernaidino, May 4, 1906, coll. S. A. Pease, 1(6) USNM.

**Host and distribution.** This species was first described from willow (*Salix* sp.) from Southern California, and has since then been collected from several states, all west of the Rocky Mountains except Wyoming: CA, ID, MT, NV, OR, UT, WA, and WY. Several additional hosts have been found: *Ceanothus*

*cordulatus*, *C. integerrimus*, *C. sanguineus*, and *C. velutinus*; *Cytisus scoparius*; *Rhamnus purshiana*. All specimens in the lent material collected from *Populus* are certainly misidentified. They are all *C. salicisnigrae*. Other specimens collected from *Alnus* and *Cornus* are questionable because they lack typical species characters. The specimens recorded feeding on sycamore, *Platanus occidentalis*, determined by Dietz and Morrison, are surely the bark form of *C. platani*.

**Affinities and discussion.** Among the species of the genus in North America, several species are more or less similar to this species in morphological characters. Of these *C. sassceri* resembles it more than others, but these two can be separated each other by *C. ortholobis* having (1) mesal margins of median lobes contiguous for part of their length, (2) the basal sclerotized zygotis narrow and elongate, and (3) the outer lobule of the third pair of lobes distinct. But it should be pointed that according to Ferris (1937), because of the extreme similarity of these two species they are occasionally indistinguishable. They may express geographical and host-induced variations. In this situation, an extremely careful comparison is essential for correct identification.

The second species which is often confused with this species is *C. longiloba*, but the combination of short and rounded median lobes, elongate and narrow basal zygotis in *C. ortholobis* will distinguish it from *longiloba* in having the median lobes elongate, and the basal zygotis very short and stout.

Other species, including: *C. salicisnigrae*, *C. lintneri*, *C. corni*, and *C. platani*, are closely related to and easily misidentified as this species. *C. ortholobis* differs from *C. salicisnigrae* in not having the characters listed under **Diagnostic Characters**. It differs from *C. lintneri* by its median lobes being rounded, and their mesal margins curved, and the normal gland spines on abdominal segment IV, which contrast with the following characters in *C. lintneri*: their mesal margins long and straight, and the gland spines on margin of abdominal segment IV more numerous, thinner, and longer. The differences between this species and *C. corni* are that in *C. ortholobis* the mesal margins of the median lobes are contiguous, and the median lobes are rounded, while in *C. corni* the mesal margins of the median lobes are parallel for about half of their length, then strongly divergent, and the divergent margins are long and straight.

For this species, some problems in misidentification may be encountered. When it is collected from *Salix*, it is often easily misidentified with *C. salicisnigrae* or *C. longiloba*; when collected from *Ceanothus*, it is often confused with *C. sassceri*. The relationships among these species need to be more thoroughly studied.

Some specimens collected from *Alnus*, *Populus* and *Cornus* and several other species of hosts lack the species-specific morphological characters, and are considered here *C. ortholobis*.

*Chionaspis pinifoliae* (Fitch)

Plates 21, 22

**Common name.** Pine needle scale

**Selected literature and synonymy.** *Aspidiotus pinifoliae* -- Fitch, 1855: 488; 1856: 256; Glover, 1876: 43; Essig, 1931: 862; Heriot, 1931: 11; Lindinger, 1933: 165; Ferris, 1937: SI-93; 1941: 47; Balachowsky, 1954: 354; Ferris, 1956: 71.

*Chionaspis pinifoliae* -- Comstock, 1880:318; Howard, 1883: 281; Sanders, 1883: 326; LeLong, 1890 (1889): 177; Cockerell, 1896: 337; Cooley, 1897: 281; Osborn, 1897 (1898): 228; Cockerell, 1899: 398; Cooley, 1899: 30, 34; King, 1901: 333; Hunter, 1902: 118; Webster and Burgess, 1902: 113; Coleman, 1903: 83; Sanders, 1904: 49; Britton, 1905: 11; Stene, 1906 (1905): 30; Carnes, 1907: 196; Wilson, 1917: 48; MacGillivray, 1921: 326; Britton, 1923: 365; Hollinger, 1923: 26; Merrill, 1923: 215; Felt, 1924: 152; Sheaffer, 1930: 18; Metcalf and Hollinger, 1930 (1929): 183; Essig, 1931: 862; Lindinger, 1935: 140; Britton, 1937: 343; Ferris, 1937: SI-13, SI-91, SI-93; Ferris, 1956: 71, 74; Takagi and Kawai, 1967: 30, 38; Tamaki, 1969: 89; Beshear, Tippins and Howell, 1973: 10; Nakahara, 1975: 202; Dekle, 1976: 55; Howell and Williams, 1976: 188; Schuder, 1981: 1; Kosztarab, 1977: 185; Rosen and DeBach, 1977:

11; Miller and Kosztarab, 1979: 5; Knight and Heikkinen, 1980: 281; Nakahara, 1982, 20; Howard and Oliver, 1985: 51; Takagi, 1985: 41.

*Mytilaspis pinifoliae* -- LeBaron, 1871: 83; Bessey, 1872: 161; Signoret, 1876: 604; Packard, 1881: 218; 1890: 805.

*Mytilaspis pinifolii* -- LeBaron, 1872: 161.

*Chionaspis pinifolii* -- Riley, 1882: 514; Lintner, 1885:184; Cockerell, 1894: 33; Gillette and Baker, 1895: 129; Lintner, 1896: 203; Cockerell, 1896:38; Pettit, 1898: 415; Lindinger, 1909; 362; 1910: 440; Lawson, 1917: 90; Lindinger, 1932: 200; Ferris, 1937: SI-93, SI-127.

*Chionaspis pinifoliae* var. *semiaurea* -- Cockerell, 1895: 731; 1899: 398; Ferris, 1937: SI-93; Balachowsky, 1954: 354.

*Phenacaspis pinifoliae* -- Ferris, 1937: SI-13, SI-91, SI-93; 1941: 47; 1942: SIV-406; Balachowsky, 1954: 354; Lindinger, 1958: 371; Brown, 1960: 163, 165; Kosztarab, 1963: 95, 96; Brown, 1965: 223; McDaniel, 1972: 338; Johnson and Lyon, 1976: 82, 90; Dekle, 1965: 13, 111; English, 1976: 54, 56.

*Phenacaspis pinifolii* -- Lindinger, 1932: 200; 1935: 140.

**Test of adult female (fig. A).** More elongated and slender than in any other species in the genus except for *C. heterophyllae*; about 2.5-4.0 mm long; sides usually parallel or slightly broadened posteriorly, but sometimes quite wide, depending upon width of leaf and their density; rather strongly convex, moderately thick in texture; white to dirty white; exuviae light yellow or brown,

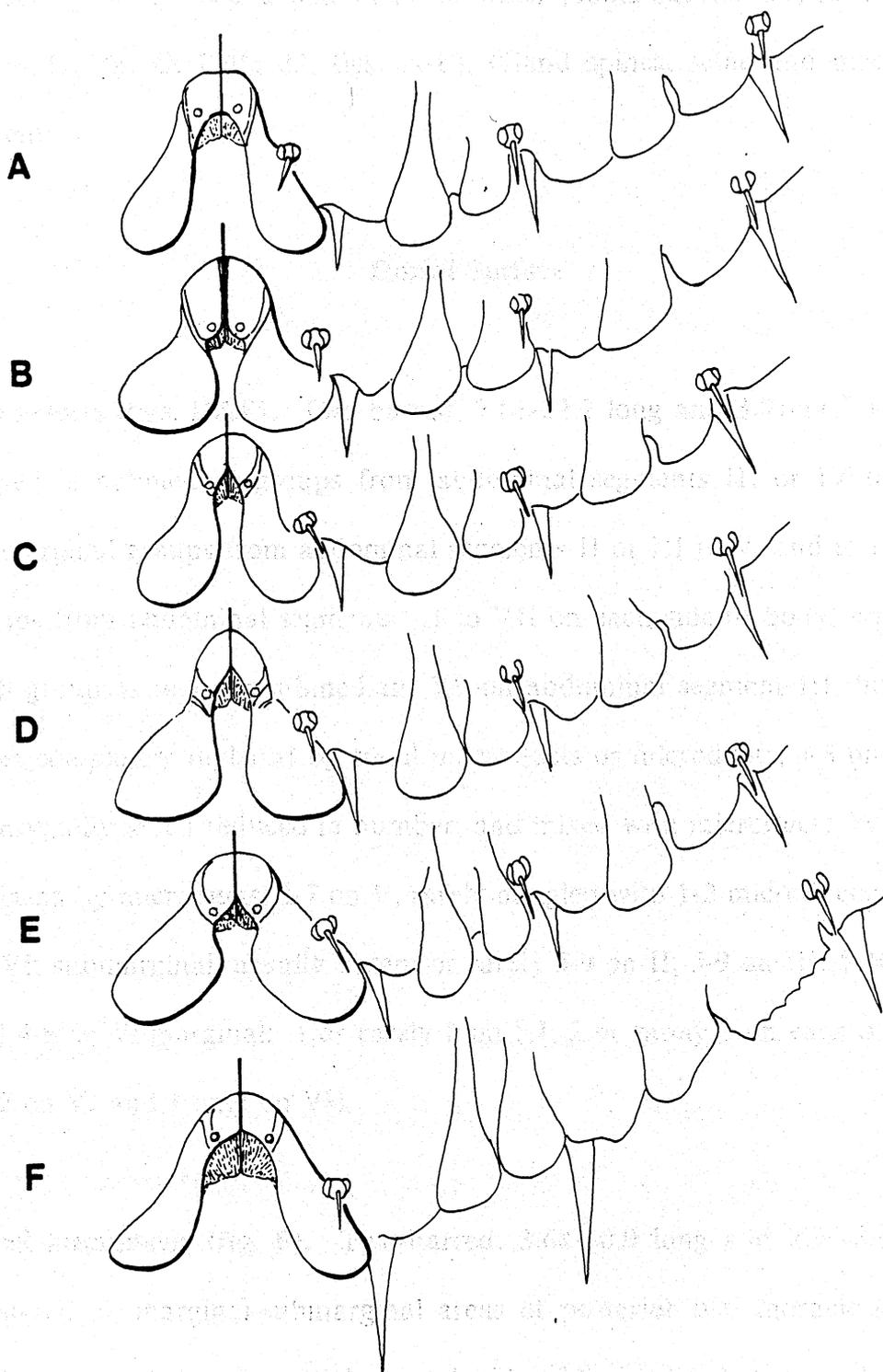
about 1 mm long, occupying about one third to one fourth of entire length of test. Ventral test very thin and inconspicuous.

## GENERAL DESCRIPTION

Body of adult female spindle-shaped but very elongate, on slides 755-1244 long and 396-594 wide; lobed laterally and broadened posteriorly, usually broadest at metathorax or abdominal segment I (fig. B).

**Pygidial margin (fig. C).** More or less circular or oval, rounded and sclerotized apically; rather large, about 210-229 long and 347-402 wide at base; 3 pairs of lobes fairly well-developed. Median lobes deeply sunken into apex of pygidium; shape and degree of divergence varies greatly from specimen to specimen (Plate 21, fig. B; Plate 22, figs. A-E); lobes small and long, relatively narrow at base but strongly broadened at about posterior half, forming a wide and semicircular apex; mesal margins well separated for a distance of one-fourth to one-half of width of 1 lobe, and basally parallel for more than one-half of their length, and then distinctly divergent; about 22.2-29.6 long from base to apex, and 8.15-12.4 wide; basal zygotis well-sclerotized, an inverted "U" or horseshoe-like in shape. Second pair of lobes bilobed and conspicuous; both lobules equally broadened and rounded apically; outer lobule slightly shorter than inner one. Third pair of lobes distinct and bilobed; rounded at apex; outer lobule usually wider than the inner one and also wider than that





**Plate 22. - *Chionaspis pinifoliae* (Fitch) (A-E),  
*Chionaspis heterophyllae* (F), variation of median lobes**

of each lobule of second pair of lobes; outer lobule shorter but rather wider (Plate 21, fig. C; Plate 22, figs. A-E). Gland spines, setae and macroducts present.

### **Dorsal Surface**

**Macroducts (figs. D&E).** Two-barred, 7.81-22.2 long and 3.91-11.7 wide, arranged in submedian groups from abdominal segments III or IV to VI, in submarginal groups from abdominal segments II or III to V, and in marginal groups from abdominal segments III to VII on each side of body; number in each group as follows: submedian: 3-9 on abdominal segment III, but sometimes completely replaced by small macroducts or microducts; 4-8 on IV, but occasionally much reduced in number, and mixed with microducts, or entirely replaced by microducts; 3-7 on V, rarely mingled with 1-2 microducts; and 1-4 on VI; submarginal: usually absent or rarely 5-9 on II, 5-9 on III, 5-10 on IV, and 4-6 on V; marginal: 1 or rarely 2 on III, 2 or rarely 3 on each of IV and V, 2 on VI and 1 only on VII.

**Small macroducts (fig. F).** Two-barred, 3.68-10.9 long and 2.96-8.96 wide, clustered on marginal-submarginal areas of posterior two thoracic segments and abdominal segments I-III on each side of body; number on each segment markedly variable from few to many; absent on prothorax; 3-10 on

mesothorax; 6-11 on metathorax; usually 5-8 on abdominal segment I, 4-9 on II, 1-3 on III.

**Microducts (fig. G).** One-barred, 7.03-9.47 long and 1.95-3.12 wide at orifice, scattered or clustered on whole surface of body, but number and distribution on each half of body surface differs markedly in different specimens; usually very few on cephalic region, and 2-12 on each of meso- and metathorax, and rarely 8-20 on submarginal area of metathorax; on abdominal segments I-V, microducts distributed on submedian areas, roughly divided into anterior group and posterior group, 5-17 on abdominal segment I, 8-27 on II, 2-31 on III, sometimes 7-15 on IV, rarely around 2 on V; on segments III-V, the posterior group usually mixed with macroducts on the same area; in some specimens, few or many microducts clustered on submarginal areas of abdominal segments I-III, if present, range on each segment greatly variable, from 11 to 36.

**Anal area.** Anal opening circular, 12.4-17.3 in diameter, located about basal two fifth of pygidium; distance from its anterior margin to mid-point of line between abdominal segments V and VI, 64.2-93.8; distance from posterior margin to base of median lobes, 93.9-143.

**Setae (fig. H).** Very few, short, slender setae, 5.47-7.90 long, 4-6 scattered on and along margins of cephalic region and 1 on each margin from meso- and

metathorax to abdominal segments I-IV of each side of body; slightly longer and stouter, ones about 7.90-9.88 long, 1 or rarely 2 on each margin of abdominal segments V and each laterad of each pair of pygidial lobes, and 1 located between 2 lobules of each of second and third pair of lobes.

### Ventral Surface

**Antennae (fig. I).** Much reduced into very small tubercles, 4.88-6.83 long and 5.86-6.83 wide at base, each with 1 long and slender seta, 15.6-24.7 long, usually laterally curved, and with 2 very short stout sensory setae, 1.95-2.93 long. Distance between antennal bases, 61.8-91.4.

**Clypeolabral shield.** Shape typical of the genus; length, 148-165 and width, 88.9-124.

**Labium.** Cup- or shield-shaped; length, 32.1-49.4, and width, 46.9-61.7.

**Spiracles (fig. J).** Shape typical of the genus; anterior spiracles, 19.8-32.1 long and atrium 12.4-19.8 wide, each with 3-7 associated trilocular pores (fig. K), each pore 3.42-3.90 in diameter; posterior spiracles with same shape and nearly same size as anterior ones or very slightly smaller, 17.3-29.6 long, each with 1-3, mostly 2 associated trilocular pores.

**Gland spines (fig. L).** Marginal and poorly-developed, 12.4-14.8 long, each with 1 associated one-barred microduct projecting in each spine; number on each margin of abdominal segments IV-VII and laterad of median lobes of each side of body as follows: 1-3 on IV, 1 on each of V, VI, VII, and laterad of median lobes.

**Gland tubercles (figs. M&N).** Basally conical and distally spine-like, very small, 4.94-9.88 long and 2.47-6.92 wide at base, each with 1 one-barred associated microduct, situated on submarginal areas of each side of body; 0-2 on prothorax; 0-3 on mesothorax; 1-3 on metathorax; 1-5 or rarely absent on I, 1-6 on II, usually 2-7 on abdominal segment III. The ones on abdominal segments II and III, sometimes marginally situated.

**Small macroducts (fig. O).** Two-barred, very small, 3.68-10.9 long and 2.44-8.98 wide, clustered on marginal-submarginal areas of meso- and metathorax and abdominal segments I-III of each side of body; number greatly variable from specimen to specimen; on abdominal segment usually wanting on prothorax; mesothorax, 3-8; metathorax, 7-11; on abdominal segment I, 3-9; II, 3-8; III, 1-3.

**Microducts (fig. P).** One-barred, of same size as those on dorsal surface, scattered and clustered on each half of body; noticeably more numerous on cephalic area, 5-18 clustered anterior of clypeolabral shield and around

antennae, and 5-22 clustered posteriolateral to anterior spiracle; 5-12 on each of meso- and metathorax, few on each of abdominal segments I-V, and 5-8 on pygidium.

**Setae (fig. H).** Very short hair-like, of about same size as those on dorsal surface, scattered on and along margins of cephalic region and on each margin of thoracic and abdominal segments of each side of body; 4-7 on cephalic region, 1 on each margin of meso- and metathorax, and abdominal segments I-VI and each laterad of each pair of pygidial lobes. Usually the one on each margin or laterad of posterior 3-4 segments little longer and stouter than those on anterior segments.

**Vulvar area.** Vulvar opening located about middle of pygidium; perivulvar pore (fig. Q) groups: median, 6-13; anterolateral, 12-28; posterolateral, 10-24; each pore 2.93-5.96 in diameter.

**Material studied.** See Appendix B.

**Host and distribution.** This species was originally described from pine, *Pinus* sp., in New York. So far it has been collected and recorded from 35 species of pine and various related hosts, all in the family Pinaceae except where noted, including: *Abies balsamea*, *A. bracteata*, *A. concolor*, *A. fraseri*; *Juniperus virginiana* (family Cupressaceae); *Picea abies*, *P. engelmannii*, *P.*

*glauca*, *P. glauca* cv. *densata*, *P. orientalis*, *P. pungens*, *P. pungens* cv. *Koster*, *P. rubens*; *Pinus attenuata*, *P. ayacahuite*, *P. banksiana*, *P. californica*, *P. canariensis*, *P. cembra*, *P. cembroides*, *P. contorta*, *P. contorta* var. *latifolia*, *P. coulteri*, *P. edulis*, *P. engelmannii*, *P. flexilis*, *P. greggii*, *P. halepensis*, *P. jeffreyi*, *P. lambertiana*, *P. leiophylla*, *P. michoacanae*, *P. monophyllae*, *P. montezumae*, *P. monticola*, *P. mugo*, *P. nigra*, *P. parviflora*, *P. patula*, *P. ponderosa*, *P. ponderosa* var. *arizonica*, *P. pseudostrobus*, *P. radiata*, *P. resinosa*, *P. strobus*, *P. sylvestris*, *P. thunbergiana*, *P. torreyana*, and *P. virginiana*; *Pseudotsuga menziesii*; *Torreya californica* (family Taxaceae); *Tsuga canadensis* and *T. caroliniana*.

It has a wide distribution throughout the conterminous United States, Canada and Mexico, wherever its hosts occur. Because this species is so close to *C. heterophyllae* in morphological characters and in habitats, these two are easily misidentified, and the distribution records in some older literature sources may be doubtful. In this study, a lot of misidentifications were found and corrected.

**Affinities and discussion.** This species is extremely similar in appearance of the test of the adult female and body characters to *C. heterophyllae* feeding on the same hosts. It is impossible to identify these two by their tests, but under a microscope, the following characters of the body of the adult female can be used to distinguish *C. pinifoliae* from *C. heterophyllae*. In *C. pinifoliae*: (1) median lobes are separated from each other for a distance of one-fourth to



*Chionaspis platani* Cooley

Plates 23, 24

**Common name.** Sycamore scurfy scale

**Literature and synonymy.** *Chionaspis platani* - Cooley, 1899:36; Fernald, 1903: 223; Hollinger, 1923: 27; Amos, 1933a:207; 1933b: 210; Takagi and Kawai, 1967: 34; Nakahara, 1982:20; Chen, 1983: 9, 91; Howard and Oliver, 1985, 47, 52; Takagi, 1985:41.

*Chionaspis parkii* - Hollinger, 1923, 25; Ferris, 1937: SI-14, SI-19, SI-23; 1942: SIV-386, SI-446; Kosztarab, 1963: 74, 75; Nakahara, 1982: 20; Takagi, 1985: 41.

*Chionaspis occidentalis* (Kosztarab) - Takagi and Kawai, 1967: 30, 38.

*Phenacaspis occidentalis* - Kosztarab, 1963: 93, 94; Takagi and Kawai, 1967: 38; Nakahara, 1975: 202.

*Phenacaspis platani* (Cooley) - Ferris, 1937: SI-94, SI-95; MacGillivray, 1921: 345; Ferris, 1942: SI-446; Balachowsky, 1954:354; Ferris, 1956:72, 74; Kosztarab, 1963: 96; Brown, 1965: 226; Takagi and Kawai, 1967: 34; McDaniel, 1972: 340; Chen, 1983: 75, 95.

**GENERAL DESCRIPTION**

This species has two different forms: a leaf-form, feeding on the leaves, and a bark-form, feeding on the bark of the host. The former is under the present valid name including the individuals under *C. occidentalis* designated by Kosztarab (1963), whereas the latter used to be under the name of *C. parkii*. The two forms will be described and illustrated separately because of their distinct differences.

### **Bark Form**

#### **Plate 23**

**Test of adult female (fig. A).** Distinctly pyriform, or oystershell-shaped, and broadened posteriorly, about 2.0-2.2 mm long; white or dirty white, usually mixed with bark particles, otherwise of typical characteristics for the genus. Exuviae brownish, occupying about one fourth to one third of the total length of the test. Ventral test white, and very thin.

**Body of adult female (Fig. B).** Spindle-shaped, length on slides 755-1288 and width 457.91-754.84; laterally lobed and posteriorly broadened; derm membranous except for sclerotized pygidium.

**Pygidial margin (Plate 23, fig. C; Plate 24, fig. A).** Triangular, large and broad, with a measurement of 210-317 long and 433-557 wide at base; apex rather pointed due to the large and well-developed median lobes. Median lobes

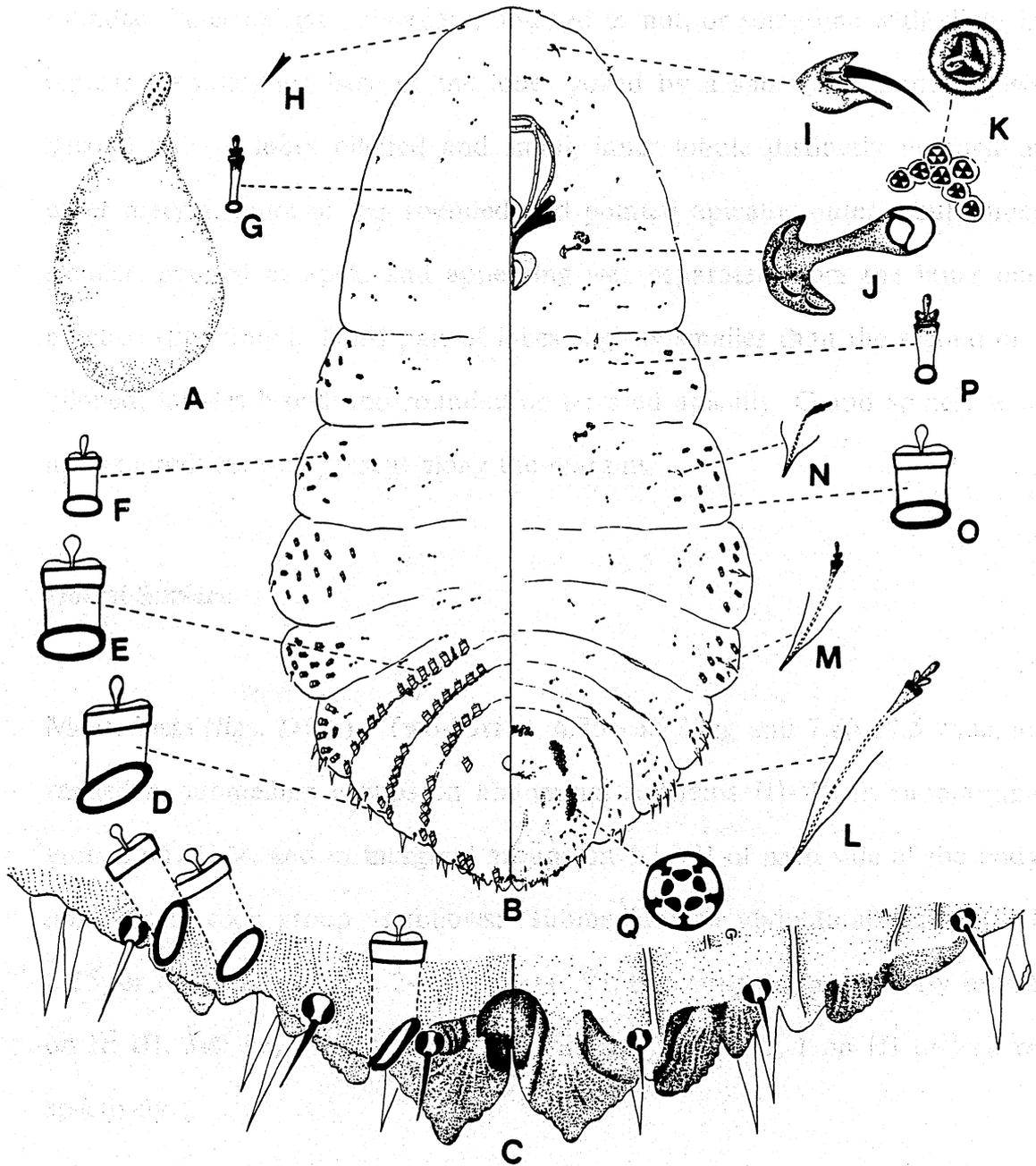


Plate 23. - *Chionaspis platani* Cooley, bark form

distinct and prominent, each lobe about 17.3-30.2 long and 14.8-19.8 wide; shape of lobes vary remarkably (fig. ), apex conspicuously pointed or rounded, inner margins divergent, notched or not, or sometime with slight irregular crenulations; base of the lobes yoked by a short and stout zygotis. Second pair of lobes bilobed and small; inner lobule distinctly notched on outer margin, more or less rounded and pointed apically; outer lobule much smaller, pointed at apex, and appearing well separated from the inner one, notched or serrated. Third pair of lobes slightly smaller than the second one, bilobed; lobules broad and rounded or serrated apically. Gland spines, setae and macroducts well present along the margins.

#### **Dorsal Surface**

**Macroducts (figs. D&E).** Two-barred, 6.76-15.8 long and 7.60-10.5 wide, arranged in submedian groups on abdominal segments III-VI, in submarginal groups on III-V, and in marginal groups on III-VII of each side of the body, numbers in each group as follows: submedian: on abdominal segment III, 2-15, or rarely absent; IV, 2-15; V, 2-11; VI, 0-2; submarginal: rarely several on II; III, 3-8; IV, 2-11; and V, 2-6; marginal: 1, 2, 2, 2, 1 on III to VII, respectively.

**Small macroducts (fig. F).** Two-barred, 5.70-8.55 long and 4.75-6.65 wide, clustered on marginal-submarginal areas of basal three abdominal segments

and thoracic segments of each side of the body. Few or absent on prothorax, 5-8 on mesothorax, 4-13 on metathorax, 5-15 on I, 8-12 on II, usually 5-12 on abdominal segment III.

**Microducts (fig. G).** One-barred, length 5.70-6.65 and orifice 1.78-2.85 wide, scattered irregularly on each half of body; on cephalic region, about 5-12; thoracic segments, each with 4-12; few on abdominal segments I-IV; and usually few or absent on abdominal segment V and pygidium.

**Anal area.** Anal opening circular, 11.6-14.2 in diameter, located about basal two-fifths to one-third of pygidium; distance from anterior edge of anus to mid-point of line between abdominal segments V and VI, 64.2-91.4; distance from posterior edge of anus to base of median lobes, 117-144.

**Setae (fig. H).** Short, slender, hair-like, 5.70-9.50 long, scattered along body margins and on cephalic region, 1 or rarely 2 on each margin of thoracic segments and abdominal segments I-III, or sometimes absent on thoracic segments; setae on the other segments longer and stouter, 1 or 2 on each margin of abdominal segments IV-VI, and laterad of lobes of pygidial margin.

#### Ventral Surface

**Antennae (fig. I).** Reduced to sclerotized tubercles, 6.65-10.7 long and 6.83-11.6 wide at base, each with 1 slender and fleshy seta, 12.7-15.6 long, sometimes curved laterally; and 2 short and spine-like sensory terminal setae, 1.90-2.85 long. Distance between antennal bases, 64.6-91.6.

**Clypeolabral shield.** Shape typical of the genus; length, 126-153; width, 98.8-139.

**Labium.** Cup- or shield-shaped; length, 39.5-55.7; width, 53.4-71.9.

**Spiracles.** Anterior spiracles (fig. J), 22.2-32.5 long and atrium 8.1-9.5 wide, each with 3-8 associated trilocular pores (fig. K). Posterior spiracles nearly the same shape as anterior ones, and slightly smaller, 14.3-29.6 long, each with 1-3 or occasionally 0 associated trilocular pores.

**Gland spines (fig. L).** Marginal, well-developed, 14.3-20.9 long, arranged on margins of abdominal segments III-VII, and laterad of median lobes of each half of the body; usually 1-3 on III, 3-5 on IV, 1-2 on V, 1-2 on VI, 1 or 2 on VII, only 1 laterad of median lobe.

**Gland tubercles (figs. M&N).** Basally conical and distally spine-like 5.70-12.45 long and 3.33-4.75 wide at base, sometimes ones on basal thoracic segments distinctly smaller; frequently absent on prothorax, 0-2 on each segment of

mesothorax and metathorax, and in small groups of 1-3 on submarginal areas of abdominal segments I-II.

**Small macroducts (fig. O).** Marginally and submarginally clustered, two-barred, of same size as ones on dorsal surface, but numbers much reduced; wanting on prothorax. 0-3 on mesothorax, 4-7 on metathorax, 5-9 on I, 2-5 on II, and usually absent on abdominal segment III.

**Microducts (fig. P).** One-barred, 5.70-7.15 long and 1.58-2.94 wide orifice, scattered on entire surface with numbers greatly variable on different areas and segments on each side of body; usually 16-30 on cephalic region, 5-10 on each of thoracic segments, and 3-5 on each of abdominal segments I-III, and very few or absent on IV and V, and several on the rest of pygidial area.

**Setae (fig. H).** Short, slender hair-like, on each side of body, 5.54-7.84 long, 5-8 scattered irregularly on cephalic region, 1 or 2 on each margin of thoracic segments and abdominal segments, sometimes absent on some segments; ones on pygidial margin usually a little longer and stouter, whereas ones on central area of pygidium much shorter.

**Vulvar area.** Vulvar opening situated about center of pygidium; perivulvar pore (fig. Q) groups: median, 10-23; anteriolateral, 15-33; posteriolateral, 9-30; each 4.56-4.75 in diameter.

## Leaf Form

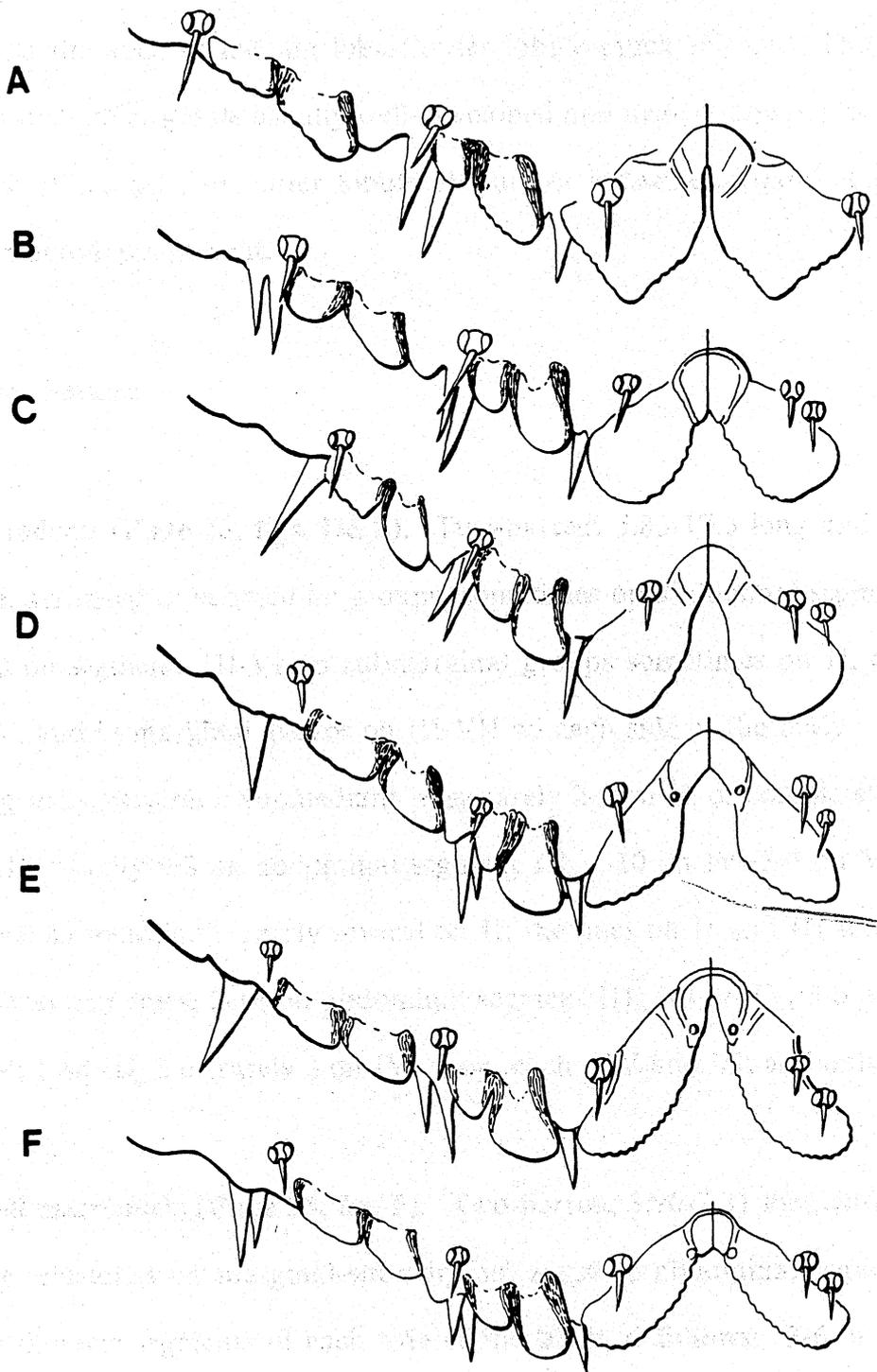
### Plates 23, 24

**Test of adult female (Plate 23, fig. A).** Similar to that of bark form. Oystershell-shaped, or elongate to pyriform; thin, slightly convex and moderately broadened posteriorly; length, 1.8-2.0 mm; white or dirty white, often mixed with yellowish pubescence of leaf. Exuviae yellowish brown, occupying about one third of the whole length of the test.

**Adult female.** Body of adult female spindle-shaped, distinctly lobed laterally and broadest at abdominal segment I or II, about 681-1275 long and 365-569 wide on slides.

**Pygidial margin (Plate 24, figs. D-F).** Large and more or less triangular, rounded and sclerotized on margin, about 179-231 long and 309-433 wide at base. Median lobes large, forming a very deep and wide notch at apex; the lobes narrow and long, greatly variable in shape (figs. B-F) and 23.4-37.1 long and 7.68-11.9 wide; distinctly serrated on inner margins, with about 8-12, or sometimes as many as 18 serrations; zygotis at base of the lobes short and stout. Second pair of lobes well-

Plate 24 - *Ctenosoma glaucum* Cresson  
Terminal lobes of different forms



**Plate 24. - *Chionaspis platani* Cooley,  
 median lobes of different forms**

developed and bilobed; inner lobule broad, as long as median lobe or extending beyond the apex of median lobes; outer lobule much reduced. Third pair of lobes with inner lobule usually well-developed and nearly subequal to the outer lobule of second pair; outer lobule obscure or indistinct. Gland spines, setae and macroducts present.

### **Dorsal Surface**

**Macroducts (Plate 23, figs. D&E).** Two-barred, 5.85-17.3 long and 4.94-9.76 wide, arranged in submedian groups, sometimes on abdominal segment II, always on segments III-VI; in submarginal groups sometimes on II, always on III-V; and in marginal groups on III-VII on each side of the body. The number greatly variable. Submedian: very rarely 2-5 on II, or completely wanting on III, usually 4-8 on abdominal segment III, 4-10 on IV, 3-6 on V, and 1-4 on VI; submarginal: rarely several on II, the ones on II and III sometimes in 2-3 irregular rows; 2-14 on abdominal segment III, 3-8 on IV, 3-6 on V; marginal: 1 on III, 2 or rarely 3 on IV, 2 on each of V and VI, and only 1 on VII.

**Small macroducts (Plate 23, fig. F).** Two-barred, 3.90-7.81 long and 2.93-4.88 wide, clustered on marginal-submarginal areas of abdominal segments I-III, and thoracic segments of each side of the body as follows: 3-6 or absent on prothorax, 4-9 on mesothorax, 5-10 on metathorax, 6-15 on abdominal segment I, 5-12 on II, 2-5 on III.

**Microducts (Plate 23, fig. G):** One-barred, 7.41-9.88 long and 1.96-2.47 wide at orifice, scattered on cephalic region, more numerous near anterior spiracles on area of promosa, thoracic and abdominal segments of submarginal and submedian areas of each half of body. The number remarkably variable from specimen to specimen. Usually 8-20 on cephalic region, 7-15 on each of mesothorax and metathorax, 2-5 on each of abdominal segments I-III, few on IV and V, and 7-14 on pygidial area. Sometimes 4-5 occupying the position of macroducts of submedian area on abdominal segment II.

**Anal area.** Anal opening rounded, located on the basal half of pygidium, and 9.88-14.8 in diameter; distance from anterior edge of anus to mid-point of line between abdominal segments V and VI, 49.4-86.5; distance from the posterior edge of anus to base of median lobes, 91.3-111.

**Setae (Plate 23, fig. H).** Few slender or hair-like setae, scattered along margins and on cephalic region, variable in length, 4.94 to 17.3; 1 or 2 very short hair-like setae, 3.71-7.41 long, on each margin of thoracic segments; and 1 or 2 longer and stouter setae on each margin of abdominal segments IV-VI and laterad of median, second and third pairs of pygidial lobes, 7.48-12.35 long.

#### **Ventral Surface**

**Antennae (Plate 23, fig. I).** Reduced into small sclerotized tubercles, 5.85-7.81 long and 4.88-8.78 wide at base, with 1 slender usually curved fleshy seta, 7.80-14.6 long; distance between antennal bases 44.5-109.

**Clypeolabral shield.** Length 116-135 and width 93.9-114; shape typical of the genus.

**Labium.** Length 37.1-49.4 and width 44.5-61.8; cup-shaped.

**Spiracles.** Anterior (Plate 23, fig. J), 20.3-26.4 long and atrium 8.6-10.4 wide, with 0-8 associated trilocular pores (Plate 23, fig. K), each pore 2.14-2.56 in diameter. Posterior spiracles nearly same shape as anterior ones and slightly smaller, 19.5-23.5 long, with 0-3 associated trilocular pores. The pores in this form are separated from each other, therefore, they are very easily counted and measured.

**Gland spines (Plate 23 , fig. L).** Well-developed, 9.88-24.7 long, arranged in marginal groups on abdominal segments IV-VII, as well as laterad of median lobes on each side of body; numbers on each margin as follows: III, 2-4; IV, 2-5; V, 1, or rarely 2; VI, 1 or 2; VII, 1; and lateral of median lobes, 1 only.

**Gland tubercles (Plate 24, figs. M & N).** Short, spine-like, clustered on sub-marginal areas of abdominal segments II and III; basally conical and distally

spine-like ones on abdominal segment I and thoracic segments of each side of the body, 7.41-12.4 long and 3.70-4.94 wide at base; numbers arranged as follows: and 1-3, or sometimes absent, on basal two thoracic segments; and occasionally several near the anterior spiracles; 1-3, or rarely 0, on metathorax and abdominal segment I; 1-5, or rarely 0 on II; 2-4 on III;

**Small macroducts (Plate 23, fig. O).** Two-barred, same size and arranged on same segments as ones on dorsal surface only slightly fewer.

**Microducts (Plate 23, fig. P).** One-barred, similar in shape and size to ones on dorsal surface, scattered irregularly on cephalic region, thoracic segments and abdominal segments on each side of body; numbers vary greatly from individual to individual; usually more numerous than those on dorsal surface; 12-25 on cephalic region, 5-14 on each of thoracic segments, 3-8 on each of abdominal segments I-III, very few or absent on IV-V, and on pygidial area as well.

**Setae (Plate 23, fig. H).** Very few, short, slender hair-like, along inner margins of cephalic region, 1 or rarely 2 on each margin from thoracic segments to abdominal segments; the ones on basal segments nearly the same length as those on dorsal surface, but the ones on abdominal segments IV-VII and laterad of median lobes much shorter than those on the same position on dorsal surface.

**Vulvar area.** Vulvar opening situated about middle of pygidium; perivulvar pore (Plate 23, fig. Q) groups: median, 4-15; anteriolateral, 11-20; posteriolateral, 9-16; each pore 4.76-4.98 in diameter.

**Type material studied.** Holotypes from *Platanus occidentalis*, IN, Indianapolis, Aug. 2, 1961, coll. MK, 1(4) VPI. Cotypes from *Platanus* sp., KS, Riley Co., coll. P.J. Parrott, 2(7) USNM?; Riley Co., coll. Cooley, #212, 1(1) USNM?; Riley Co., coll. Ckll., #001, 1(1) USNM?; Riley Co., coll. R. Cooley, 1(3) BM.

**Material studied.** *Platanus occidentalis*, IN, Indianapolis, Marion Co., July 9, 1964, coll. MK, 3(3) CDA; LA, Sibley, June 28, 1971, coll. FWH 3(3) FSCA; Marksville, June 8, 1971, coll. FWH, 3(5) FDA; Lebeau, June 8, 1971, coll. FWH, 11(20) FDA; Near Effie, July 7, 1870, coll. FWH, 1(2) VPI; New Orleans, June 2, 1925, coll. H.K. Plank, A.#24816, 1(2) VPI; MO, St. Louis, (road side), Mar. 25, 1961, coll. MK, MO 105, 1(2) VPI; NC, Townsend in the Smokies, July 5, 1968, coll. unknown, NC 48, 1(1) VPI; OH, Newark, Jan. 4, 1903, coll. JGS, O 1461, 2(8) VPI; Newark, Rec'd Apr. 13, 1904, coll. JGS, 1(3) USNM; TX, Cuero, June 5, 1898, coll. Ckll, 10244, 1(2) U; VA, Presquile Wildlife near Hopewell, April 22, 1972, coll. MK, VA 1047, 2(6) VPI; Res. Station, Steeles Tavern, Apr. 17, 1980, coll. MK, VA 1560, 1(4) VPI; Chesapeake, Feb. 15, 1966, coll. J. Pierce, VA 324, 1(4) VPI. *Platanus* sp.,

IN, Indianapolis, July 10, 1913, coll. C.H.B., 4(6) USNM; Indianapolis, Aug. 9, 1913, coll. Morrison and Dietz, Cooley coll. 77, 1(8) USNM; TX, Sherman, T-788, 2(4) UCD; San Marcos, Aug. 17, 1979, coll. D.R. Riley, 1(6) UCD; Athens, T-829, 1(1) UCD; Palestine, Aug. 15, 1918, T-614, 2(4) UCD; Palestine, T-784, 1(2) UCD; Denison, T-779, 2(2) UCD; Denison, T-821A, 2(4) UCD; Ft. Worth Ag. College, Aug. 14, 1918, coll. R.B. Pitts, T500, 2(2) UCD; Ft. Worth, T-832, 1(1) UCD; Between Edna and Wharton, 1921, coll. GFF, T-250, 2(2) UCD; Sherman, T-798, 1(2) UCD; Dallas, Aug. 16, 1908, coll. W.A. Hookes, 8919, 1(3) USNM; 40 Miles fr. Uralde, July 19, 1923, coll. ERS, 1(5) USNM; VA, 2145 Thrasher Rd., Greenbriar Farms Inc., Chesapeake Co., Feb. 14, 1969, coll. J.M. Pierce, VA 659, 2(5) VPI; Presquile Island, N.W. Refuge, Apr. 22, 1972, coll. J. Davidson, 2(2) VPI; Presquile Island, Apr. 22, 1972, coll. S. Nakahara, NV-184, 1(3) USNM; Chesterfield Co., Midlothian, Jan. 18, 1979, coll. Robert Bailey, VA 1476, 1(1) VPI; Chesapeake, Feb. 15, 1966, coll. J.M. Pierce, C133, 1(3) VPI; MEXICO, Monterey, Nuevo Leon., June 14, 1960, coll. S.W. Brown and Nelson-Rees; M-III-5, 5(10) UCD; Laredo, June 21, 1974, coll. W.R. Walton, 47-2128, 1(2) USNM; Eagle Pass, Oct. 27, 1940, coll. C.M. Locke, 4794, 1(4) USNM; Monterey, June 19, 1960, coll. S.W. Brown and Nelson-Rees, M-III-5, 1(2) CDA. Host Unknown, MD, Baltimore, June 22, 1958, MD 11, 1(4) VPI.

**Host and distribution.** The two different forms associated with the feeding sites used to be treated as separate species. The leaf-form was originally collected

and described from sycamore, *Platanus sp.*, in Riley Co., KS, while the bark form was collected from the same host in Columbia, MO. It has so far been recorded only from hosts in the genus *Platanus*. It has a distribution in the southern, central, and eastern United States including: ID, KS, LA, MD, MO, NC, OH, TX, and VA.

**Affinities and discussion.** The leaf-form of this species is similar in morphological characters to the leaf-form of *C. gleditsiae*, but the combination of the dorsal submedian macroducts present on abdominal segments III-VI, although sometimes absent on VI, and usually more than 4 macroducts on each segment, can be used to distinguish *C. platani* from the latter.

The bark-form closely resembles *C. acericola*; but in *C. platani* gland tubercles occur on thoracic segments, at least 1-2 on metathorax or mesothorax, while in the latter species these gland tubercles are absent on thoracic segments. Also the zygotis at the base of the median lobes is elongate in *C. acericola*, whereas in *C. platani* the zygotis is short and stout. Another good character is that there are usually 1-2 dorsal submedian macroducts are on abdominal segment VI in *C. platani*.

Since the study on dimorphism by Takagi and Kawai (1967), and their designation of *Phenacaspis* as the synonym of *Chionaspis*, the name for this species has been accepted as *platani*, which was used by Cooley (1899) to describe specimens from the leaves of *Platanus*. The name *C. parkii* is considered a junior synonym.

The accompanying illustrations are chiefly based on the following specimens:

Plate 23. Collected from bark of *Platanus* sp. on Presquile Island

National Wildlife Refuge, Virginia, IV-22-1972 by J. Davidson.

Plate 24. Fig. A. Same data as Plate 1;

Fig. B. Cotype of leaf form, collected on *Platanus* sp. leaf from Riley Co., KA, by P. J. Parrott, 1899 or earlier;

Fig. C. Collected on *Platanus* sp. from Texas, date and collector unknown;

Fig. D. Collected on *Platanus occidentalis* leaf from Indianapolis, IN, VIII-1-1961 by MK;

Fig. E. Collected on *Platanus* sp. leaf from Monterey, Mexico, VI-14-1960 by S. W. Brown and Nelson-Rees;

Fig. F. Collected on *Platanus occidentalis* leaf from Sibley, Louisiana, VI-28-1971 by F. W. Howard.

*Chionaspis salicisnigrae* (Walsh)

Plates 25, 26

**Suggested common name:** Black willow scurfy scale

**Literature and synonymy.** *Aspidiotus salicis-nigrae* - Walsh, 1868: 40, Ferris, 1937: SI-24; 1941:48.

*Mytilaspis salicis* - LeBaron, 1871: 140; 1872: 140, Forbes, 1891: 23.

*Diaspis salicicorticis* - Bessey, 1874: 244.

*Chionaspis salicis* - Comstock, 1881: 320; Osborn, 1882: 214; Comstock, 1883: 106; 1888: 151; Pack, 1890: 593. Lugger, 1895: 224; Osborn, 1898a: 224; 1898b:4.

*Chionaspis salicis-nigrae* - Cockerell, 1894: 107; Cooley, 1899: 19; Hunter, 1900: 101; Gilleta and Baker, 1895: 129; Sanders, 1904: 49; Hartman, 1916: 102; Lawson, 1917: 269; Britton, 1928: 365; Hollinger, 1923: 27; Essig, 1928: 78; Ferris, 1937: SI-24;1941: 48; 1942: SIV-446; Lindinger, 1949: 211; Borchsenius, 1950: 236; Balachowsky, 322, 348; Lindinger, 1958: 366; Borchsenius, 1963: 185, 226; Kosztarab, 1963: 75; Dekle, 1965: 10, 38; Takagi and Kawai, 1967: 30, 38; Danzig, 1970: 1018; Bazarov and Shmelev, 1971: 122; McDaniel, 1971: 291; Kawai, 1972: 38; Borchsenius, 1973: 186, 226; Nakahara, 1975: 202; Danzig, 1980: 311; Kawai, 1980: 290, 291; Chou, 1981:

84; Nakahara, 1982: 20; Howard and Oliver, 1985: 52; Takagi, 1985: 42; Tang, 1986: 249.

*Chionaspis ortholobis bruneri* - Cockerell, 1898: 133.

**Test of adult female (Plate 25, fig. A).** Oystershell-shaped, or moderately elongated; large, about 2.6-4.0 mm; often enlarged conspicuously, becoming broadest near middle; strongly convex and firm in texture; white to dirty white; exuviae terminal, usually light brown or yellowish brown, sometimes almost colorless, occupying about one third to one fourth of total length of test. Ventral test relatively heavy, white, remaining attached to dorsal test in some specimens.

#### GENERAL DESCRIPTION

**Plate 25, figs. B-Q, unless stated otherwise**

Body of adult female (fig. B) spindle-shaped, broadest at metathorax or abdominal segment I; large, 931-1490 long and 500-892 wide; lobed laterally and widened posteriorly; derm membranous except for sclerotized pygidial margin.

**Pygidial margin (fig. C).** Very broad, more or less triangular; about 201-279 long and 402-569 wide at base. Median lobes large, well-developed; large and broad, about 19.7-27.7 long and 13.8-17.8 wide; rounded apically; mesal

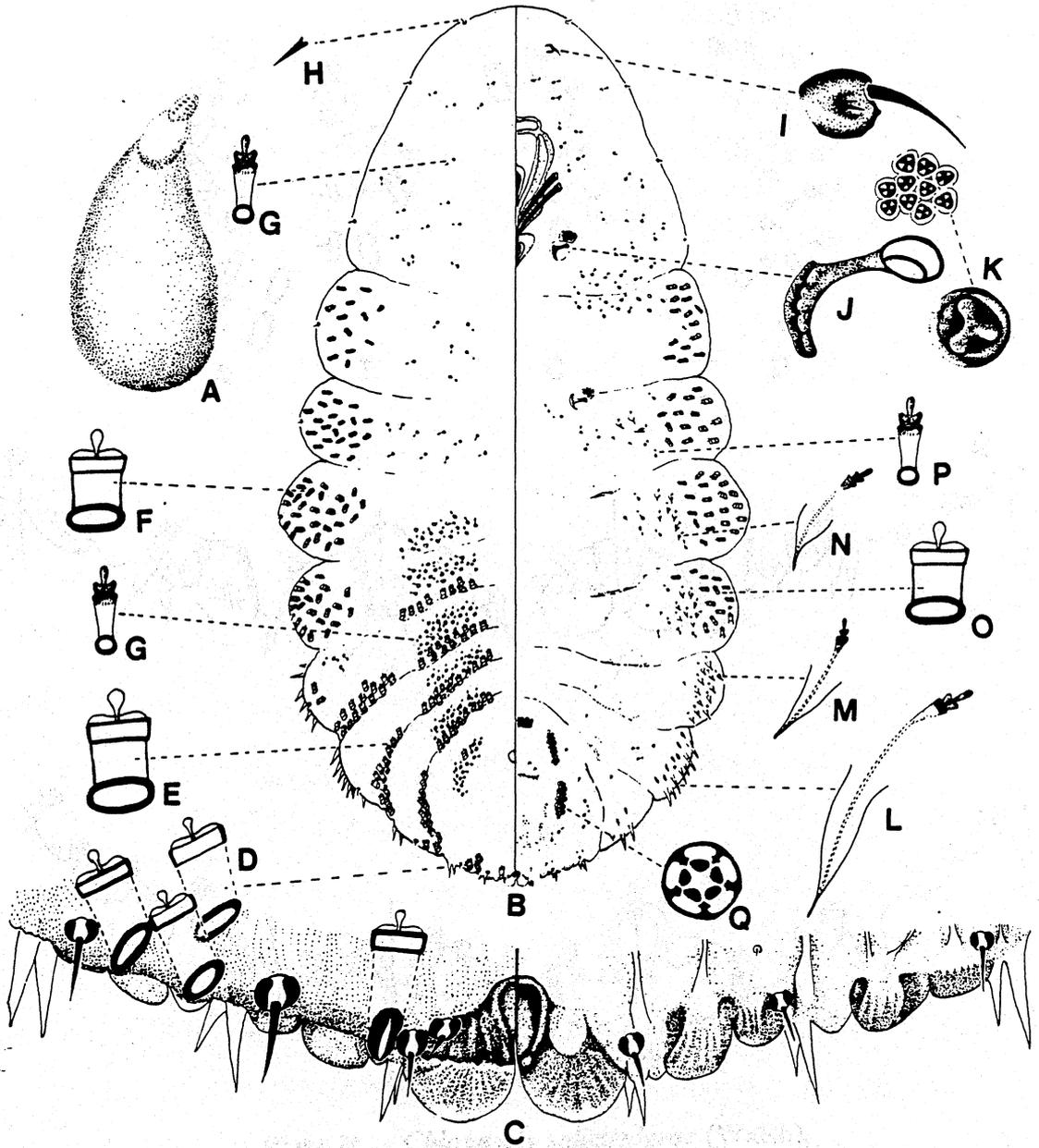


Plate 25. - *Chionaspis salicisnigrae* (Walsh)

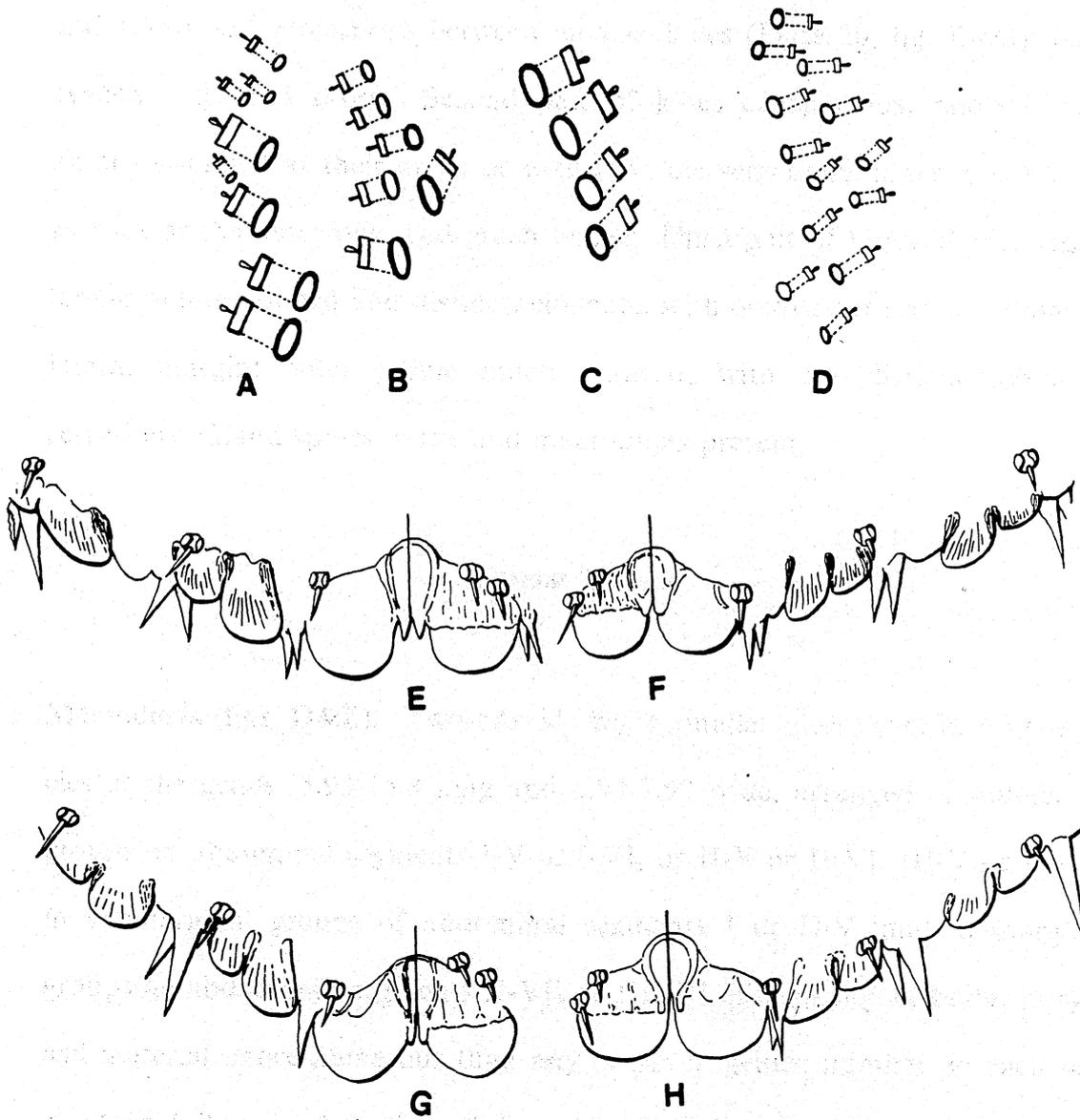


Plate 26. - *Chionaspis salicisnigrae* (Walsh),  
 variation of main characters

margins sometimes with several fine serrations; lobes closely united together or separated from each other at their base, if separated, 2 distinct tooth-like and sclerotized projections between median lobes (Plate 26, fig. E&G); basal zygotis wide and short. Second pair of lobes conspicuous, bilobed, both lobules rounded at their apex, or with few fine serrations; inner lobule twice as wide as the outer one, and much longer. Third pair of lobes bilobed, inner lobule well-developed and distinct, elongate, with or without fine serrations on lateral margin; outer lobule much reduced, with 3-5 distinct tooth-like serrations. Gland spines, setae and macroducts present.

#### **Dorsal Surface**

**Macroducts (figs. D&E).** Two-barred, much smaller than those in other species of the genus, 5.93-15.8 long and 4.94-7.90 wide, arranged in submedian groups on abdominal segments I-V or I-VI, or II-V or II-VI, III-V or III-VI, in submarginal groups of abdominal segments I or II-V, and in marginal groups on abdominal segments II-VII or III-VII of each side of body; in typical material, more numerous than any others in genus; number on each segment as follows: submedian: 0-6 on abdominal segment I, 9-24 or rarely lacking on II, 3-21 on III, 5-17 on IV, 6-11 on V, and 1-6 or sometimes absent on VI; submarginal: 5-24 on II, 10-21 on III, 7-16 on IV, and 5-13 on V; marginal: 0-1 on II, 1 or 2 on III, 2-3 on IV, V and VI, respectively, and only 1 on VII.

**Small macroducts (fig. F).** Two-barred, very small, 3.95-11.9 long and 3.95-5.93 wide, clustered on marginal-submarginal area of abdominal segments I-III and thoracic segments on each side of body; number greatly variable, usually 0-3 on prothorax, 5-18 on mesothorax, 8-23 on metathorax, 9-27 on abdominal segment I, 8-18 on II, 5-26 on III.

**Microducts (fig. G).** One-barred, 5.93-11.9 long and 1.97-2.96 wide at orifice, scattered on cephalic region and thoracic segments, and clustered regularly on submedian and submarginal areas of abdominal segments I-V or VI of each side of body; sometimes only very few or wanting on submedian areas; number arranged as follows: on submedian area, 6-27 or rarely wanting on abdominal segment I; 6-27 on II, 13-38 or rarely 1-2 on III, 7-29 or rarely 0-1 on IV, 3-27 or rarely absent on V, 3-18 or sometimes completely lacking on VI; in some specimens, 5-16 present on submarginal areas of abdominal segments I-III.

**Setae (fig. H).** Very short and hair-like, or slender, 3.95-15.8 long, scattered on and along margin or submargin of cephalic region, margins of thoracic and abdominal segments I-VII and laterad of median lobes of each half of body; usually 5-7 on cephalic region, 1 or 2 on each margin of thoracic segments and abdominal segments I-IV; 1 or 2 on each margin of abdominal segment V-VII and laterad of median lobes, slightly longer and stouter, 5.93-19.8 long.

**Anal area.** Anal opening circular, 11.9-19.6 in diameter, located about basal two thirds of pygidium; distance from anterior margin of anus to mid-point of line between abdominal segments V and VI, 65.2-103; distance from posterior margin of anus to base of median lobes, 101-162.

### Ventral Surface

**Antennae (fig. I).** Reduced into small tubercles, about 4.69-9.88 long and 5.93-11.9 wide at base, each with 1 large and fleshy seta, 16.8-23.7 long, and with 2 very short and stout terminal sensory setae, only 1.56-5.92 long; in very few specimens, each antenna also with 2 slender setae, slightly shorter than large one. Distance between antennal bases, 69.2-113.

**Clypeolabral Shield.** Shape typical of the genus; length, 105-188; width, 86.9-128.

**Labium.** Cup- or shield-shaped; length, 35.6-59.3; width, 49.4-59.3.

**Spiracles (fig. J).** Very long and narrow bar supporting opening of thoracic spiracles; anterior spiracles (fig J), 25.4-31.6 long and atrium 8.6-11.4 wide, each with 8-18 associated trilocular pores (fig. K), each pore 2.41-3.23 in diameter; posterior spiracles very similar in shape to the anterior ones, but

slightly smaller, 20.0-29.6 long, each with 2-8 associated trilocular pores, or rarely absent.

**Gland spines (fig. L).** Very well-developed, more numerous than in any others of the genus; 9.70-19.8 long, marginally arranged on abdominal segments IV-VII and laterad of median lobes of each side of body; usually 5-10 on abdominal segment IV, 2 or rarely 3 or 1 on V, 2 on each of VI, VII, and laterad of median lobes.

**Gland tubercles (figs. M&N).** Submarginal, spine-like or basally conical and distally spine-like, 5.93-17.8 long and 2.34-3.91 wide at base, clustered on thoracic segments and abdominal segments I-III, on each half of body; more numerous than those of any other species of genus, often absent or rarely 2-3 on prothorax, and almost always wanting on mesothorax, 1-9 on metathorax, 1-8 on abdominal segment I, 5-16 on II, usually 8-19 on III.

**Small macroducts (fig O).** With same shape, size and distribution as those on dorsal surface; number on each segment of each side of body as follows: 1-4 on prothorax, 5-18 on mesothorax, 3-16 on metathorax, 6-15 on abdominal segment I, 3-9 on II, and 0-2 on III.

**Microducts (fig. P).** Same size as those on dorsal surface, or smaller, scattered on cephalic region, thoracic and prepygidial segments of each half of body;

10-35 on cephalic region, 5-15 on each of thoracic segments, 5-12 on each of abdominal segments I-V, and on pygidium.

**Setae (fig. H).** Very short and hair-like, on cephalic area, margins of thoracic segments and abdominal segments I-IV, and slightly longer and stouter ones on margins of abdominal segments V-VII and laterad of median lobes, with same size and distribution as those on dorsal surface; number as arranged below: 5-8 on cephalic area, 1 or 2 on each margin of thoracic segments and abdominal segments I-VII, and laterad of median lobes.

**Vulvar area.** Vulvar opening situated about middle of pygidium; perivulvar pores (fig. Q), number in each group as follows: median, 21-32; anterolateral, 24-48; posterolateral, 16-35; each pore 3.12-5.47 in diameter.

**Diagnostic Characters.** Compared with other closely related species in the genus, this species has the following distinctive characters which are very easily used for general identification: (1) all dorsal macroducts are much smaller than those of other species; (2) dorsal ducts including macroducts, small macroducts and microducts on abdominal segments I-VI, and gland spines and gland tubercles are much more numerous than those of any other species in the genus.

Because of the extreme variation in the morphological characters, many authors prepared long and detailed descriptions, but no description includes

all morphological variations of characters, therefore, it is very difficult to use a key or a description to identify specimens correctly. The selected characters listed below, I believe, are the most important characters for identifying specimens. In the material studied from North America, 10 combinations of these characters appeared which are shown in Table 1. Specimens collected from the same colony may show different combinations of characters.

(1) Among the total submedian dorsal ducts on abdominal segments II or III-V, one-half are microducts, and the other half are macroducts;

(2) Submedian dorsal ducts on abdominal segments III-V are composed of only macroducts, but in a few specimens there are 1-5 microducts on some segments;

(3) Submedian dorsal ducts on abdominal segments II-V or III-V are composed of more macroducts than microducts;

(4) Only microducts are on dorsal submedian area of abdominal segment VI;

(5) Only macroducts are on dorsal submedian area of abdominal segment VI;

(6) Both micro- and macroducts are on dorsal submedian area of abdominal segment VI;

(7) With 2 distinctly tooth-like and well-sclerotized projections between median lobes;

(8) Without the 2 tooth-like projections as described above;

(9) One to 4 dorsal submarginal macroducts on abdominal segment VI;

(10) Without dorsal submarginal macroducts on abdominal segment VI.

Specimens collected from the same colony may belong to different combinations. When more material is examined, other combinations may be found.

**Material studied.** *Fraxinus americana*, OH, Hocking Co.,

May 19, 1960, coll. MK & DMD, 1(6) VPI. *Populus canadensis*, IN, Flagstaff, April 10, 1912, coll. unknown, 1(3) USNM. *Populus deltoides*, OH, Resthaven Wildlife Area in Castalia, Sept. 2, 1960, coll. MK, 1(2) VPI; WI, Madison, Dec. 13, 1913, coll. N. F. Howard, 1(5) USNM (apparently from F. M. Trimble); at Washington, Jan. 19, 1960, coll. F. T. Kenworthy, 1(3) USNM. *Populus grandidentata*, OH, Hocking Co., May 20, 1961, coll. MK, 1(2) VPI. *Populus jackii*, AZ, Flagstaff, Sept. 24, 1936, coll. R. B. Streets, 4(49) UCD. *Populus tremuloides*, IA, Ames, date unknown, coll. R. L. Webster, 1(4) USNM; OH, Lucas Co, July 9, 1961, coll. MK, 2(5) VPI; Wooster, March 1914, coll. J. S. Houser, 1(3) VPI; PA, Laceyville, date unknown, coll. unknown, 3(14) UCD; WI, Madison, Jan. 1909, coll. H. C. Severin, 2(7) USNM. *Populus* sp., AZ, Flagstaff, 1(3) UCD; IL, Chicago, Dec. 10, 1906, coll. W. L. De Wolf, 2(8) USNM; MA, Malden, date unknown, coll. unknown, 1(3), USNM; MN, St. Paul, date unknown, coll. Pettit, 3(6) UCD; St. Anthony Park, Jan. 2, 1903, coll. A. G. Ruggles, 1(8) USNM; St. Anthony Park, date unknown, coll. O. Lugger, 1(7) USNM; ND, Carrington, April 18, 1922, coll. R. L. Webster, 1(3) USNM; NE, Lincoln, date unknown,

**Table 1. Combinations of Main Characters of Adult Females of *Chionaspis salicisnigrae* (Walsh) in North America.**

Combinations of Characters	Characters Described Above									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
I	+			+				+	+	
II	+			+				+		+
III		+		+				+	+	
IV		+			+		+		+	
V	+				+		+		+	
VI	+				+		+			+
VII	+					+	+		+	
VIII	+			+			+		+	
IX		+	+				+		+	
X		+	+					+	+	

coll. Burner, 1(4) UCD; Lincoln, date unknown, coll. E. M. Ehrhorn, 1(2) UCD; NY, Catskill, May 18, 1948, coll. J. A. Naegele, 1(6) USNM; Oshokan, Sept., 1917, coll. L. D. Howard, 1(7) USNM; Lobas Co., Nov. 22, 1903, coll. A. E. Rouland, 1(5) USNM; OH, Leetonia, Oct. 21, 1912, coll. H. G. Wolfgang, 1(3) USNM; Sugar Grove, June 10, 1917, coll. RRL, 2(9) USNM; WY, June 26, 1939, coll. M. L. Wilson, 1(5) USNM. *Salix amygdaloides*, TX, Magenta, Oldam Co., Aug. 26, 1910, coll. C.R. Ball, 1(4) USNM. *Salix babylonica*, KS, Hutchinson, June 5, 1942, coll. E.L. Todd, 1(5) USNM; VA, Williamsburg, June 25, 1965, coll. D.P. Innes, 3(12) VPI. *Salix brachycarpa*, ID, Basinger, Sep. 15, 1938, coll. J.H. Christ, 1(5) USNM. *Salix exigua*, DC (fr. NM), Apr. 6, 1942, coll. H.Y. Gouldman, 1(1) USNM. *Salix interior* var. *pedicellata*, NE, E of Maxwell, Lincoln Co., May 29, 1945, coll. W. Kiener, 1(7) USNM. *Salix interior* var. *wheeleri*, NE, Lincoln, June 4, 1945, coll. W. Kiener, 1(5) USNM. *Salix laevigata*, SD, Olivet, Let. Nov. 25, 1903, coll. S.M. Daboll, 1(6) USNM. *Salix lasiolepis*, CA, Ventura, Aug. 14, 1933, coll. unknown, 1(3) CDA. *Salix nigra*, AL, Jackson Co., 4.2 mi. E Scottsboro, July 31, 1977, coll. F.W. Eiland II, 16(21) AU; AR, Green Co., July 28, 1973, coll. MLW & W. Bomer, 5(5) AU; AZ, Santa Cruz County, San Rafael Ranch, May 14, 1933, coll. C.T. Vorhies, 4(43) UCD; IN, Winamac, Sep. 15, 1919, coll. C.C. Dean, 1(3) USNM; MO, Patton, Oct. 20, 1976, coll. L. Henning, 2(7) USNM; OK, Blaine Co., May 3, 1958, coll. A. Apt, 1(4) USNM; TX, Austin, Apr. 21, 1919, coll. unknown, 4(9) UCD; Austin, Feb. 17, 1919, coll. unknown, 1(3) UCD. *Salix* sp., AL, Morgan Co., date unknown, coll. K.

Morris, 2(2) UGAES; **AR**, near Hot Springs, Oct. 1, 1977, coll. G.W. Dekle, 3(3) FSCA; **AZ**, Nogales, Oct. 14, 1946, coll. Peltier & Callaghan, 1(3) USNM; **CO**, Summer 1901, coll. A.N. Caudell, 1(2) USNM; Fort Collins, Let. Jan. 30, 1926, fr. G.S.Langford, 1(3) USNM; Boulder, Jan. 23, 1929, coll. E.D. Bueker, 1(1) BM; Fort Collins, Nov. 1925, coll. G.S. Langford & TDAC, 2(11) BM; Denver, March, 1933, E. Bethel, 1(2) UCD; Nueses River, Uvalda Co., Mar. 1, 1918, coll. H.B. Parks, 5(6) UCD; Sherman, Apr. 1918, coll. unknown, 1(2) UCD; Sherman, Apr. 28, 1918, coll. unknown, 2(4) UCD; **IL**, Washington Park, Chicago, Nov. 6, 1907, coll. Hodgkiss, 1(2) FSCA; Chicago, April 21, 1913, coll. J. Wolff, 1(3) USNM; **IN**, Hammond, date unknown, coll. H. F. Dietz, 3(6) UCD; Hammond, Nov. 5, 1912, coll. E. S. Tillman, 1(5) USNM; Porter Co., Nov., 1973, coll. B. Cummings, 3(14) CDFA; Valparaiso, Nov., 1973, coll. B. Cummings, 2(2) CDFA; Lafayette, March 26, 1910, coll. P. Webster, 1(2) USNM; **LA**, New Orleans, March 12, 1919, coll. B. R. Sasscer, 1(3) USNM; New Orleans, March 28, 1911, coll. J. C. Barber, 1(2) USNM; Waggaman, Oct. 27, 1923, coll. H. K. Plank & T. F. Catchings, 2(8) USNM; Harvey, at New Orleans, March 12, 1934, coll. U. G. Haddon, 1(3) USNM; Algiers, April 13, 1945, coll. Rau, 1(5) USNM; Bertrandville, Feb. 15, 1944, coll. Plummer, 1(4) USNM; Destrahan, July 23, 1943, coll. Miller & Anderson, 1(5) USNM; Kerner, Apr. 18, 1944, coll. Plummer, 1(5) USNM; New Orleans, June 22, 1933. coll. Edwin Latt, 1(5) USNM; New Orleans, Sep. 25, 1933, coll. M.J. Kerr, 1(3) USNM; Waggaman, Oct. 27, 1923, coll. T.H. Jones & Bradley, 1(6) UCD; **MN**, St. Paul, Sep. 12,

1899, coll. W. Shaw, Let. fr. A. I. Quaintance, 1(7) USNM; **MO**, 1941, coll. I.A. Denning, 1(4) USNM; Columbia, Let. Apr. 20, 1912, coll. L. Haleman, 1(3) USNM; **MS**, Agric. College, May 24, 1908, coll. unknown, 1(2) USNM; 1935, coll. unknown, 1(4) USNM; West Point, Aug. 2, 1930, coll. E.E. Byrd, 4(18) UCD; **NC**, 1936, coll. unknown, 1(3) USNM; Wilmington, Dec. 22, 1943, coll. G. Plummer, 1(1) USNM; **ND**, Fargo, Let. Oct. 18, 1927, coll. V. Lindgren, 1(3) USNM; **NE**, Mumper, Dec. 21, 1935, fr. A.C. Elmer, 1(3) USNM; Alliance, Let. Apr. 4, 1917, coll. Mrs. A. Freshla, 1(5) USNM; **NM**, Valencia, Sep. 6, 1963, coll. D.C. Heininger, 3(11) CDA; Roswell, July 1913, coll. A.G. Hammar, 1(4) USNM; **OH**, Vinton, June 10, 1900, coll. J.S. Hine, 1(14) USNM; Cleveland, Let. Dec. 1, 1933, coll. A.W. Gardiner, 1(3) USNM; Xenia, Feb. 14, 1913 coll. J.G. Sanders, 1(4) USNM; Columbus, Nov. 28, 1916, coll. PRL, 1(3) USNM; Columbus, May 10, 1903, coll. JGS, 1(6) BM; Columbus, Oct. 13, 1919, coll. PRL, 1(4) USNM; Columbus, date and coll. unknown, 1(5) USNM; Columbus, May 10, 1903, coll. JGS, 1(5) USNM; Castalia, Resthaven Wildlife Area, Sep. 2, 1960, coll. MK, 1(2) VPI; Conkles Hollow, May 19, 1960, coll. MK, 1(4) VPI; Crane Hollow, Hocking Co., Apr. 16, 1960, coll. P Freytag & MK, 1(4) VPI; **OK**, Oklahoma City, Nov. 25, 1950, 1(5) USNM; **SD**, Sioux Falls, let. Apr. 10, 1908, coll. R. Matheson, 1(2) USNM; **VA**, Williamsburg, June 25, 1965, coll. D.P. Innes, 2(5) VPI; **WI**, Madison, May 5, 1913, coll. JGS, 1(3) USNM; **WY**, Laramie, July 27, 1979, coll. E.W. Spackman, 1(1) USNM; Location, date and coll. unknown, 4(8)

USNM; March 15, 1902, coll. Phillips, 1(2) VPI; MEXICO, Nov. 25, 1931, coll. A. L. Williamson, 1(3) USNM.

**Host and distribution.** This species was originally described from *Salix nigra* in IL. So far as known, it has been collected from several species of the family of Salicaceae, including: *Populus canadensis*, *P. deltoidea*, *P. grandidentata*, *P. jackii*, *P. tremuloides*, *Populus* sp., and *Salix amygdaloides*, *S. babylonica*, *S. brachycarpa*, *S. exigua*, *S. interior*, *S. laevigata*, *S. lasiolepis*, *S. nigra*, and *Salix* sp.. It has also been recorded on *Fraxinus americana*, also *Cornus* spp. and *Ceanothus* spp., but specimens collected from these latter two hosts from several localities which were examined in the present study are thought to have been misidentified.

It has a very wide distribution in the United States including: AL, AR, AZ, CA, CO, DC, FL, IA, ID, IL, IN, KS, LA, MA, MN, MO, MS, ND, NE, NC, NM, NY, OH, OK, SD, TX, VA, WI, and WY. It has also been collected from Canada and Mexico.

**Affinities and discussion.** Several species in Europe and Asia, *C. polypora*, *C. salicis*, *C. micropori* and *C. montana*, are very closely related to this species. As described by Tang (1986), this species differs from *C. polypora* in having dorsal macroducts on the submarginal area and microducts on the submedian area of abdominal segment I. It differs from *C. micropori* and *C. montana* by having both macroducts and microducts on the dorsal surface, while *C.*

*micropori* only has very small ducts on the dorsal surface, and *C. montana* only has microducts on the submedian areas of prepygidial segments. It is also distinguishable from *C. salicis* in having both macroducts and microducts on abdominal segment V, whereas in the latter species, only macroducts are present on submedian area of abdominal segment V, but in the material studied from North America, only macroducts are present on dorsal submedian area of abdominal segment V.

In North America, three species, *C. ortholobis*, *C. longiloba*, and *C. lintneri*, are somewhat similar in morphological characters to this species. By aid of the description and the paragraph of diagnostic characters above, they can be identified from each other without much difficulty.

As early as 1867, Walsh designated this species as *Aspidiotus salicis-nigrae*, but the short description is not satisfactory for species identification at present. Comstock (1880) considered it identical with the European and Asian species, *C. salicis*. It was Cooley who undertook a comprehensive study of it without the type materials of Walsh's. After a lengthy study, he discarded the preoccupied name, *Mytilaspis salicis*, used by Le Baron (1871). He clarified the difference between this species and *C. salicis*, and also compared it with several other closely related species in North America. He concluded that this is a native species of North America, and is separate from *C. salicis*. He also mentioned the morphological characters that separated it from *C. corni*, *C. lintneri*, *C. longiloba*, and *C. ortholobis*. Although some of his conclusions are not acceptable today, his contribution is helpful to modern science.

An outstanding work by Danzig (1970) leads coccidologists to more controversy over the consideration of *C. micropori*, *C. montana*, *C. polypora*, and *C. salicisnigrae* as synonyms of *C. salicis* represented in Europe and the Far East. From the material she studied, she found that two forms are distinctly different in size and number of dorsal ducts on the pygidium in specimens from the opposite ends of its distribution; the amount of variability increases to two or three forms, as well as intermediates, in the specimens collected in the center of its distribution. She also found that these different forms, which were previously considered different species, can occur in the same scale insect colony. As a result, she concluded that the morphological diversities of these "species" are subject to individual, clinal, or seasonal variation.

In the present study, many specimens collected from hundreds of localities in more than 30 states of the United States as well as from Canada and Mexico have been carefully studied, and then compared with works undertaken in Europe and Asia, and with several closely related species in North America. On the basis of this comprehensive study, *C. salicisnigrae* is thought to be a separate species because both morphological characters and living habitats are distinctly distinguishable from its European and Asian relatives, and local relatives as well, even though a great variation of morphological characters have been found.

*Chionaspis sassceri* Cockerell and Robbins

Plate 27

**Suggested common name** Western scurfy scale

**Literature.** *Chionaspis sassceri* - Cockerell and Robbins, 1909: 105-107; Lindinger, 1914: 116; MacGillivray, 1921: 329; Essig, 1926: 310; Bodenheimer, 1930: 15; Ferris, 1937: SI-17 ( At least one published reference under the name of *Chionaspis etrusca* Leonardi exists, this being based upon an erroneous conclusion.); 1942: SIV-387; 1942: SIV- 446; Ebeling, 1959: 268; Takagi and Kawai, 1967:30, 38; Nakahara, 1975: 202; Gill, 1982: 11; Nakahara, 1982: 20; Takagi, 1985: 42.

**Test of female (fig. A).** Oystershell-shaped, white or dirty white, about 2.0 mm long and 0.8 mm wide; exuviae at one end, the first one light yellow, second light brown, occupying about one-third of total length of test. Ventral test white and very thin, developed very well along edge, when test is removed, it stays on surface of host.

**GENERAL DESCRIPTION**

Body of adult female (fig. B) spindle-shaped, margins laterally lobed, the posterior half much broader than anterior half; 678-1149 long and 398-675 wide.

**Pygidial margin (fig. C).** Triangular and very broad, 184-234 long and 345-475 wide at base; sclerotized apically. Median lobes large and conspicuous, smooth, semicircular; 18.5-26.3 long and 10.8-17.0 wide; separated completely to base and parallel at their basal half; the base yoked by a short and strong sclerotic zygotis and with very narrow separation. Second pair of lobes well-developed and obviously bilobed, inner lobule rounded at apex and as wide as half width of a median lobe; outer one much smaller than inner and pointed apically. Third pair of lobes poorly-developed, only inner lobule conspicuous, rounded; outer lobule reduced. Gland spines, setae and macroducts present.

### Dorsal Surface

**Macroducts (figs. D&E).** Two-barred, 7.4-13.6 long and 6.7-7.4 wide, arranged in submedian and submarginal groups along posterior edge of segments on abdominal segments II-VI, and in marginal groups on abdominal segments II-VII on each side of body; numbers vary from specimen to specimen, arranged as follows; submedian: II, 0-4; III, 4-14; IV, 5-11; V, 4-9 and VI, 1-7;

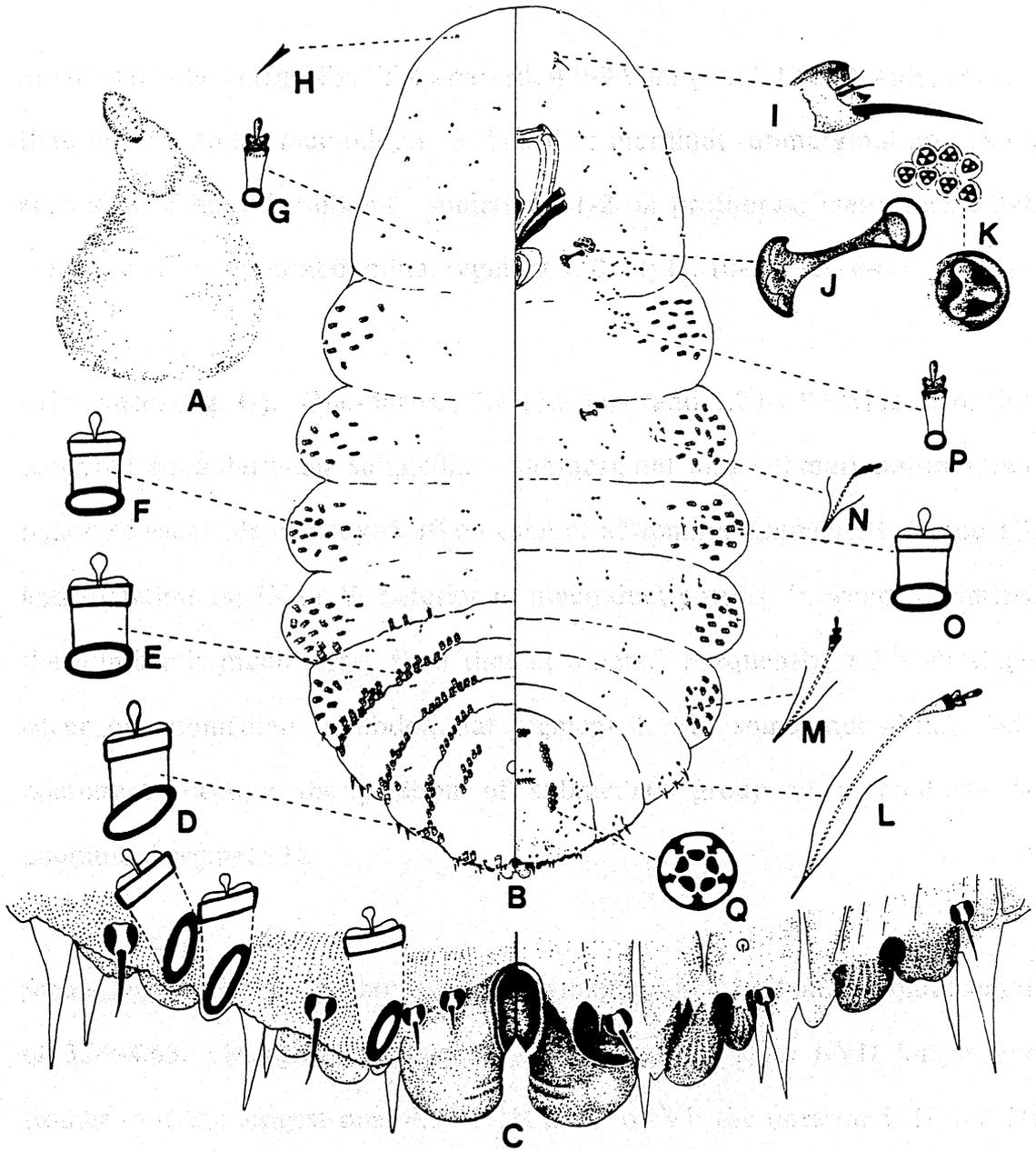


Plate 27. - *Chionaspis sassceri* Cockerell & Robbins

submarginal: II, 5-18; III, 9-15; IV, 6-19 and V4-9; marginal: II, 1-3; III, 1-3; IV, 1-2; V, 2; VI, 2 and VII, 1 only.

**Small macroducts (fig. F):** Two-barred, 4.9-9.9 long and 4.8-6.2 wide, smaller than normal dorsal macroducts; arranged in marginal-submarginal groups on each side of body as follows: sometimes 1-2 on prothorax; mesothorax, 0-9; metathorax, 0-10; on abdominal segment I, 0-14; II, 10-15; III, 6-8.

**Microducts (fig. G).** One-barred, 7.4-11.2 long and 1.24-1.92 wide at orifice, scattered irregularly on submedian, submarginal and submarginal-marginal region of each side of body; 5-10 on each of abdominal segments I, II and III, and sometime on IV or V, anterior to macroduct groups. In some specimens, the number is much larger than that of others. Frequently, 1-5 microducts occur on submedian of abdominal segment I. In some individuals, 3-12 microducts occupy the position of submedian group of macroducts on abdominal segment II.

**Setae (fig. H).** Few very short hair-like, along margins and on prosoma, length of 3.09-4.63. Marginal setae along abdominal segments I-VII longer and stouter, but the longest one, 4.94-7.41, on V or VI; the ones on I, II and III getting smaller anteriorly; usually the shortest ones on I and II; the ones on VI and VII shorter than those on V, but much longer than those on I-III.

**Anal area.** Anal opening circular, 7.72-13.9 in diameter, located at posterior of median group of perivulvar pores of venter. Distance from anterior edge of anus to mid-point of line between abdominal segments V and VI, 55.6-69.5; distance from the posterior margin to the base of the median lobes, 108-127.

### **Ventral Surface**

**Antennae (fig. I).** Sclerotized, reduced to a small tubercle, 6.18- 13.90 long and 5.86-12.72 wide at base; each antenna with 1 lateral fleshy seta, usually curved, 10.8- 21.6 long. Distance between two bases of antenna, 32.4-83.4.

**Clypeolabral shield.** Length, 116-164; width, 77.2-116.

**Labium.** Length, 35.5-49.4; width, 40.1-61.8; shield-shaped.

**Spiracles.** Anterior (fig. J), 20.8-26.3 long and atrium 8.1-10.4 wide, with 2-14 associated trilocular pores (fig. K) at each spiracle. Posterior resemble anterior in shape, but a little smaller, usually slightly stouter, 18.5-26.3 long, with 0-4 associated trilocular pores. It is usually very difficult to count the exact number of the associated trilocular pores.

**Gland spines (fig. L).** Marginal, 20.0-41.7 long, with an associated one-barred microduct on abdominal segments III-VII of each side of the body; Usually the

longest ones on IV, or sometime on V, 30.9- 41.7 long; number on III, 1-7; IV, 2-8; V, 1-3, most 2; VI, 1-2, most 2 and VII, 1-2. Frequently the gland spines on abdominal segment III are arranged submarginally.

**Gland tubercles (figs. M&N).** Distally spine-like, basally conical, 8.16-13.6 long and 4.89-7.71 wide at base, with an associated one-barred microduct, arranged in submarginal groups on thoracic segments and basal abdominal segments I and II: 0-10 on prothorax; 0-3 on mesothorax; 0-7 on metathorax; 0-4 on abdominal segment I, 2-7 on II.

**Small macroducts (fig. O).** Two-barred, smaller than dorsal macroducts, 4.94-9.93 long and 4.57-6.28 wide, scattered irregularly on two or three thoracic segments, and on submarginal and marginal region of abdominal segments I-III, numbers as follows: occasionally 1-4 on prothorax; mesothorax, 10-25; metathorax, 8-20; on abdominal segment I, 9-21; II, 5-21; on III, 3-11.

**Microducts (fig. P).** One-barred, 7.41-11.1 long and 1.42-2.09 wide orifice, scattered on cephalic region, thoracic and some abdominal segments; 5-10 on cephalic region, 6-16 on prothorax, 4-7 on mesothorax, 5-9 on metathorax, 5-11 on abdominal segment I, 4-7 on II, 0-8 on III, 0-9 on IV, 0-5 on V, and 5-7 on pygidium, of each side of body.

**Setae (fig. H).** Very small, hair-like, scattered on cephalic region, length 6.17-8.62. Very few setae also scattered irregularly on entire ventral surface of body. Marginal setae, little stouter and longer, on abdominal segments III-VII, some of them lateral of lobes of pygidial margin.

**Vulvar area.** Vulvar opening in the middle of pygidium; perivulvar pore (fig. Q) groups (fig. ): median, 8-16; anteriolateral, 14-36; posteriolateral, 7-23; each pore 3.86-5.20 in diameter.

**Type material studied.** Cotypes from *Citrus* sp., CA, Fallbrook, Apr. 7, 1909, coll. C.F. Baker, Let. fr. Ckll., 14171, 10(14) USNM.

**Other material studied.** *Ceanothus velutinus*, CA, Emerald Bay, Lake Tahoe, Sept. 21, 1952, coll. F.L. Blanc, 52I231, 2(5) CDA. *Ceanothus prostratus*, OR, 2 mi W Quartz Mt. Lake Co., July 2, 1968, coll. DRM and R.F. Denno, 1312, 2(4) CDA. *Ceanothus* sp., CA, Pollock Pines, Mar. 22, 1959, coll. R.F. Wilkey, 3(15) CDA; Michigan Bluff, Placer Co., Oct. 25 1967, coll. R.P. Allen, Calif. 20, 10(23) VPI; Idyllwild, Riverside Co., May 14, 1975, coll. R. Gill and B. Gove, 4(14) CDA; Mt. Wilson, May 1908, coll. R.S. Woglum, 1(3) USNM; 37380 Rohlen Road, Anza, Feb. 27, 1986, coll. Don Domenigoni, C 120, 9(21) VPI; CO, Mt. Baldy, coll. Timberlake, 1(5) USNM. *Citrus* sp., CA, Fallbrook, 1(5) BM. *Fremontia* sp., CA, Frazier Park, Kern Co., May 12, 1976, coll. Easley, et.al., 76E14-24, 4(8) CDA. *Tamarix* sp., CA, Coachella

Valley, May 1928, coll. GFF, 1(4) UCD; Indio, Nov. 1924, coll. L.E.M., 2(9) UCD; Indio, 1922, coll. GFF, 1(2) UCD.

**Host and distribution.** This species was first collected on orange (family Rutaceae) in 1909. Since then it has been recorded throughout the state of California, and also has been found in two other states: Colorado and Oregon. It seems that the hosts are associated with evergreen shrubs including *Ceanothus prostratus*, *C. velutinus*, and *Ceanothus* spp. in the family Rhamnaceae; *Fremontodendron* (= *Fremontia*), family Bombacaceae, and *Tamarix*, family Tamaricaceae.

**Affinities and discussion.** The distinguishing characters of this species cause a problem because it is so similar to *Chionaspis ortholobis* that they are sometimes indistinguishable. Ferris (1937) even pointed out that it is doubtful if the two are in reality separate species, but he concluded that the following main morphological differences are useful until other better characters are found. The characters differentiating it from *C. ortholobis* are: (1) the median lobes are noticeably rounded, and separated from each other to their base while in *C. ortholobis*, the median lobes are contiguous or close together for a distance; (2) outer lobule of third pair of lobes is greatly reduced; whereas in the latter, outer lobule distinct; (3) the zygotis at the base of median lobes is shorter, while in the later, the zygotis is elongate and narrow. They are occasionally more or less similar to each other when collected from different localities.

## *Chionaspis triformis* Tippins and Beshear

### Plates 28, 29

**Suggested common name.** Birch scurfy scale

**Literature and synonymy.** *Chionaspis triformis* - Tippins and Beshear, 1974: 146; Nakahara, 1975: 202, 1980: 21.

*Chionaspis betulae* - Tippins and Beshear, 1970: 1021-1022; Beshear, Howell and Tippins, 1973: 9; Knipscher, Miller and Davidson, 1976: 9.

**Test of adult female (Plate 28, fig. A).** Oystershell-shaped; white to dirty white; 1.1-1.2 long, 0.4-0.7 wide, only slightly concave. Exuviae occupying about one-third of length of test, light yellow to brownish yellow. Ventral test thin, white.

### GENERAL DESCRIPTION

Three forms have been found, described and illustrated by the authors under the name of *Chionaspis betulae* in 1970. Because the name was occupied previously, it was changed to the present name by the authors. On the basis of the specimens from the type locality, and from the materials at hand, only two forms have been found. They are described and illustrated below.

## Bark Form

### Plate 29, fig. A

Body spindle-shaped, margin of free abdominal segments lobed laterally; broadest at abdominal segment I or II; about 552-766 long and 249-362 wide on slides. Live: yellowish mottled with brown or reddish brown.

**Pygidial margin (Plate 29, fig. A).** Triangular and obtuse, 163.66-191.50 long and 229.80-321.55 wide at base, sclerotized at posterior end. Median lobes well developed, distinct, yoked by a conspicuous zygotis; each lobe rounded and delicately serrated on margin. Second pair of lobes bilobed, smaller than median lobes, outer lobule reduced and much smaller than inner one. Third pair of lobes bilobed, much reduced. Gland spines, setae and macroducts present.

### Dorsal Surface

**Macroducts (Plate 28, fig. D&E).** Two-barred, 9.26-16.6 long and 5.71-8.01 wide, arranged in submedian, submarginal and marginal groups on abdominal segments III-VII on each side of the body. Numbers of macroducts few; submedian: none on abdominal segment III, only 1 occurring on abdominal segment V, sometimes 2 on this position and 1 on IV; submarginal: III, 0-2; IV, 0-2; V, 1-2; marginal: III, 0-1; IV, 1-2; V, 2, rarely 3; VI, 2 and VII, 1 only.

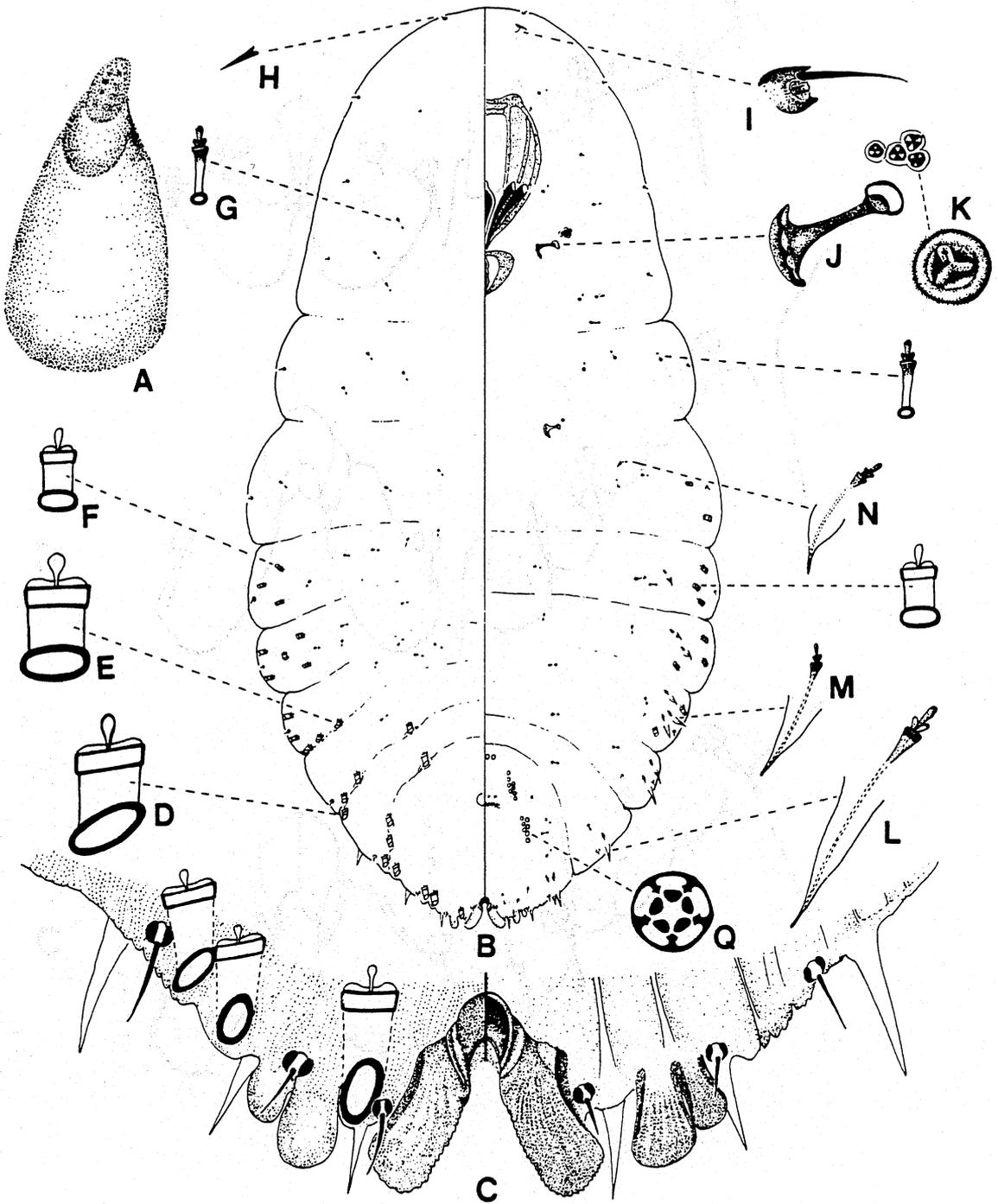
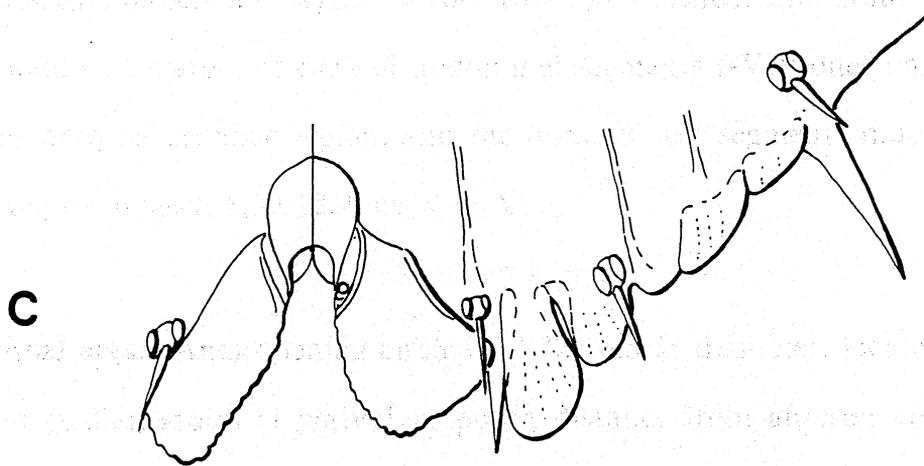
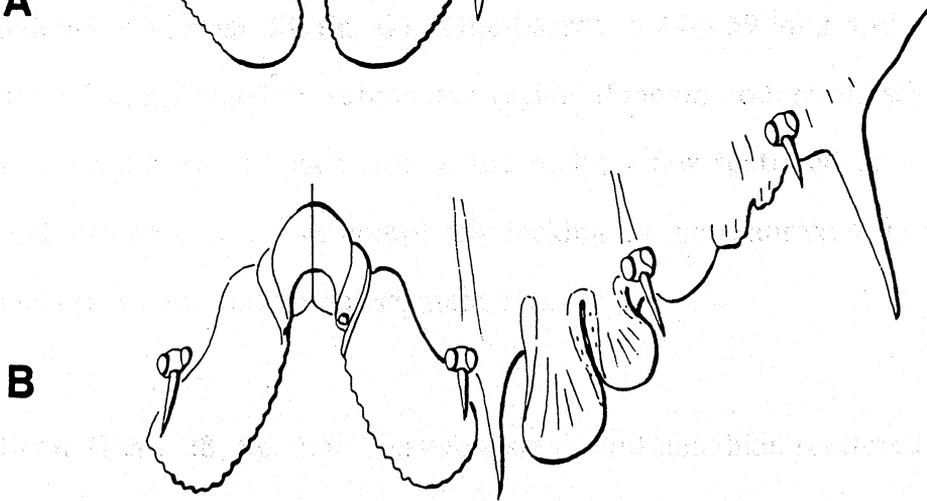
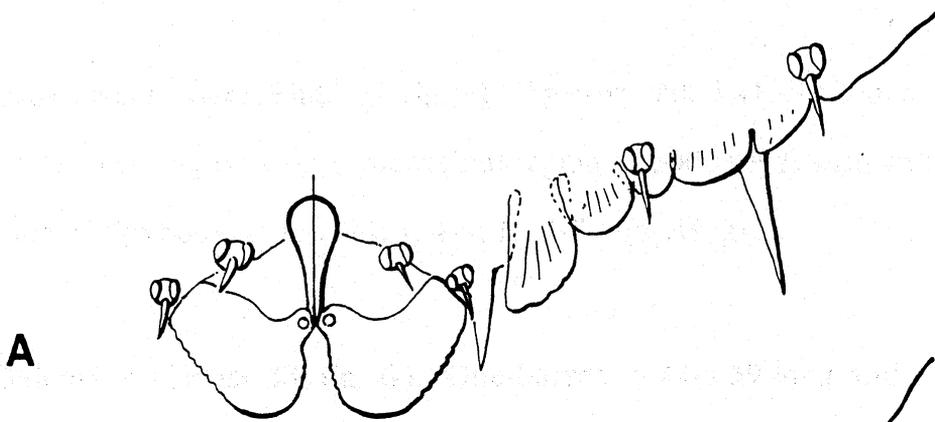


Plate 28. - *Chionaspis triformis* Tippins & Beshear, leaf form



**Plate 29. - *Chionaspis triformis* Tippins & Beshear,  
median lobes of different forms**

**Small macroducts (Plate 28, fig. F).** Two-barred, 5.41 -9.12 long and 3.70-6.18 wide, occurring only on submarginal region of abdominal segments I-III of each side of the body as follows: I, 4-9; II, 4-7 and III, 2-3.

**Microducts (Plate 28, fig. G).** One-barred, 5.44-8.39 long and 1.46-1.95 wide at orifice, arranged on submedian region alone on abdominal segments I to III and metathorax of each side of the body; a few scattered on cephalic region and mesothorax; 2-5 or completely lacking on metathorax; 4-9 on I, 4-7 on II; usually 3-5 on abdominal segment III.

**Setae (Plate 28, fig. H).** Very few small and hair-like, scattered on and along margins of cephalic region, 3.70-6.18 long; 1 slender and stout seta borne on middle of margin of each of abdominal segments I-VII; ones on I-III as small as ones on cephalic region, and the ones on rest segments much stouter and longer; longest, 6.30-12.4, on V or VI.

**Anal area.** Anal opening circular, 7.72-10.8 in diameter, located at posterior of median group of perivulvar pores; distance from anterior edge of anus to mid-point of line between abdominal segments V and VI, 51.0-69.5; distance from posterior edge of anus to base of median lobes, 84.9-98.8.

#### **Ventral Surface**

**Antennae (Plate 28, fig. I).** Reduced to small sclerotized tubercles, 5.78- 7.72 long and 5.45-7.80 wide at base, each antenna with 1 curved lateral fleshy seta, 12.5-17.0 long; distance between antennal bases 38.6- 52.5.

**Clypeolabral shield.** Length 104-112; width 66.4-84.9; shape typical for the genus.

**Labium.** Length 30.9-37.1; width 41.7-46.3; shield-shaped.

**Spiracles.** Anterior (Plate 28, fig. J), 20.1-23.2 long and atrium 7.4-8.6, wide with 6-8 associated trilocular pores (Plate 28, fig. K) at each spiracle. Posterior spiracle nearly similar in shape and size to anterior one, 18.5-19.3 long, most lacking associated trilocular pores, rarely only 1 present.

**Gland spines (Plate 28, fig. L).** Marginal, 15.5-23.6 long, each with an associated one-barred microduct on each side of body; 2-3 on abdominal segment IV and only 1 on each of V, VI and VII.

**Gland tubercles (Plate 28, figs. M&N).** Conical basally and spindle-shaped distally, 9.02-11.6 long and 3.55-7.22 wide at base, each with an associated one-barred microduct, submarginally arranged on basal two abdominal seg-

ments and occasionally on thorax; sometimes 1 on metathorax; 1-4, or rarely absent, on abdominal segment I, 2-5 on II.

**Small macroducts (Plate 28, fig. O).** Two-barred, 5.34-10.1 long and 3.70-6.01 wide, scattered submarginally and marginally on abdominal segments I-III, sometimes on thoracic segments, on each side of the body as follows: 0-3 on each of metathorax and mesothorax; 2-5 on I, 2-6 on II; usually 1-3 on III.

**Microducts (Plate 28, fig. P).** Same shape, size and location as but somewhat more numerous than those on dorsal surface, especially on cephalic region and pygidium.

**Setae (Plate 28, fig. H).** Very few, hair-like, on cephalic region and on thoracic segments, and abdominal segments as well, 3.64-6.28 long; marginal setae of abdominal segments IV-VII, stouter and longer, 5.18-11.6 long; each segment with 1, or sometimes 2 on the posterior segments.

**Vulvar area.** Vulvar opening in the middle of the pygidium; perivulvar pore (Plate 28, fig. Q) groups: median, 4-8; anteriolateral, 11-17; posteriolateral, 8-16; each pore 3.02-4.09 in diameter.

#### Leaf Form

#### Plate 28

Body spindle-shaped (fig. B) margin of free abdominal segments not obviously lobed laterally; broadest at abdominal segment I or II; length, 387-603; width, 278-232.

**Pygidial margin (fig. C).** Triangular, sclerotized and rounded apically, 136-150 long and 217-254 wide at base. Median lobes long and narrow, 24.7-27.8 long and 10.8-11.2 wide, sunken deeply into pygidium, forming an acute notch; inner margin divergent and curved from base to apex, with 12-18 distinct and fine serrations; base of median lobes yoked by a short and stout zygois. Second pair of lobes well-developed, bilobed; inner lobule as long as median lobe, outer lobule much smaller. Third pair of lobes much reduced or completely rudimentary. Gland spines, setae and macroducts present.

#### **Dorsal Surface**

**Macroducts (figs. D&E).** Two-barred, 6.18-16.1 long and 6.05-8.03 wide, arranged submedially on abdominal segments IV-VI, submarginally on III-V, and marginally on III-VII on each half of body; numbers greatly reduced as follows: submedian: 0-1 on IV, 1 on V, and 0-1 on VI; submarginal: 1 on III, 1-2 on IV, and 1 or 2 on V; marginal: 1 on III, 1 or 2 on IV, 2 on each of V and VI, and only 1 on VII.

**Small macroducts (fig. F).** Very small, two-barred, 4.94-7.41 long and 3.45-4.94 wide, usually 3-5 scattered on marginal and submarginal areas of each of abdominal segments I-III, usually absent on thoracic segments of each side of the body.

**Microducts (fig. G).** One-barred, 6.17-8.65 long and 1.24-2.47 wide orifice, scattered irregularly on whole surface of body, but very few in numbers.

**Setae (fig. H).** Very few, small and slender, hair-like, 4.94-6.18 along margins and on cephalic region; 1 on each margin of basal 3 or 4 abdominal segments; stouter and longer setae, 6.34-9.78 long, 1 or rarely 2 on each margin of abdominal segments V-VII.

**Anal area.** Anal opening circular, 8.65-10.8 in diameter, located at posterior of median group of perivulvar pores; distance from anterior edge of anus to mid-point of the line between abdominal segments V and VI, 39.5-40.2; distance from posterior edge of the anus to base of median lobes, 60.2-66.7.

### **Ventral Surface**

**Antennae (fig. I).** Reduced into small sclerotized tubercle, 4.94-6.18 long and atrium 3.96-6.12 at base, each with 1 laterally fleshy seta, usually curved, 9.88-10.8 long; distance between antennal bases, 36.8-44.8.

**Clypeolabral shield.** 86.4-106.5 long, and 69.5-74.1 wide, with typical shape of the genus.

**Labium.** 33.4-37.1 long, and 30.9-43.2 wide, cup- or shield-shaped.

**Spiracles.** Anterior (fig. J), 17.3-19.8 long and atrium 7.0-7.6, each with 3-7 associated trilocular pores (fig. K); posterior spiracles, nearly the same shape as anterior, but a little stouter and smaller, 16.1-16.1 long; number of associated trilocular pores greatly reduced, 1 or 2, sometimes 3-4 present. In this species, number of associated trilocular pores is very difficult to count.

**Gland spines (fig. L).** Marginal, 3.71-9.65 long, each with one associated one-barred microduct, situated on abdominal segments IV-VII on each side of the body as follows: 2-4 on IV; 1 on each of V, VI and VII, respectively.

**Gland tubercles (figs. M&N).** Stout spine-like, 3.71-8.65 long and 3.45-6.18 wide at base, each with an associated microduct, located on submarginal region of abdominal segments I-III on each side of body; 0-2 on I, 2-4 on II and 3-5 on III. Gland tubercles absent on thoracic segments.

**Small macroducts (fig. O).** Very few, two-barred, 4.94-6.54 long and 3.95-5.58 wide, clustered on submarginal region of abdominal segments I-III on each

side of body as follows: 0-3 on I; 1-3 on II; and 0-3 on III; sometimes absent on all abdominal segments or very few on thoracic segments.

**Microducts (fig. P).** Only very few, one-barred, 5.56-8.64 long and 1.24-2.33 wide at orifice, poorly-developed, scattered on entire surface of body from cephalic region to pygidial area; slightly more numerous on anterior part of body.

**Setae (fig. H).** Very few short and slender, hair-like, 4.32-6.18 long, scattered on cephalic region, more numerous along margins; same size setae on thoracic and abdominal segments on each side of body, and sometimes absent on margins; if present, each margin with only 1, but with 1-2 on submedian and submarginal areas of abdomen. Stout and long setae usually present on posterior segments and pygidial margin, 5.85-9.76 long; each segmental margin with 1 or rarely 2.

**Vulvar area.** Vulvar opening situated about middle of pygidium; perivulvar pores (fig. Q) quinquelocular, arranged in five groups, each group with fewer pores than any other species in the genus; median, about 4; anteriolateral, 10-12; and posteriolateral, 6-8; each pore 3.95-4.45 in diameter.

**Type material studied.** Paratypes from *Betula nigra*, GA, Spalding Co., Feb. 11, 1968, coll. RB, 2(2) UGAES; Jasper Co., Aug. 28, 1969, coll. H.H.

Tippins, 6(6) UGAES. *Betula* sp., Jasper Co., May 22, 1968, coll. RB, 2(2) UGAES; Spalding Co., Jan. 3, 1969, coll. H.H. Tippins, 3(3) UGAES. Holotype from *Betula* sp., Spalding Co., Jan. 3, 1969, coll. RB, 1(1) CDA.

**Other material studied** *Betula nigra*, FL, Providence, Nov. 11, 1977, coll. AEG, 3(3) FDA. GA, Jaskson Lake, Jasper Co., April 24, 1987, coll. RB, 2(2) VPI. *Betula* sp., GA, Delkalb Co., April 2, 1974, coll. RJB, 1(1) UGAES.

**Host and distribution.** So far this species has been found only on *Betula nigra* in Jasper and Spalding Co, Georgia, and Florida.

**Affinities and discussion.** According to the original description by Tippins and Beshear (1970:1022), the bark form of this species is very similar in morphological characters to *C. acericola* and the leaf-form is similar to *C. gleditsiae*.

The bark form differs from *C. acericola* in that the median lobes of *triformis* are not notched, gland tubercles are always present on abdominal segment I, and small macroducts are absent on submedian regions of abdominal segment II and IV; but with some exceptions.

The leaf form of this species and the leaf-form of *gleditsiae* are so similar that they are sometimes indistinguishable. The only character which can be used is that *gleditsiae* has more than 20 dorsal macroducts.

The only specimen representing an intermediate form in the original description (Tippins and Beshear, 1970) was borrowed from the original describers. It was described as an intermediate between the two forms because it has 1 of the median lobes identical to the bark form while the other one is similar to that of leaf form. The specimen was carefully checked and the pygidial margin was illustrated here (Plate 29, fig.C) so as to show the differences from that of the other forms. I disagree with the conclusion that this specimen is an intermediate form of the species. It is actually a member of the leaf form, because 1 of the median lobes is exactly identical to that of the leaf form, and the other is also somewhat similar to that of the leaf form but it is slightly wider and shorter. The median lobe which was thought similar to that of the bark form is distinctly dissimilar to that form (Plate 29, fig. A). In addition, the basal sclerotized zygotis and other characters are quite typical of the leaf form. Such abnormal characters on animals, especially on scale insects, are not unusual.

*Chionaspis wistariae* Cooley

Plates 30, 31

**Suggested common name.** Wistaria scurfy scale

**Literature and synonymy.** *Chionaspis wistariae* Cooley - Cooley, 1897: 280, 1899: 39; Berlese, 1898: 379; Cockerell, 1899: 398; Kuwana, 1902: 77; Fernald, 1903: 226; Kuwana, 1907: 198; Lindinger, 1910: 1; Weiss, 1916: 11; Kuwana, 1917: 15; MacGillvrary, 1921: 349; Kuwana, 1928: 4; Lindinger, 1933: 166; Kanda, 1941: 186; Hunt, 1941: 363; Ferris, 1942: 388; Felt, 1943: 394; Hewitt, 1943: 269; Slesman, 1945: 44; Takahashi, 1952: 8, 1953: 48; Ferris, 1956: 74; McKenzie, 1956: 30; Kosztarab, 1963: 78; Murakami, 1970: 65; Kawai, 1972: 54; Kosztarab, 1974: 5; Nakahara, 1975: 202; Kawai, 1977: 156; Paik, 1978: 310; Kawai, 1980: 201; Nakahara, 1982: 21; Tang, 1984: 129; Takagi, 1985: 43, 60.

*Phenacaspis fujicola* Kuwana -Kuwana, 1931: 8; Takahashi, 1953: 48; Chen, 1983: 74.

*Phenacaspis wistariae* (Cooley) - Ferris, 1955: 53, 1956: 67; Takagi, 1961: 24; Takagi and Kawai, 1967: 29; Kawai, 1980: 292; Chen, 1983: 74.

*Trichomytilus fujicola* Lindinger, 1934: 64.

*Trichomytilus wistariae* Lindinger, 1933: 166.

**Test of female (Plate 30, fig. A).** Shape and size vary, usually elongate oystershell-shaped, moderately broadened, white or dirty white, delicate in texture; about 1.5 - 2.5 mm long; exuviae brown or yellowish brown, occupying about one-third of total length; second exuviae covered with secretion.

## GENERAL DESCRIPTION

**Body of adult female (Plate 30, fig. B).** Spindle-shaped, expanding toward posterior end, margins laterally lobed; broadest at first abdominal segment; on slides 636-1111 long and 383-586 wide.

**Pygidial margin (Plate 30, fig. C and Plate 31, figs. A-D).** Triangular, sclerotized at apex, 185-230 long, 306-418 wide at base. Median lobes well-developed, large and distinct; three different forms found: bark form, leaf form, and intermediate form (Plate 31, figs. A-D). These are described, illustrated and discussed in order.

### Bark Form

#### Plates 30, 31

**Pygidial margin (Plate 30, fig C; Plate 31, fig. A).** Median lobes well-developed, large and prominent, projecting; firmly united at their bases with a thickened zygosis; inner margins parallel or nearly so at base for one third

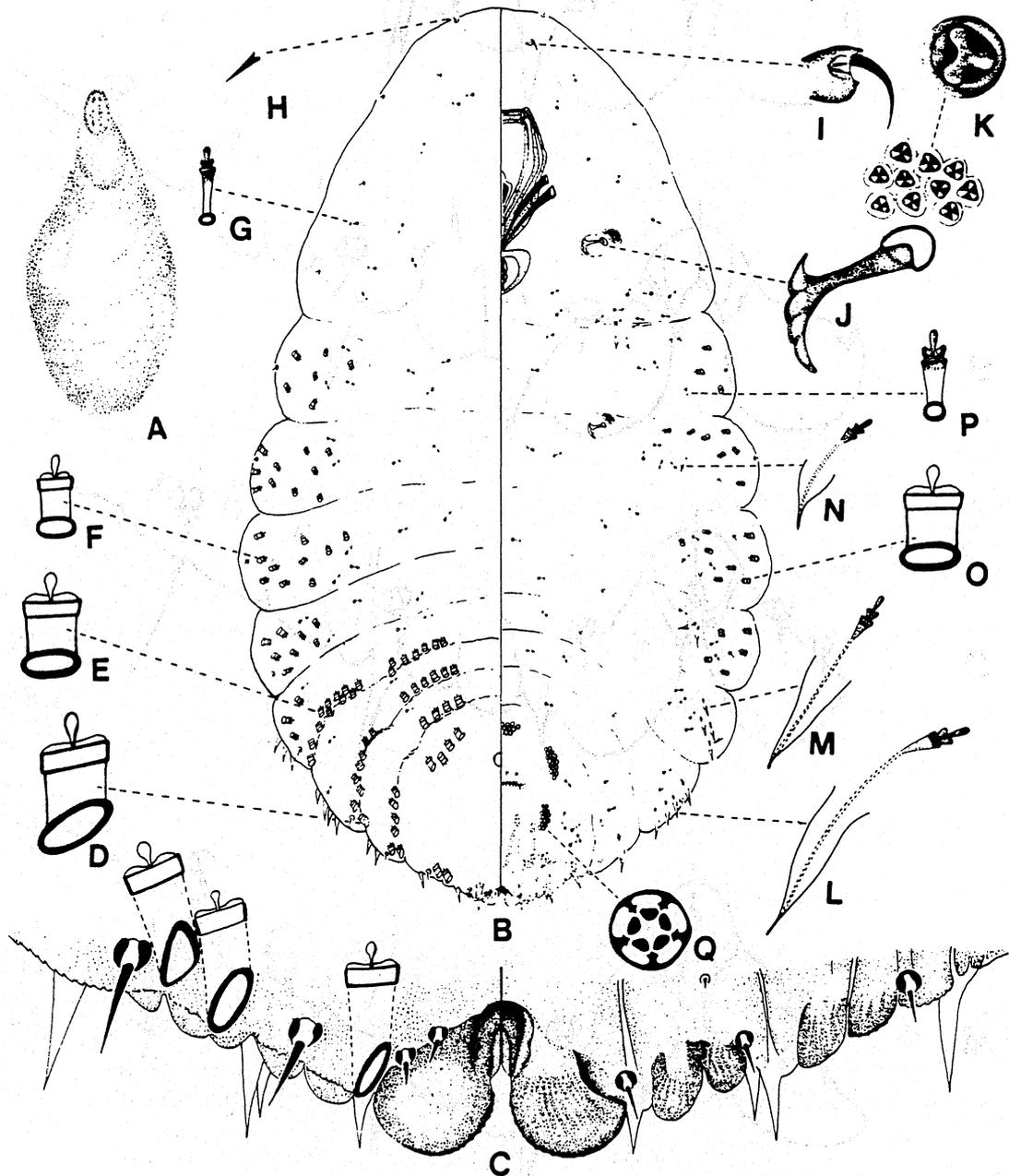


Plate 30. - *Chionaspis wistariae* Cooley, bark form

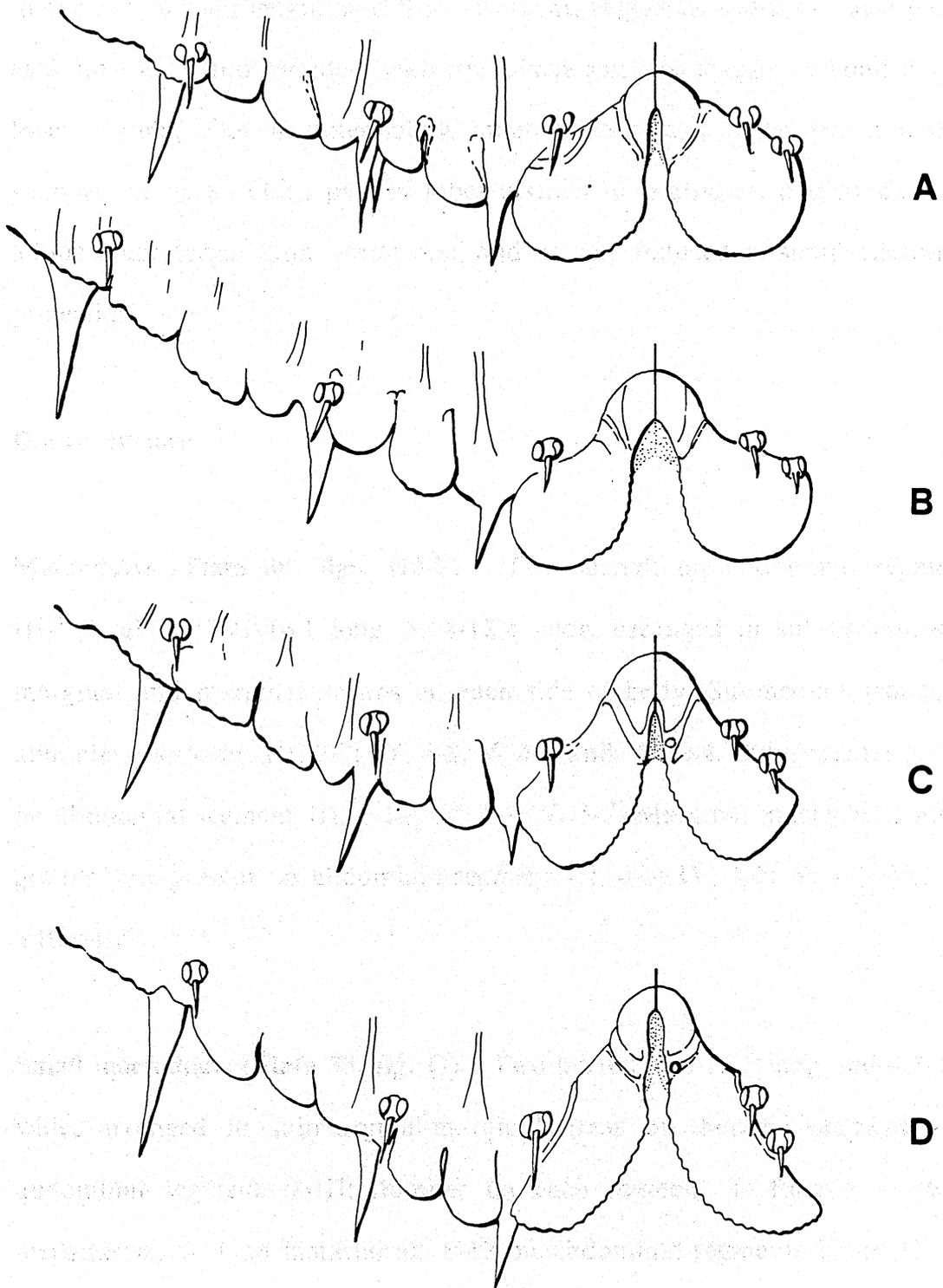


Plate 31. - *Chionaspis wistariae* Cooley,  
median lobes of different forms

to one half of their length, and then divergent; beginning at base of divergence, each lobe wide and rounded, with irregularly serrated margin. Second pair of lobes distinct, bilobed; outer lobule much smaller than inner one, and both rounded at apex. Third pair of lobes distinct or indistinct; if distinct, inner lobule much larger than outer one, and usually reduced to small sclerotized projection.

### **Dorsal Surface**

**Macroducts (Plate 30, figs. D&E).** Two-barred, on abdominal segments III-VII, about 7.41-16.1 long, 8.64-12.4 wide, arranged in submedian, submarginal and marginal groups on each side of body. Submedian groups on abdominal segment III, 3-7; IV, 3-8; V, 4-7 and VI, 2-4. Submarginal groups on abdominal segment III, 6-10; IV, 5-9; V, 5-7. Marginal macroducts not in groups, but present on abdominal segment III, 4-5; IV, 1-2; V, 1-2; VI, 1-2; VII, only 1.

**Small macroducts (Plate 30, fig. O).** Two-barred, 6.3-15.5 long and 4.8-11.4 wide, arranged in submarginal-marginal areas of thoracic segments and abdominal segments I-III; number on each segment as follows: 2-6 on mesothorax, 5-11 on metathorax, 8-12 on abdominal segments I and II, and 2-5 on III.

**Microducts (Plate 30, fig G).** One-barred, very small, 4.94-7.41 long and 1.48-2.35 wide at orifice, only few scattered irregularly on cephalic region, and on prothorax, mesothorax and metathorax, and as well as on abdominal segments and pygidium of each side of body; some microducts also scattered on pygidium.

**Setae (Plate 30, fig. H).** Very few, hair-like, 3.70-4.94 long, on cephalic region along margin; 1 or rarely 2 small and slender marginal setae on each thoracic segment, or sometimes absent, also on abdominal segments I-IV; stouter and longer setae on margins of abdominal segments V, VI, and VII, 6.18-18.6 long, the longest usually on VI.

**Anal area.** Anal opening circular, diameter, 10.8-12.3, located just posterior of median group of perivulvar pores on venter, distance from anterior margin of anus to midpoint of line between abdominal segments V and VI, 55 - 64; distance from the posterior edge of anus to the base of median lobe, 104-120.

#### **Ventral Surface**

**Antennae (Plate 30, fig. I).** Reduced to small sclerotized tubercles, 6.18-8.55 long and 4.94-8.03 wide at base; each with a lateral and curved fleshy seta, 13.9-19.2 long; distance between their bases 55.6-72.6.

**Spiracles.** With narrow bar supporting opening, anterior spiracles (Plate 30 fig. J), about 15.4-23.0 long and atrium 7.6-9.3; each with 10-20 associated trilocular pores (Plate 30, fig. K). Posterior spiracles similar to anterior ones in shape, and nearly same size, 18.5-23.2; each with 3-8 associated trilocular pores.

**Gland spines (Plate 30, fig. L).** All marginal, slender, 17.2-30.9 long, each with an associated one-barred microduct; number on each margin of abdominal segments III-VII as follows: III, 4-6; IV, 3-4; V, 1-2; VI, 1; VII, 1 only.

**Gland tubercles (Plate 30, figs. M&N).** Conical basally and spinelike distally, 7.41-12.1 long, 4.94-6.18 wide at base, sumarginally clustered on abdominal segments I and II, and on thoracic segments of each side of the body; number in each group as follows: 0-3 on prothorax; 1-4 on mesothorax; 2-3 on metathorax; 2-4 on abdominal segment I, 3-5 on II.

**Small macroducts (Plate 30, fig. O).** Same shape, size, location and nearly same number as those on each segment of dorsal surface.

**Microducts (Plate 30, fig. P).** Same shape, size, location as those of dorsal surface, but more numerous, 5-15 on cephalic region, 3-9 on each of thoracic segments, 2-5 on each of abdominal segments I-V, and 6-8 on pygidium.

**Setae (Plate 30, fig. H).** Very small, hair-like, about same size as, or slightly smaller than, those on dorsal surface; 3-6 on cephalic region, 1 or rarely 2 on each of thoracic segments, 1-3 on abdominal segments I-V, and 3-5 on pygidium.

**Vulvar Area.** Vulvar opening slit-like, located anteriorly on pygidium; perivulvar pores (Plate 30, fig. Q): median group with 13-18; anterolateral groups with 21-29; posterolateral groups with 15-20; each pore 4.56-4.94 in diameter.

### **Leaf Form**

#### **Plate 31, fig. D**

**Pygidial margin (fig. D).** Median lobes sunken into pygidium, and strongly divergent; each lobe long and narrow; 26.2-34.0 long and 7.66-10.8 wide, each inner margin with 12-16 serrations. Base of median lobes yoked by a short zygotis. Second pair of lobes well-developed, bilobed, both lobules rounded at apex; inner lobule much larger than outer one. Third pair of lobes also well-developed and bilobed, outer lobule much smaller than inner one.

#### **Dorsal Surface**

**Macroducts.** Two-barred, 8.2-17.3 long, 7.7-12.5 wide, arranged in submedian, submarginal and marginal groups on abdominal segments III-VI, III-V and III-VII and laterad of median lobes; number in each group of each segment as follows: submedian: 2-8 on III, 4-9 on IV, 4-7 on V, and 2-4 on VI; submarginal: 7-12 on III, 6-11 on IV, and 4-6 on VI; marginal: 0-2 on III, 1-2 on IV, 2 on each of V and VI, and 1 laterad to median lobes.

**Small macroducts.** Two-barred, 6.5-15.7 long, and 4.6-11.5 wide, scattered on marginal/submarginal areas of mesothorax and metathorax, and abdominal segments I-III; number on each segment as follows: 1-5 on each of meso- and metathoracic segments, 3-9 on each of abdominal segments I and II, and 0-5 on III.

**Microducts.** One-barred, 5.2-10.5 long, 2.6-5.6 wide at orifice, arranged irregularly on cephalic region, thoracic and abdominal segments; usually 3-7 on cephalic region, 2-5 on each of thoracic segments, 2-6 on each of abdominal segments I-III, and few or absent on abdominal segments IV, V, and pygidium.

**Setae.** Very short, hairlike, dispersed irregularly on cephalic region, and margin of thoracic and abdominal segments; usually 4-8 on cephalic region, located on submedian, submarginal and marginal area; 1 on each of thoracic and abdominal segments, becoming slightly larger posteriorly.

**Anal area.** Anal opening circular, 10.1-12.4 in diameter, located anterior to middle of pygidium; distance from anterior margin of anus to midpoint of line between abdominal segments V and VI, 46.0-57.5; distance from posterior margin of anus to base of median lobes, 95.7-109.

### **Ventral Surface**

**Antennae.** Very small sclerotized tubercles, 6.2-8.6 long, 4.5-8.7 wide at base, each with a long lateral fleshy seta, 15.3-19.2 long; and each with 2 very short sensory terminal setae, 2.3-4.5 long. Distance between antennal bases, 49.8-72.5.

**Clypeolabral shield.** Typical shape of the genus, 105-138 long, and 80.4-114.9 wide.

**Labium.** Cup or oval shape, 34.5-46.4 long, and 38.3-58.0 wide.

**Spiracles.** Nearly same shape as the bark-form, 15.4-23.2 long, and atrium 8.6-9.3 wide; each with 8-17 associated trilocular pores, each pore 3.2-4.0 in diameter. Posterior spiracles similar to the anterior ones, but slightly smaller, 18.5-23.1 long, and with 3-7 associated trilocular pores.

**Gland spines.** Marginal, 15.3-34.5 long, situated on abdominal segments III-VII and laterad of median lobes, each with an associated one-barred microduct; number on each margin as follows: 3-5 on III, 3-4 on IV, 1, rarely 2 on V, 1 on each of VI and VII, respectively, and 1 laterad of median lobes.

**Gland tubercles.** Basally conical and distally spine-like, clustered on submarginal areas of thoracic segments and abdominal segments I-II, small and short, about 4.8-6.2 long and 3.2-4.3 wide at base, each with a very small associated microduct; absent or rarely 1-2 on prothorax, 0-1 on mesothorax, 0-2 on metathorax and each of abdominal segments I-II.

**Small macroducts.** Same shape, size, location and about same number on each segment as the ones on dorsal surface.

**Microducts.** Same shape, size and location as the ones on dorsal surface, more numerous, 6-15 on cephalic region, 3-8 on each of thoracic segments, 2-6 on each of abdominal segments I-II, and few on abdominal segments III-V, and 3-5 on pygidium.

**Setae.** Very small, hair-like, 4-7 scattered on or along submargin or/and margin of cephalic region, 1 rarely 2 on each of thoracic segments, 1-3 on submedian and sumarginal or marginal areas of abdominal segments I-V, and 3-4 on pygidium, usually 2 above vulvar opening.

**Vulvar area.** Vulvar opening located anterior of middle of pygidium; number in perivulvar pore groups as follows: median, 13-17; anteriolateral: 20-29; posteriolateral: 15-20. Each pore 3.8-4.6 in diameter.

### **Intermediate Form**

#### **Plate 31, figs. B & C**

Several specimens were considered intermediate forms as shown in Plate 31, figs. B&C). Several specimens originating in Tokyo collected in Washington, DC (fig. B), are somewhat similar but not the typical bark form. The specimen collected from Huntington Gardens, CA, as shown in fig. C is more or less similar and closer to the typical leaf form.

**Material studied** *Wisteria chinensis*, CA, Vista, Sept. 1954, coll. G. Beckett, 1(1) CDA. *Wisteria floribund*, CA, Huntington Gardens, July 15, 1979, coll. DRM, 6(10) USNM. *Wisteria multijuga*, DC, fr. JAPAN, Jan. 6 1938, coll. J.B. Woods, E2-A44554, 2(4) USNM. *Wisteria nankinensis*, DC, fr. JAPAN, Jan. 18, 1937, coll. Limber, EQ-A38987, 1(1) USNM. *Wistaria* sp., CA, San Diego Co., Sept. 30, 1954, coll. Glenn Becket, 54J177, 9(11) CDA; Chula Vista, San Diego Co., Oct. 27, 1950, coll. K.H. Baker, 50K31, 2(4) CDA; San Marino, Los Angeles Co., June 2, 1980, coll. J. White, 80F5-16, 3(16) CDA; Santa Barbara, Santa Barbara Co., June 21, 1943, coll. Tower, 43E1616, 1(2)

CDA; Monticello, Nov. 2, 1939, coll. Vandenberg Feltrop, 1(2) USNM; San Diego Co., Balboa Park, Feb. 25, 1939, coll. Bumagarchner, 29C34, 5(12) CDA; Santa Barbara, at Hatfields Nursery, May 21, 1943, coll. C.R. Tower, 43E1616,2(4) UCD; DC, fr. JAPAN, Mar. 26, 1929, coll. Wood and Owery, PQ=CA#A4712, 1(3) USNM; fr. JAPAN, May 25, 1934, coll. W.B. Wood, PQ#029500, 1(2) USNM; HW, fr. JAPAN, Oct. 1, 1974, coll. S. Ochikubo, 1(1) USNM.

**Host and distribution.** This species is only found on the leaves and branches of *Wisteria* (= *Wistaria*) (family Fabaceae) including: *W. floribunda* W. *multijuga*, *W. nonkinensis*, *W. sinensis* and several other unknown species. Chen (1983) reported this species feeding on an unknown shrub. *C. wistariae* is a native of Japan. It was accidentally introduced to China (Chen, 1983 and Tang, 1984) and to the United States. It was first discovered on a branch of *Wisteria* at San Francisco, California (Cooley, 1897: 40). Now it is also known from Pennsylvania.

**Affinities and discussion.** Three to seven dorsal submedian macroducts on abdominal segment III distinguish *C. wistariae* from the following species: *C. acericola*; *C. gleditsiae*; *C. kosztarabi*; *C. nyssae*; *C. pinifoliae*; *C. platani* and *C. triformis*. Lack of dorsal submedian and submarginal microducts on abdominal segments I, II and III separate it from *C. longibola*.

Takahashi (1952a, 1953) mentioned that *Chionaspis wistariae* Cooley and *Phenacaspis fujicola* Kuwana are different forms of the same species; the former feeds on the bark of branches, whereas the latter feeds on the leaves. It was Takagi (1961) who first described and illustrated the distinguishing characters of the two forms. He stated that median lobes of the leaf form are deeply sunken into the apex of the pygidium, the second pair of lobes are well developed with inner lobule slightly widened apically, and the third pair of lobes is distinct with the inner lobule produced, while the median lobes of the bark-form are produced, the second pair being less produced than in the leaf-form, and the third pair of lobes is reduced to low prominences.

The dimorphism, or morphological differences associated with the feeding sites of this species were further demonstrated by Takagi (1985). He counted the total number of dorsal macroducts, the perivulvar pores and the gland spines on abdominal segments III-VII, and also the numbers of associated trilocular pores at each spiracle. He concluded that the difference in the number of the macroducts is associated with the different feeding sites. He found that the difference between the bark-form and the leaf-form was obvious when he plotted the number of perivulvar pores against the number of dorsal macroducts on a scatter diagram. When the individuals feeding on the petioles and the petiolules were added, the whole group was indistinguishable because the characters of the individuals collected from petioles and petiolules overlapped with those of both the bark-form and the leaf-form.

The leaf-form of this species, originally *Phenacaspis fujicola*, was found a long time ago in California and in other localities. In our current study, we have checked all specimens collected from several localities, and both forms have been found either under the name *C. wistariae* or *P. fujicola*. We found the main distinguishing characters between the two forms collected from the bark and the leaves to be almost the same as was described and illustrated by Takagi. In addition, we found several specimens of adult females which appear to be an intermediate form (plate 31, fig. B&C). Their median lobes are neither parallel at their base nor strongly divergent, and some are closer to the bark-form, others closer to the leaf-form.

## POLYMORPHISM, A LITERATURE REVIEW AND HYPOTHESIS

In the past few decades, several scale insects have been found to have leaf and bark forms, i. e., host induced dimorphism. These forms were so dissimilar that they were treated as different species and often placed in different genera.

The more important studies are summarized here. Lupo (1943) in Italy, and Stafford and Barnes (1948) in California, reported that *Lepidosaphes conchiformis* (Gmelin) (= *L. ficus* (Signoret)) has both a bark form and a leaf form. The first or overwintering generation occurs on the bark, and the second or summer generation on the leaves. The bark feeding form (*L. conchiformis*) and the leaf infesting form (*L. ficifoliae* (Berlese)) were treated as separate species. The morphological differences of these two "species" were mainly based on shape and size of lobes, but also on degree of sclerotization of median lobes, and the characters of the tests. They noted that crawlers of the bark form settled on the leaves, and the adults became morphs of the leaf form, whereas the crawlers of the leaf form settled on the bark, and the adult females became morphs of the bark form. Therefore, they concluded that *L. ficifoliae* was a "derivative" of *L. conchiformis*.

Takahashi (1952) noted that in *Chionaspis celtis* Kuwana, feeding on *Celtis sinensis*, the adult females on branches are typical *Chionaspis*, while those on the leaves are dimorphic; some median lobes are the *Chionaspis* type

while others are the *Phenacaspis* type. The same situation was found in "*Phenacaspis*" *aucubae* Cooley on *Aucuba* and in *Chionaspis akebiae* Takahashi on *Akebia lobata*. An intermediate form was also discovered in *Chionaspis saitamensis* Kuwana. Here the median lobes were variable in shape and to a certain degree they protruded from the pygidial margin. Takahashi mentioned that the "*Phenacaspis*" type adult females were found on both the branches and the leaves, whereas the *Chionaspis* type occurred chiefly on branches. He confirmed that in some species of *Chionaspis* or "*Phenacaspis*" the females are dimorphic, and dimorphism is associated with the feeding site. The above observations led him to propose "*Phenacaspis*" as a synonym of *Chionaspis*.

Takahashi's observations and proposals were later supported and confirmed by Takagi (1961, 1970, 1985), and Takagi and Kawai (1967). They formally proposed *Phenacaspis* as a junior synonym of *Chionaspis*. They also found that "*Phenacaspis*" *nyssae*, which only feeds on leaves, was remarkably similar, except for the median lobes, to *Chionaspis sylvatica*, which only feeds on the bark of the same host, hence they considered the former as a leaf form of the latter.

Knipscher et al. (1976) carried out a detailed biological study on both the bark and leaf forms of *Chionaspis nyssae* (synonym: *P. nyssae*). Their observations and conclusions further confirmed the proposal made by Takagi and Kawai.

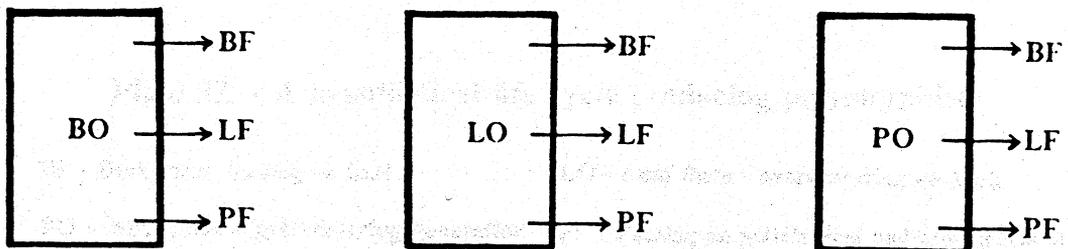
Tippins and Beshear (1970) described a new species, *Chionaspis triformis*, from *Betula nigra*. They found three forms--bark, leaf, and intermediate.

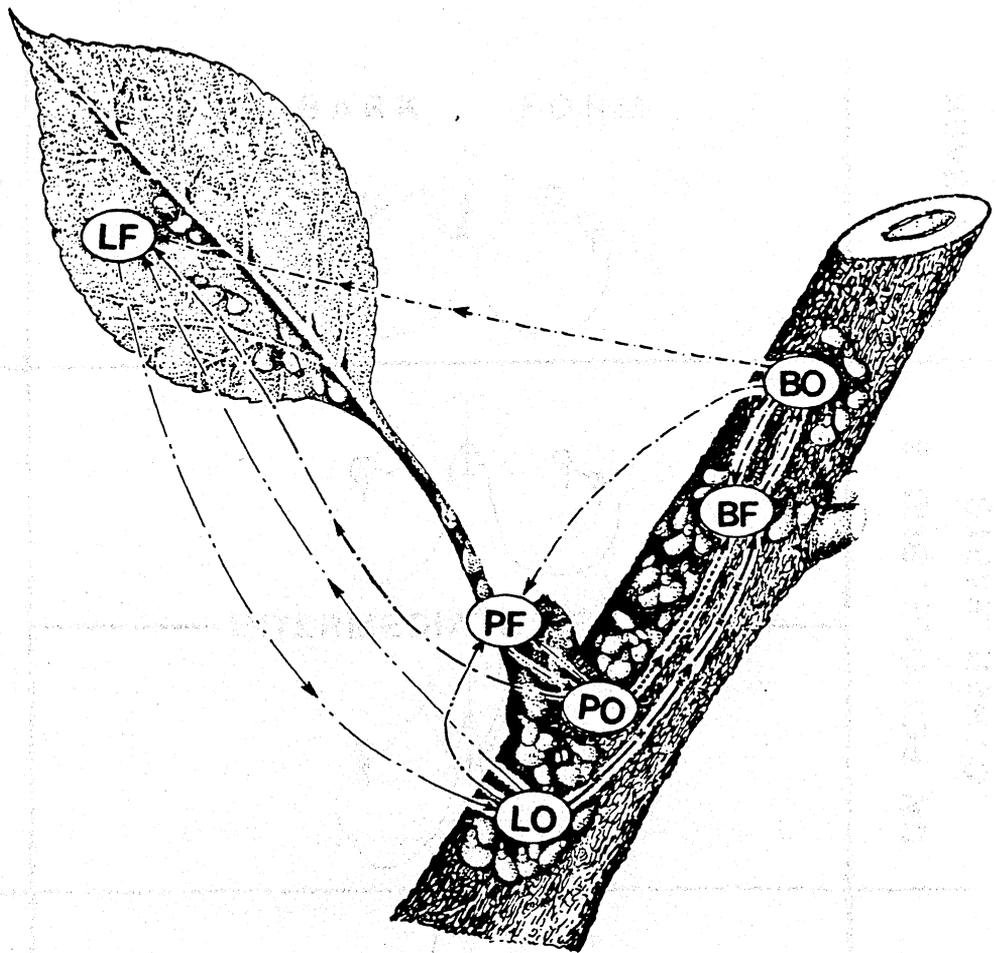
Danzig (1970) proposed that in some species of scale insects, the morphological variations are caused by clinal variation or seasonal environmental factors, and she stated that these variations or seasonal forms are present in the species with two generations per year. The first, or winter generation, feeds on bark and the second, or summer generation, on leaves. She thought that the nutritional content of the ingested saps at different feeding sites affected the pygidial structures. She also provided some evidence that the transfer of scale insects from leaf to bark or vice versa causes the leaf and bark dimorphism, but she did not give further detailed information.

During the present study, more specimens were examined for all the species of *Chionaspis* in North America than in any previous study. The specimens of the five species which have been found to have bark and leaf forms were carefully checked, except for *C. nyssae* which was done by Knipscher et al. (1976). The bark and leaf forms of *C. gleditsiae* and *C. triformis* were found to have little variation and no distinct intermediate forms. However, intermediate forms were found in *C. platani* and *C. wistariae*. The intermediate forms were either more or less similar to the bark form or the leaf form, or were between the two, thus forming a gradual degree of variation. These observations suggest a hypothesis of polymorphism for the adult female in some species of *Chionaspis*, which might also fit other scale insect species with

host site induced polymorphism. This hypothesis is subject to several unknown factors that affect the structure of the median lobes, resulting in the bark form, leaf form, and the many variations of the intermediate form.

As mentioned in the general biology section, most of the species in this genus in North America have two generations, overwintering as eggs or adult females which settled on bark the previous fall. If the overwintering stage is the adult female, she may lay eggs during any month. With the approach of spring the eggs hatch. If the overwintering stage is the egg, with the increase in temperature the eggs hatch. The first generation crawlers appear in early spring, and move out from under the test of their mother, moving until they find a suitable place to settle. Eventually they may settle on bark again, or move to the leaves, petioles, buds, or other parts of the host. The possible movements of the crawler from the overwintering adult generation are shown in Plates 32 and 33 and are exemplified as follows:





**Plate 32. - A hypothetical life cycle producing polymorphism**

**BF - Bark form, feeding on bark**

**LO - Leaf form - overwintering on bark**

**BO - Bark form - overwintering generation.**

**PF - Feeding on petiole, bud and other parts of plant**

**LF - Leaf form, feeding on leaf**

**PO - Overwintering on bark, intermediate form**

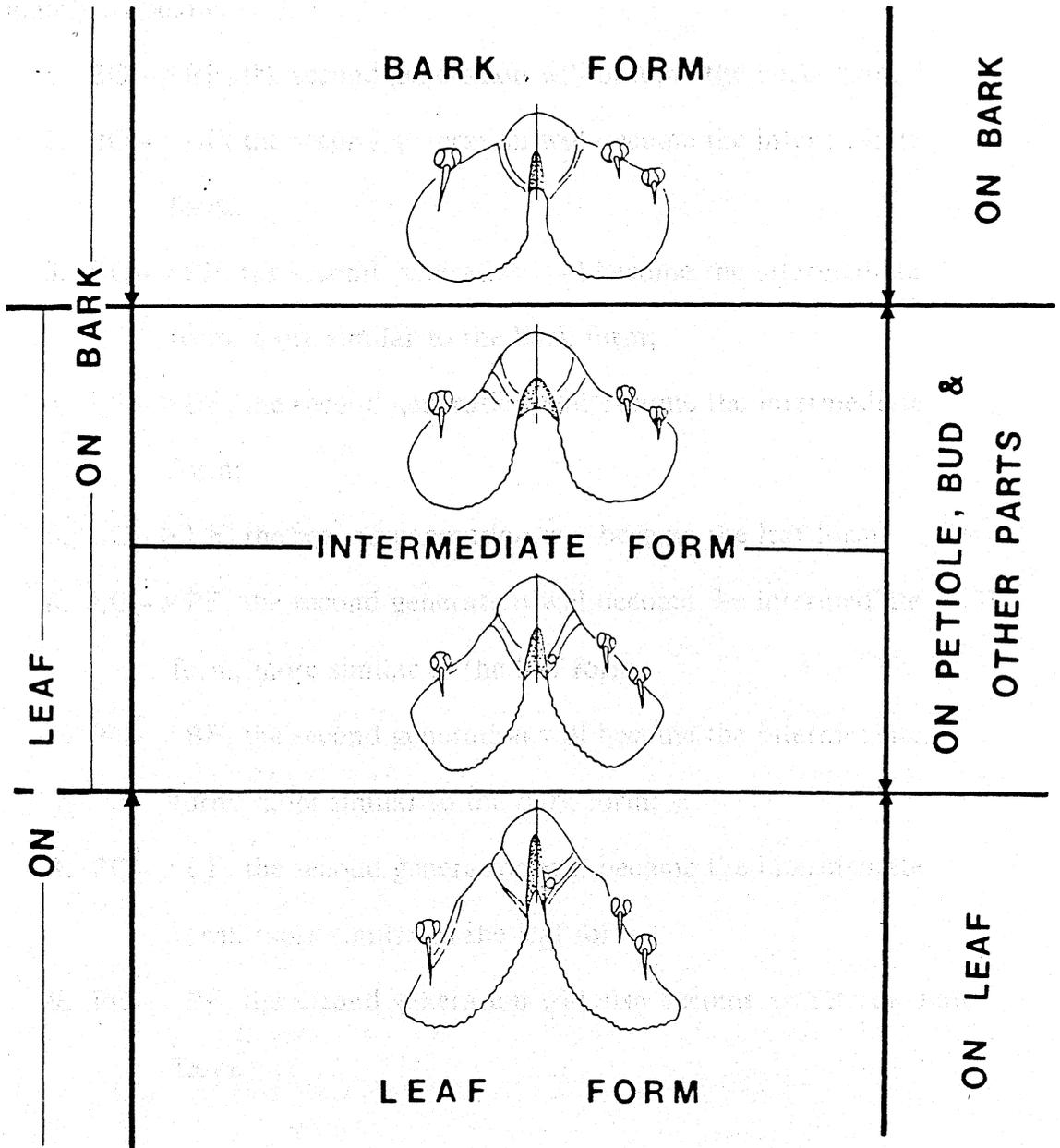


Plate 33. - Diagram of host-site associated polymorphism

The morphology of the median lobes of the new generation is thought to be affected by the crawlers, their mother, their grandmothers, and so on, but mainly as below:

1. BO-- > BF, the second generation will become the bark form;
2. BO-- > LF, the second generation will become the intermediate form;
3. BO-- > PF, the second generation will become the intermediate form, more similar to the bark form;
4. LO-- > BF, the second generation will become the intermediate form;
5. LO-- > LF, the second generation will become the leaf form;
6. LO-- > PF, the second generation will become the intermediate form, more similar to the leaf form;
7. PO-- > BF, the second generation will become the intermediate form; more similar to the bark form;
8. PO-- > LF, the second generation will become the intermediate form, more similar to the leaf form;
9. PO-- > PF, the second generation will also become an intermediate form.

If the crawler remains on the same plant part, the form or morph remains the same. If, however, the crawler selects a different plant part, the change from one morph to another always goes through an intermediate stage.

It is presumed that the forms of the second generation are not only affected by the form of their mother (the previous generation), but also by the forms of their grandmothers, greatgrandmothers, and so forth; therefore, the forms of adult females collected from the field are very rarely either typical bark forms or leaf forms, regardless of whether they are on the bark or leaves at the time of collection. This suggests that there should be an infinite number of variations of median lobes, being referred to as continuous variations in intermediate forms between the two typical bark and leaf forms.

Some coccidologists have suggested that the change of the median lobes or forms of adult females are mainly affected by the nutrition of the plant parts (Knipscher et al., 1976). Obviously the nutrition or chemical composition of the different plant parts is different. It will probably affect the development of adult females, but I believe that among different species of plants, regardless of whether they belong to the same genus or different genera, the differences in nutrition must be much greater than the differences among different parts of the same plant. The morphological characters of the median lobes in adult females of the same species remain essentially the same even though they are feeding on different hosts. Therefore, I think the polymorphism associated with different feeding sites appears to be affected by the location of the feeding sites more than the nutrition, and the physical structure of plant tissue at the feeding sites, and possibly genetic factors, also the chemical contents associated with the metabolic processes of the host.

## DISCUSSION OF PHYLOGENY BASED ON CLUSTER ANALYSIS

The phylogenetic and evolutionary relationships of all the species of *Chionaspis* in the world have not been worked out. Takagi (1985) proposed an evolutionary scenario for the genus *Chionaspis* and for the feeding polymorphism caused by feeding sites. He considered the major derivative characters (apomorphic) to include: (1) a distribution that expands from subtropical or temperate areas to cooler climates; (2) host plant range which is increasing; (3) enlarged median lobes, semicircular in shape and connected by a zygotis, and fused. He proposed that the primitive characters (plesiomorphic) include those present in two species, *C. syzygii* and *C. trochodendri*, and in some related genera (*Narayanaspis* and *Aulacaspis*). These are: separated median lobes, with less developed or without basal zygotis, and to be uniform in size and shape and with reduction in the number and size of other morphological characters.

An ideal phylogenetic and evolutionary relationship study of *Chionaspis* species requires consideration and analysis of the similarities and differences for all stages in each species as well as for both sexes. This type of analysis must consider all useful characters, including morphological, ecological, behavioral, and biological characters with traditional methods, as well as nu-

merical analysis. Unfortunately, only limited information was available for this study. Therefore, only a general discussion is provided here in addition to a cluster analysis based on 23 numerical characters in 19 species by using the 1985 version of Ward's Minimum Variance Cluster Analysis (SAS Institute, 1982). Even though the present conclusions are somewhat general, the goal was to produce a more refined dendrogram by using additional numerical data.

For the cluster analysis, the individual characters were selected and weighted. Although no one method of analysis is better than all the others in every respect, the final result will be much better if the characters are accurately chosen. Based on the numerical data available, 23 characters were chosen for use in the cluster analysis, including the length and width of the body (and their ratio), of the pygidium, median lobes, and clypeolabral shield; the distance from posterior margin of anus to base of median lobes and the distance from anterior margin of anus to the midpoint of lines between abdominal segments V and VI, the ratio of these two distances; length of anterior and posterior spiracles; the number of dorsal macroducts, of trilocular pores associated with both anterior and posterior spiracles, of gland spines and tubercles, and of perivulvar pores. Other measurements used were: diameter of anus, length and width of labium; length of antenna, and the long seta of the antenna; and the distance between the antennal bases. Each number is a mean of 10 specimens, when ten specimens were available. The resultant dendrogram is shown in Figure 1. This dendrogram gives only a general

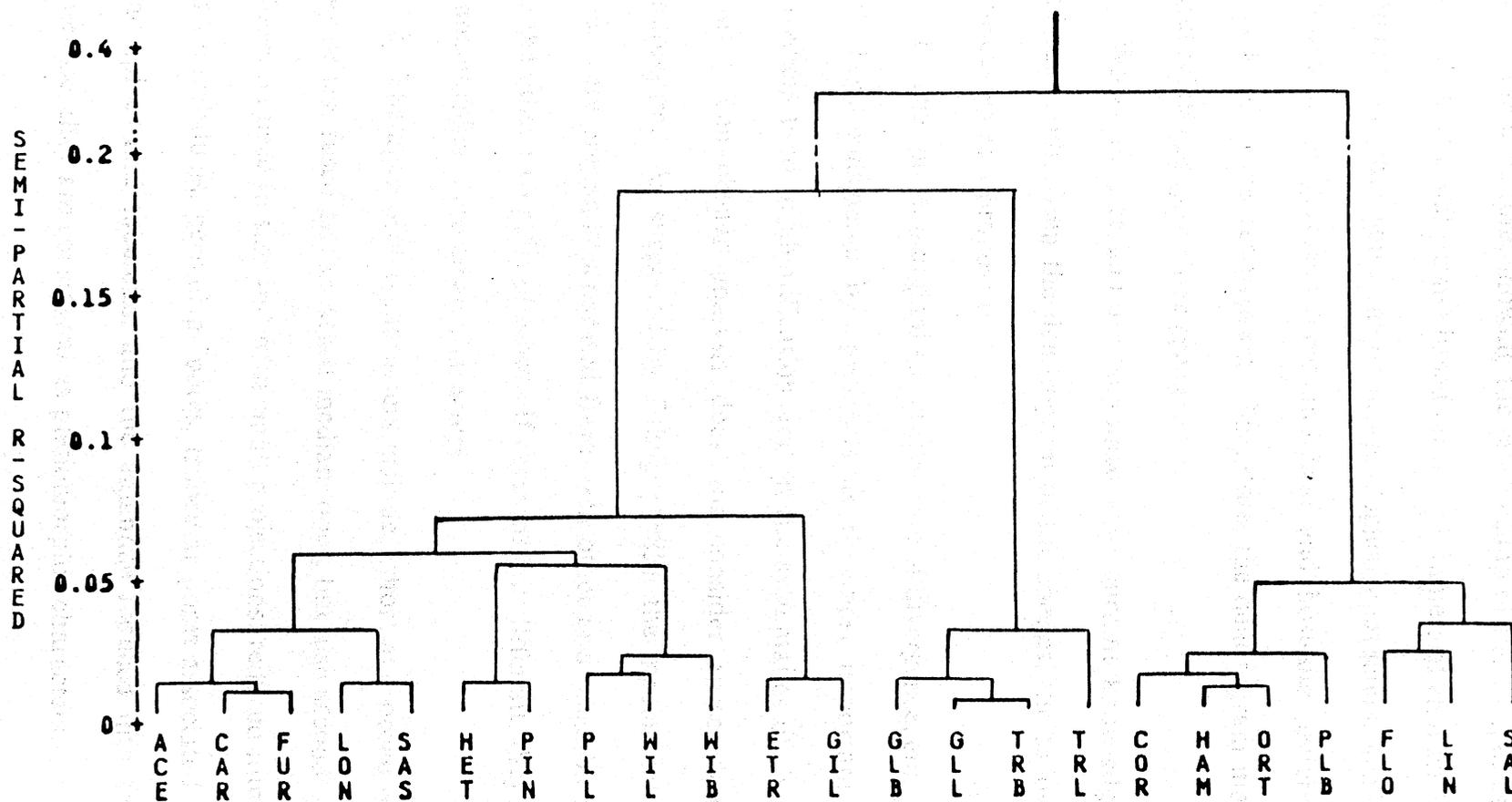


Figure 1. Dendrogram showing relationship of 19 species of *Chionaspis* based on Ward's Minimum Variance Cluster Analysis using 23 numerical characters. Species with only 1 form are abbreviated using the first 3 letters of the species name; those with 2 forms using the first 2 letters plus B for bark form or L for leaf form.

phylogenetic picture, showing the relationship of the 19 species (4 species with both bark and leaf forms) based on the 23 numerical characters. It should be pointed out that some major morphological characters, such as the special features of the pygidial lobes and host and host-site preferences, were not considered in the dendrogram. Therefore, the dendrogram may not show the exact relationship of these species.

When these results are combined with current knowledge of the group and the results from the dendrogram of the species, the following phylogeny is discussed and proposed:

1. The shape, marginal structures, rate of divergence, etc. of median lobes have been considered by specialists as the most important morphological characters used in identification and in the systematics of the species in this genus. The cluster analysis does not consider these characters in the dendrogram. As suggested by Takagi (1985), the median lobes in primitive forms were originally separated from each other and resembled in shape and size the other two pairs of lobes. If their form is different, they are considered as apomorphic (derivative) characters.

2. The apomorphic characters include: short and broad or semicircular, more or less fused and enlarged median lobes; but also second and third pairs of lobes reduced in size and with small projections; reduced numbers of dorsal and ventral ducts, perivulvar pores, trilocular pores associated with spiracles, gland spines and tubercles; and the antennae reduced into small tubercles. Otherwise, they are considered as plesiomorphic characters.

3. The evolution of all characters is not always parallel or simultaneous. Some characters may be apomorphic, others on the same species may be plesiomorphic. Many such examples are available, as in *C. salicisnigrae*, where the shape of median lobes appears apomorphic, while the development of dorsal ducts is considered plesiomorphic. In contrast, in *C. gleditsiae*, *C. nyssae*, *C. triformis*, the dorsal ducts are apomorphically reduced in both bark and leaf forms, whereas the median lobes of leaf forms are plesiomorphic.

4. Based mainly on the shape and size of median lobes and some other biological characters, which are not included in the dendrogram and should be emphasized, the species of this genus in North America are proposed to be divided into six groups:

Group 1, includes the species with the most apomorphic type median lobes which are also more or less fused: *C. americana*, *C. caryae*, *C. floridensis*.

Group 2, consists of the species with apomorphic type median lobes and with some other plesiomorphic characters: *C. acericola*, *C. corni*, *C. furfura*, *C. ortholobis*, *C. salicisnigrae*, *C. sassceri*.

Group 3, includes the species feeding on *Tamarix*, and with a posteriorly shifted anus, also with quite apomorphic-type median lobes: *C. etrusca* and *C. gilli*.

Group 4, includes the species with more or less apomorphic median lobes which are pointed and tapering at apex: *C. hamoni*, *C. lintneri* and *C. longiloba*.

Group 5, includes the 5 species with polymorphism, regardless of the shape of median lobes: *C. gleditsiae*, *C. nyssae*, *C. platani*, *C. triformis* and *C. wistariae*. But the median lobes of the bark form are obviously apomorphic-type, while those of the leaf form are plesiomorphic-type. Another related species, *C. kosztarabi*, is also included in this group.

Group 6, includes the two conifer-feeding species, *C. heterophyllae* and *C. pinifoliae* which possess the most plesiomorphic-type median lobes.

In summary, the phylogenetic and evolutionary relationships of all the species are not clear yet. The results of the dendrogram and the symplematic discussion here are only preliminary steps of a general approach in the needed relationship studies for this group. A more detailed and accurate phylogenetic study should be completed in the future, which is to be based on all the species in the world and on all the developmental stages of both sexes. A second simultaneous study being conducted in our laboratory, based on the adult males, will help to fill in existing gaps in our knowledge on the phylogeny of the genus *Chionaspis*.

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## APPENDIX

### Material Studied for *Chionaspis heterophyllae*

*Picea abies*, GA, Spalding Co., Dec. 12, 1985, coll. HHT, 3(6), VPI; Talbot Co., HHT, Jan. 22, 1975, 1(2), UGAES; IN, W. side of Hawkins Grad House, Purdue University, W. Lafayette, coll. MS, Jan. 9, 1986, 1(2), VPI.

*Picea pungens*, WA, Bellevue (fr. FL), Dec. 7, 1978, coll. J.N. Pott 1(1) FSCA.

*Pinus caribaea*, DC, April 19, 1933, coll. Spessard & Limber, 1(1), USNM; FL, Miami, Jan., 23, 1922, coll. TES, 1(3), USNM; Steinhatchee, May 9, 1978, coll. FJM, 3(3), FSCA; Lake Buena Vista, Sept. 28, 1977, coll. ABH, 2(2), FSCA; Camp Pinchot, July 3, 1932, coll. EWG, 1(5), USNM; MS, Wade, Aug. 23, 1931, coll. LEM, 3(24), UCD.

*Pinus clausa*, FL, Gainesville, March 29, 1977, coll. CL, 2(2), FSCA; Keyville, Feb. 16, 1966, coll. PSL, 1(1), FSCA; Milligan, Feb. 20, 197, coll. DR & AEG, 3(3), FSCA; Altamonte, Nov. 5, 1980, coll. RS, 3(3), FSCA; Hobe Sound, Feb. 2, 1978, coll. EWC, 2(2), FSCA; Port St. Lucie, Nov. 4, 1975, coll. EWC, 1(1), FSCA.

*Pinus echinata*, AL, Walker Co., Aug. 17, 1975, coll. MLW, 7(18), AU; Cherokee Co., Leesburg, Aug. 10, 1976, coll. CHR, 1(1), AU; Randolph Co., July 25, 1977, coll. CHR et al., 2(6), AU; FL, Brooksville, Jan. 8, 1980, coll. HLM & WJS, 2(2), FSCA; Tama, April 27, 1966, coll.

CWH, 3(3), FSCA; GA, Rest Area on I-85, Gwinett Co., Dec. 17, 1985, coll. MK, 2(6), VPI; NC, Burke Co., March 1, 1965, coll. A. H. Maxwell, 1(1), VPI; SC, Waterboro, Dec. 7, 1985, coll. MK, 2(4), VPI; Fair Play, Conce Co., Dec. 17, 1985, coll. MMK, 3(10), VPI.

*Pinus elliottii*, AL, Perdido, Baldwin Co., May 12, 1978, coll. CHR, 4(4), AU; FL, Ft. White, Columbia Co., Dec. 9, 1981, coll. KB, 4(7), USNM; Homestead, March 1, 1975, coll. FDB, 1(5), USNM; Gainesville, Feb. 24, 1966, coll. C. Bush, 1(1), FSCA; West Palm Beach, May 17, 1979, coll. RTB, 3(3), FSCA; Lake Buena Vista, Feb. 15, 1982, coll. BH, 4(4), FSCA; Morriston, Oct. 29, 1980, coll. FJM, 2(2), FSCA; Gainesville, Feb. 24, 1966, coll. AEG, 9(9), Sept. 20, 1974, coll. RCW, 3(3); March 10, 1966, coll. AEG, 4(4); Sept. 5, 1965, coll. REW, 3(3); Oct. 15, 1967, coll. KRL, 2(2), FSCA; Tyndall Air Force Base, Jan. 29, 1980, coll. DR, 4(4), FSCA; Vero Beach, Sept. 20, 1979, coll. SPB, 3(3), FSCA; Oconee, Sept. 25, 1968, coll. FLW, 5(5), FSCA; Tampa, Feb. 24, 1984, CK, 3(3), FSCA; Clermont, Feb. 22, 1980, coll. LJC, 3(3), FSCA; Ft. Walton, Jan. 28, 1981, coll. DR, 2(2), FSCA; Sanford, June, 1961, coll. COY, 2(2), FSCA; Eustis, Jan. 10, 1980, coll. LJC, 4(4), FSCA; Hinse, Sept. 21, 1970, coll. CWD & CC, 11(11), FSCA; Mayo, May 16, 1975, coll. CW, 5(5), FSCA; Starke, Feb. 7, 1975, coll. AEG, 2(2), FSCA; Archer, Jan. 3, 1980, coll. CR, 3(3), FSCA; Kissimmee, May 10, 1978, coll. GTS, 3(12), AU, 4(4), FSCA; Delray Beach, April 5, 1978, coll. JEB, 2(2), FSCA; Wausau, Aug. 21, 1975, coll. AEG, 3(11), AU, 6(6), FSCA; Wausau, Sept. 18, 1975, coll.

AEG, 4(4), FSCA; Jasper, Aug. 25, 1975, coll. CW, 4(4), FSCA; Highland Co., Archbold Sta., April 28, 1975, coll. RFD, JAD & DRM, 1(1), FSCA; Longwood, Feb. 6, 1975, coll. HMV, 2(2), FSCA; Brooksville, June 5, 1980, coll. RHP, 2(2), FSCA; Lake Jem, Jan. 21, 1980, coll. LJC, 3(3); Oct. 7, 1980, coll. LJC, 5(5), FSCA; Sarasota, Nov. 14, 1980, coll. JF, 2(2), FSCA; Groveland, Jan. 8, 1981, coll. LJC, 3(3), FSCA; Lake City, Feb. 13, 1979, coll. GTS & WJS, 3(3), FSCA; Fernandina Beach, Feb. 15, 1979, coll. CTS & WS, 3(3), FSCA; Parrish, Nov. 17, 1978, coll. JF, 4(4), FSCA; Vineland, March 22, 1978, coll. FLW, 2(2), FSCA; Winter Haven, Feb. 13, 1979, coll. unknown, 4(4), FSCA; Bowling Green, Dec. 11, 1978, coll. JF, 2(2), FSCA; Lake Wimico, Feb. 13, 1979, coll. JF, 3(3), FSCA; Sumatra, Feb. 15, 1979, coll. JF, 2(2), FSCA; Mims, July 13, 1978, coll. GTS, 5(5), AU, 5(5), FSCA; Nassau Co., Dec. 7, 1985, coll. MK, 4(10), VPI; Baldwin, March 15, 1978, coll. LSW, 4(4), FSCA; Blichton, April 1, 1980, coll. FJM(FM), 5(5), FSCA; Palm Beach, April 17, 1980, coll. MR, 3(3), FSCA; Jacksonville, Jan. 16, 1980, coll. HC, 3(3), FSCA; Apopka, May 8, 1978, coll. GTS, 1(1), FSCA; Boynton, April 5, 1978, coll. KS, 2(2), FSCA; Windermere, Dec. 7, 1973, coll. FLW, 4(4), FSCA; St. George, April 5, 1978, coll. QCA, 4(4), FSCA; Waldo, Jan. 12, 1966, coll. AEG, 3(3), FSCA; Macclenny, Jan. 23, 1975, coll. CW, 4(4), FSCA; Ferndale, July 6, 1979, coll. LJC, 2(2), FSCA; Oak Hill, Jan. 28, 1966, coll. JNP, 4(4), FSCA; Panama City, Jan. 29, 1980, coll. DR, 2(2), FSCA; Lacoochee, Dec. 18, 1965, coll. Ladonia O'Berry, 2(2), FSCA; Sebring,

July 30, 1979, coll. JF & ZS, 4(4), FSCA; Miami, Dade Co., March 26, 1977, coll. DRM, 1(3), USNM; Ft. Lauderdale, Dec. 19, 1979, coll. MM & DC, 3(3), FSCA; GA, Welcome Center, I-95, Glynn Co., Dec. 7, 1985, coll. MK, 1(3), VPI; Calhoun Co., May 28, 1968, coll. WRR, 1(1).

*Pinus glabra*, GA, Grady Co., March 6, 1974, coll. HHT, 1(1), UGAES.

*Pinus mitis*, GA, Jan. 17, 1920, coll. unknown, 1(2) USNM.

*Pinus mugo*, CT, Rockville, May 10, 1948, coll. L. Deveaux, 2(6), USNM; DC, W. Potomac Park, Sept. 27, 1944, coll. H. D. Wester, 1(9), USNM; MA, Boston, July 11, 1921, coll. HEM, 1(1); Sept. 20, 1939, coll. O. H. Hardy, 1(6), USNM; Newtonville, April 23, 1931, coll. CWC, 1(6), USNM; MO, Florissant, July 15, 1976, coll. LH, 1(7), USNM; NY, Cass Park, Ithaca, Jan. 4, 1977, coll. DGN, 1(5), USNM; Wallkill, Oct. 23, 1944, coll. R. Grill, 1(2), USNM; VA, Charlottesville, Oct. 1, 1938, coll. W. H. Stoneburner, 1(1), USNM; Hampton, Summer 1932, coll. CRW, 2(6), VPI; Hood's Nursery, Feb. 16, 1940, coll. F. R. Freund, 1(5), VPI; Insectary, VPI Campus, Blacksburg, June 7, 1976, coll. S.W. Bullington, 5(15) VPI.

*Pinus nigra*, DC, June 2, 1937, coll. unknown, 1(5), USNM; MD, Baltimore, Nov. 3, 1961, CWM, 1(4), USNM; NY, Syracuse, July 2, 1975, coll. NFJ, 5(5), FSCA; Roslyn, L. I., Dec. 8, 1943, Plummer, 1(6), USNM; PA, fr. Fern Park, FL, Dec. 15, 1966, coll. TLK, 3(3), FSCA; VA, Montgomery Co., VPI Arboretum, Aug. 13, 1985, coll. JL, 2(5), VPI.

*Pinus palustris*, AL, Dauphin Is. Mobile Co., May 13, 1978, coll. MLW, 8(13), AU; Grand Bay, Sept. 28, 1925, coll. T. C. Catchings, 1(2), USNM; South Dade Co., Aug. 29, 1975, coll. CHR, 3(5), AU; FL, Brookville, Feb. 15, 1922, coll. H. L. Sanford, 1(2), USNM; Cleveland, May 23, 1980, coll. ZS, 4(4), FSCA; Eustis, March 13, 1980, coll. L. P. DeWolf & A. L. Rentley, 1(1), FSCA; Gainesville, Sept. 20, 1974, coll. RCW, 2(2), FSCA; Miami, Sept. 2, 1919, coll. S. B. Walker, 5(9), FSCA; Lake Hamilton, Jan. 10, 1974, coll. W. E. Wynn, 1(1), FSCA; Nakomis, Jan. 20, 1980, coll. ZS, 2(2), FSCA; Okeechobee, Oct. 28, 1980, coll. SPB, 4(4), FSCA; Orchid Island, May 15, 1978, coll. SPB, 4(4), FSCA; Relay, Feb. 1, 1974, coll. RCW, 2(2), FSCA; Rockledge, March 19, 1980, coll. R. E. Burns, 4(4), FSCA; Tampa, April 26, 1966, coll. C. W. Hale, 2(2), FSCA; Vero Beach, June 27, 1978, coll. SPB, 2(2), FSCA; VA, Azalea Garden, Norfolk, May 7, 1967, coll. MK, 1(1), VPI.

*Pinus resinosa*, CT, Easton, Nov. 29, 1946, coll. GHP, 1(3), USNM; Fairfield, Nov. 12, 1950, coll. S. W. Bromley, 1(1), AU; Orange, Dec. 1, 1950, coll. GHP, 1(2), USNM; MO, St. Louis Co., July 14, 1976, coll. LRH, 1(1), USNM; NY, Syosset, L. I., Dec. 9, 1948, coll. B. Moore, 1(3), USNM; Jericho, Long Island, Oct. 25, 1944, coll. Mallia, 1(5) USNM; OH, Pike Lake, Pike Co., July 24, 1960, coll. MK, 1(2), VPI; VA, Montgomery Co., VPI Arboretum, June 26, 1985, coll. MHR & JL, 2(4), Blacksburg, April 24, 1985, 1(4), VPI.

*Pinus rigida*, **NJ**, Sept., 1956, coll. J. W. Andresen, 1(6), USNM; **NY**, Suffolk, Long Island, Nov. 16, 1943, coll. Hein, USNM; **VA**, Blue Ridge Parkway, date and collector unknown, 1(2), USNM.

*Pinus strobus*, **MA**, Amhurst, Cooley Collection, 1(3), USNM; **MD**, Glenn Dale, Sept. 12, 1940, coll. W. B. Wood, 1(1), USNM.

*Pinus sylvestris*, **FL**, Lakeland, Dec. 10, 1972, coll. GJC, 9(9), FSCA; Jasper, Dec. 30, 1975, coll. CW, 4(4), FSCA; Jacksonville, April 23, 1971, coll. SES, 8(8), FSCA; **MO**, Aug. 29, 1975, coll. LRH, 6(6), FSCA; **MD**, Croumsville, March 31, 1962, coll. S. Joseph, 1(3), USNM; **MI**, fr. Holly Hill, FL, Dec. 12, 1979, coll. JNP, 8(8), FSCA; **NC**, Greensboro, fr. Holly Hill, FL, Dec. 3, 1970, coll. JNP, 2(2), FSCA; **OH**, Bristolville, July 13, 1976, coll. DGN, 4(13), USNM; Burghill, Sept. 30, 1975, coll. DGN, 3(14), USNM; Hocking Co, April 16, 1960, coll. PF & MK, 1(2), VPI; Kirtland, March 15, 1976, coll. DGN, 2(10), USNM; Peninsula, May 1, 1975, coll. DGN, 1(1), USNM; **PA**, fr. Fern Park, FL, Dec. 15, 1966, coll. TLK, 4(4); fr. Daytona Beach, FL, Dec. 11, 1968, coll. JNP, 4(4); fr. Miami, FL, Dec. 18, 1979, coll. M. Corman, 1(1), FSCA; **RI**, Providence, Jan. 20, 1890, coll. P. Gorham, 1(1), USNM; **VA**, Blacksburg, Montgomery Co., VPI campus, Dec. 11, 1985, coll. MHR, 3(7), VPI; Montgomery Co., Brush Mt., March 27, 1974, coll. MHR, 2(3), VPI; Montgomery Co., Brush Mt., June 17, 1985, coll. MK & JL, 2(7), VPI; Fairfax Co., April 20, 1980, coll. MMK, 1(2), VPI. **CANADA**, fr. Daytona Beach, FL, Dec. 11, 1964, coll. JNP, 12(12), FSCA.

*Pinus taeda*, **AL**, Lee Co., June 21, 1977, coll. CHR, 1(1), AU; Auburn, Dec. 15, 1985, coll. MLW & MK, 1(2), VPI; **AR**, Nashville, Aug. 19, 1930, coll. P. Millar, 1(2), USNM; **FL**, Stuart, July 26, 1977, EWC, 4(4), FSCA; Tall Timbers Research Station, March 7, 1974, coll. HHT, UGAES; Winter Haven, Feb. 7, 1966, coll. G. H. Baker, 3(3), FSCA; White Springs, Dec. 15, 1985, coll. MMK, VPI; **GA**, Welcome Center West Point, Dec. 16, 1985, coll. MK, 2(7), VPI; **LA**, Urania, March 1, 1934, coll. P. Siggers, 2(9), USNM; Magnolia, Sept. 13, 1922, coll. W. Bradley, 1(4), UCD; Line Grove, June 12, 1967, coll. D. Pollet, 4(4), FSCA; **NC**, Cabarrus Co., April 13, 1965, coll. A. H. Maxwell, 1(2), VPI; **TX**, Magnolia Springs, Feb. 25, 1976, coll. R. S. Cameron, 5(5), FSCA; **VA**, Desert Beach Zone, Seashore State Park, March 19, 1969, coll. MLW & JH, 5(10), May 8, 1971, coll. PLL, 2(6), VPI; Nansemond Co., May 10, 1974, coll. MK, 2(8), VPI; Smith Mt. Lake, picnic area, Sept. 19, 1986, coll. MHR & TXL, 1(1), VPI; Williamsburg, Oct. 7, 1985, coll. MHR, 3(7), VPI.

*Pinus thunbergii*, **FL**, Crestview, Sep. 12, 1984, coll. D. Reese, 2(2) FSCA; Daytona Beach, May 11, 1966, colls. J.N. Pott & G.W. Dekle, 7(7) FSCA; Dundee, Jan. 22, 1980, coll. Training Class, 3(3) FSCA; Floral City, Oct. 29, 1980, coll R.H. Phillips, 3(3) FSCA; Samsula, June 11, 1981, coll. J.N. Pott, 3(3) FSCA; Tampa, Apr. 7, 1969, coll. E.R. Simmons, 5(5) FSCA; **MD**, Chevy Chase, Apr. 11, 1939, coll. G.F. Gravatt, 1(2)

USNM; VA, Chesapeake, Mar. 25, 1985, coll. J.C. Jenkins & B.L. Madron, 2(6) VPI.

*Pinus virginiana*, AL, near Oneonta, Blount, Co., Aug. 7, 1981, coll. CHR 3(3) AU; Auburn, Dec. 15, 1985, coll. MLW & MK, 5(9) VPI; NC, Rest area on I-40, after Statesville, Dec. 16, 1985, coll. MK, 1(2) VPI; NJ, Barrens, Sep. 1, 1974, coll. DRM & R.D. Gordon, 2(2) USNM; SC, Landrum, Dec. 6, 1985, coll. MK, 2(5) VPI; VA, Lamsburg, Dec. 17, 1985, coll. MK & M. Kosztarab, 1(3) VPI; Cheriton, Northampton Co., Aug. 16, 1978, coll. MK, 1(2) VPI; Prince William Forest Park, Sep. 14, 1985, coll. MHR, 1(2) VPI; Rankin Farm, Brush Mtn., Montgomery Co., June 17, 1985, colls. MK & J. Lasota; Smith Mt. Lake, boat dock, Sep. 19, 1986, coll. Liu, 1(2) VPI; Road to Rankin Farm, Brush Mtn., Montgomery Co., Aug. 13, 1985, coll. J. Lasota, 2(5) VPI; Campbell Co., Fort Hill Cemetery, Aug. 15, 1963, colls. MK & D.F. Vest, 1(2) VPI; Charlottesville, Feb. 9, 1967, let. fr. C.L. Morris, 1(3) VPI; Virginia Beach, Oct. 10, 1978, coll. MK, 2(3) VPI.

*Pinus* sp., AL, Auburn, Aug. 15, 1974, coll. MLW, J. Gilder, & CHR, 1(2) AU; Cullman, Aug. 9, 1979, coll. E. Paddock, 1(3) CDA; Auburn, Feb. 29, 1976, coll. B.J. Muse, 1(1) AU; Auburn, on pines of *Toumeyella* project, coll. B.J. Muse, 2(6) AU; Auburn, Forestry Plot, Nov. 2, 1977, coll. I. Daniels, 3(9) AU; Chambers, Co., 2 mi. N of Roanoke on U.S. 431, June 30, 1977, coll. MLW, 5(5) AU; Chambers Co., Oct. 2, 1976, coll. MLW, 1(2) AU; CA, Santea, San Diego Co. (fr. GA), Mar. 23,

1967, coll. B. Mathers, 7(7) CDA; Blythe (fr. NM), Jan. 12, 1985, coll. A. Guthrie, 2(5) CDA; Blythe Inspection Station (fr. SC), Nov. 11, 1982, coll. J. Suther, 4(24) CDA; CT, Norwalk, Dec. 14, 1959, coll. W. Edwards, 1(3) USNM; DC, Washington, Sep. 23, 1927, coll. W. Middleton, 1(3) USNM; Washington (fr. MD), Dec. 6, 1921, coll. H.Y. Gouldman, 1(2) USNM; FL, Boca Raton, Feb. 8, 1978, coll. K. Stolley, 6(6) FSCA; Boca Raton, Feb. 15, 1978, coll. J. Bennett, 6(6) FSCA; Brewster, July 13, 1983, coll. H.L. Gillis, 4(4) FSCA; Buena Vista, Feb. 24, 1922, coll. H.L. Sanford, 1(3) USNM; Carrabelle, Mar. 25, 1980, coll. Q. Anglin, 2(2) FSCA; Coral Gables, Apr. 11, 1974, coll. Training Class, 4(4) FSCA; Delray Beach, Nov. 22, 1979, coll. M. Sanders, 3(3) FSCA; Dover, Oct. 3, 1958, coll. C. Hale, 2(9) FSCA; Eustis, May 7, 1980, coll. L.J. Chambliss, 2(2) FSCA; Fruit Cove, May 19, 1981, coll. K. Miller, 2(2) FSCA; Ft. Myers, Apr. 15, 1980, coll. A. Gambill, 3(3) FSCA; Ft. Walton, Mar. 3, 1981, coll. D. Reese, 3(3) FSCA; Gainesville, Mar. 29, 1977, coll. C. Lieberman, 1(1) FSCA; Gainesville, June 30, 1973, coll. E. Grissell, 3(3) FSCA; Gainesville, Sep. 18, 1974, coll. G.F. Carter, 5(5) FSCA; Hawthorne, May 1976, coll. G. Decker, 3(3) FSCA; Hialeah, Oct. 24, 1979, coll. G.T. Muraoka 1( ) USNM; Hobe Sound, Sep. 7, 1978, coll. E.W. Campbell, 1(1) FSCA; Inverness, June 12, 1979, coll. A.E. Graham & R.H. Phillips, 2(2) FSCA; Jacksonville, Jan. 18, 1982, coll. J. Garbark, 5(5); Jasper, Dec. 30, 1976, coll. C. Webb, 3(3) FSCA; Jupiter, Nov. 9, 1976, coll. M. Tiriolo, 3(3) FSCA; Kendall, Apr. 25, 1966, coll. J.S. Sloan,

1(2) FSCA; Lake Buena Vista, Sep. 28, 1977, coll. F.L. Ware, 1(1) FSCA; Lake City, Sep. 7, 1978, coll. C. Webb, 3(3) FSCA; Largo, Mar. 16, 1966, coll. C.E. Bingaman, 2(2) CDA, 1(1) FSCA; Macclenny, Mar. 8, 1976, coll. C. Webb, 1(1) FSCA; Miami, Feb. 6, 1917, coll. H. Morrison, 1(4) USNM; Miami, Dade Co., Mar. 26, 1977, coll. DRM, 1(3) USNM; Miami, Mar. 24, 1980, coll. G.T. Muraoka, 1(5) USNM; Miami, Nov. 1, 1960, coll. J.R. McFarlin, 3(3) FSCA; Mims, Nov. 21, 1980, coll. L. Zellers, 3(3) FSCA; Ocala, Jan. 11, 1974, coll. F.J. McHenry, 1(1) FSCA; Ocala, Dec. 10, 1980, coll. A.L. Morrison, 2(2) FSCA; Orange Park, May 9, 1980, coll. K. Elliott, 2(2) FSCA; Oviedo, Aug. 20, 1980, coll. P. Henderson, 1(1) FSCA; Panama City, Jan. 13, 1982, coll. D. Reese, 3(3) FSCA; Panola, June 20, 1979, coll. W.J. Shirley, 3(3) FSCA; Port St. Lucie, Nov. 28, 1978, coll. E.W. Campbell, 3(3) FSCA; Punta Gorda, June 23, 1981, coll. W.T. Walsh, 2(2) FSCA; Seffner, Feb. 22, 1973, coll. S. Fuller, 9(9) FSCA; Stuart, Mat. 3, 1979, coll. E.W. Campbell, 1(1) FSCA; Tallahassee, June 20, 1979, coll. Q.G. Anglin, 4(4) FSCA; Tampa, July 5, 1966, coll. G.W. Barber, 5(5) FSCA; Vero Beach, Jan. 11, 1983, coll. E.W. Campbell, 3(3) FSCA; Wauchula, Apr. 22, 1964, coll. G.P. Lamb, 4(4) FSCA; White City, Jan. 23, 1964, coll. W.R. Llewellyn, 1(1) FSCA; Windermere, Nov. 3, 1980, coll. L. Zellers, 3(3) FSCA; Winter Garden, July 6, 1978, coll. G.T. Smith & W.J. Shirley, 1(2) FSCA; GA, Atlanta, Sep. 24, 1977, coll. GWD, 1(1) FSCA; Clinch Co., Oct. 1, 1966, coll. RB, 1(2) UGAES; Calhoun Co., Apr. 26, 1972, coll. RB, 1(1) UGAES;

Savannah, Let. Apr. 1, 1902, coll. W.F. Fiske, 1(6) USNM; Buford, Dec. 19, 1976, coll. I. Daniels, 1(1) AU; Atlanta, Sep. 24, 1977, coll. GWD, 4(4) FSCA; **KY**, Louisville, Nov. 1, 1965, coll. Don Tarter, 1(5) CDA; Louisville, Oct. 4, 1973, coll. Bob Ray, 1(7) VPI; **MA**, Springfield, May 11, 1900, coll. W.F. Yale, 1(2) USNM; Arlington, let. Jan. 8, 1909 fr. H.L. Frost, 2(1) USNM; Worcester, Aug. 25, 1920, coll. A.E. Adams, 1(3) USNM; **MD**, Beltsville, Oct. 9, 1970 fr. J.A. Fluno, 1(2) USNM; Old Edmonton Ave., Catonsville, Aug. 10, 1959, coll. MK, 4(7) VPI; Towson, Nov. 11, 1952, coll. W.N. Jeffers, 2(7) USNM; Hyattsville, Aug. 23, 1927, coll. HSM, 1(14) USNM; Univ. of Maryland, College Park, May 22, 1974, coll. SN, 1(2) USNM; **MI**, (fr. Seminole, FL), Dec. 13, 1979, coll. E.W. Miller, 2(2) FSCA; **MS**, Perkinston, Feb. 10, 1931, coll. J.P. Kislanko, 8(17) CDA; State College, Aug. 15, 1968, coll. G.W. Dekle, 1(1) FSCA; Picayune, May 11, 1929, coll. P.K. Harrison, 1(1) USNM; Ocean Springs, Dec. 14, 1907, coll. unknown, 1(4) USNM; Wade, Aug. 23, 1931, coll. H. Dietrich, 1(2) UCD; **NC**, Lucama, Mar. 22, 1959, coll. MK, 3(7) VPI; **NY**, Delphi Falls, May 1975, coll. G.A. Cooke, 23(23) FSCA; New York City, Leavitt & Son, Oct. 27, 1923, Let. C. Welford, 1(4) USNM; fr. CN, Dec. 28, 1942, coll. Burns 7 Fox, 1(2) USNM; **OH**, Conkles Hollow, Hocking Co., May 19, 1960, coll. MK, 1(3) VPI; **TN**, S of Knoxville, oct. 24, 1977, coll. I. Daniels, 5(9) AU; **TX**, Marshall, Fall 1919, coll. Hollinger, 1( ) UCD; **SC**, 8 mi. N Georgetown, May 12, 1941, coll. R.A. Cushman, 1(4) USNM; Hungting Island, Beaufort, June 21, 1969, coll.

RB, 1(1) UGAES; VA, Assateague Island, Sep. 25, 1971, coll. SN, 1(1) USNM; Brush Mt., Montgomery Co., Dec. 12, 1976, coll. J.P. McCaffrey, 1(1) VPI; Prince Edward Co., Rt. 307, Dec. 30, 1978, coll. MK, 2(5) VPI; Virginia Truck & Ornamental Res. Sta., Virginia Beach, Aug. 16, 1974, coll. P.B. Schultz, 2(2) VPI; VPI Arboretum, Blacksburg, May 25, 1967, colls. MK, S. Afifi, A. Kennedy, 2(4) VPI; Essex Co., Dec. 31, 1965 fr. C.L. Morris, 1(3) USNM; Botetourt Co., Rt. 307, Dec. 30, 1978, coll. MK, 2(2) VPI; Shenandoah Natl. Forest, Sep. 12, 1929, coll. R.G. Pierce, 1(3) USNM; Lee Co., Oct. 21, 1977, coll. I. Daniels, 6(10) AU; WV, Newcreek, May 31, 1959, coll. MK, 2(2); Mountain Creek Lodge, Pipestem State Park, July 21, 1985, coll. MHR, 2(5) VPI; MEXICO, 10 km. SE El Seco, Puebla, July 14, 1967, colls. DRM & J. Villanueva, 1(1) UCD; Sep. 17, 1975, coll. D.R. Riley, 1(3) USNM; Feb. 2, 1976, coll. F. Itule, 1(2) USNM; 12 NE Chupaderas, Sinaloa, Mar. 12, 1972, coll. DRM & F.D. Parker, 1(1) USNM.

Material Studied for *Chionaspis pinifoliae*

*Abies balsamea*, VA, Horticulture Garden, VPI campus, Dec. 10, 1986, coll. S. Femrite, 1(1).

*A. fraseri*, VA, Avery Co., June 22, 1965, coll. A. H. Maxwell, 1(3)  
VPI;

*Abies* sp., TX, Laredo, Dec. 10, 1956, coll. Fouts, Slide No. 581017,  
1(2) USNM.

*Juniperus virginiana*, VA, near Richmond, Sep. 19, 1951, coll. F.D.  
Bennett, 1(4) USNM;

*Picea abies*, IN, W side of Hawkins Graduate House, Purdue Univ.,  
W Lafayette, Jan. 9, 1986, coll. M. Shour, 2(5) VPI; OH, Antioch College  
(front of McGregor Hall), Yellow Springs, July 20, 1985, coll. L. Rhoades,  
1(2) VPI; Ohio State Univ., Columbus, June 13, 1960, coll. MK, 1(3) VPI;

*P. excelsa*, MD, Frederick 8346, June 22, 1958, coll. MK, 2(3) VPI;  
DC, Nov. 24, 1880, coll. unknown, 1(1) USNM;

*P. engelmanni*, NM, Mts. W of Springerville, July 1918, coll. GFF,  
1(1) UCD; Tres Ritos, July 16, 1946, coll. GFF, 2(2) UCD; OR, Wallowa  
Lake, Feb. 4, 1939, coll. J.I.M., 2 (9).

*P. glauca*, IA, Ames, Letr. Mar. 25&27, 1929, fr. H.H. Richardson  
1(1) USNM; MT, Missoula, Letr. Arp. 6, 1926 fr. H.R. Flint, 1(5)  
USNM;

*P. glauca* cv. *densata*, **IL**, Sep. 10, 1923, fr. D. Hill Nursery Comp., 1(4).

*P. orientalis*, **OH**, Dawes Arboretum, Licking Co., Sep. 5, 1961, coll. MK, 1(2) VPI.

*P. pungens*, **CO**, Denver, Aug. 26, 1964, coll. K.R. Langdon, 4(4) FDA; S Bdo., Aug. 7, 1941, coll. C.R. Tower, 1(1) CDA; Evergreen, Oct. 22, 1923, coll. Williams & Thomas, 5(5) FDA; **DC**, Naval Hospital, Washington, May 12, 1920, coll. H.L. Sanford, 1(5) USNM; Washington (fr. S Daytona, FL), Dec. 7, 1978, coll. J.N. Pott 2(2) FDA; **IA**, Shenandoah, Feb. 8, 1961, coll. W. Kemper, 1(1) USNM; **ID**, Montpelier, May 8, 1957, coll. GFK, 1(3) USNM; Montpelier, Sep. 3, 1963, coll. GFK, 1(7) USNM; **IL**, LaGrange, Dec. 15, 1943, coll. C.N. Hurst, 1(7) USNM; **MD**, Baltimore, 5206 Anthony Ave., Apr. 27, 1961, coll. Chas. McNair, 1 (3) USNM; **MT**, Missoula, coll. Prof. Kirkwood, Letr. Sep. 24, 1927, 1(3) USNM; **NE**, Apr. 22, 1921, coll. R.G. Pierce, 1(4) USNM; **NM**, Bernalillo Co., Oct. 4, 1977, coll. T. Davis, 1(1) UGAES; **OH**, Columbus, June 10, 1961, coll. MK, 1(3) VPI; **PA**, Mt. Airy, Philadelphia, Letr. Nov. 18, 1914, coll. M. Vernon Cassel., 1(2) USNM; **UT**, Salt Lake City, Jan. 6, 1931, coll. GFK, 1(6) USNM; Heber, Sep. 5, 1951, coll. GFK, 1(8) USNM; Maeser, June 5, 1954, coll. GFK, 1(5) BM; 6 mi. N Beaver, May 23, 1955, coll. GFK, 1(11) USNM; Midway, May 3, 1956, coll. GFK, 1(4) USNM; Uintah Co., July 11, 1956, coll. GFK, 1(3) USNM; Fort Duchesne, July 12, 1956, coll. GFK, 1(3) USNM; **VA**, VPI campus,

Blacksburg, May 19, 1969, coll. A. D'Ascoli, 1(2) VPI; WV, Peterstown, let. Nov. 23, 1946, fr. F. Waldo Craig, 1(4) USNM;

*P. rubens*, ME, St. Francis, Sep. 20, 1944, coll. J.L. Bean, C.H. Hoffman, 1(3) USNM; NC, Henderson Co., Rt. 1, Horseshoe, Aug. 2, 1970, coll. G. Chastain 1( ) USNM;

*Picea* sp., CA, Arcadia, Jan. 15, 1964, coll. J. Hodge, 1(2) USNM; CO, Denver, let. Apr. 19, 1923, coll. T.A. Schomburg, 1(3) USNM; DC (fr. CANADA), 1937, 1(3) USNM; FL, S Daytona Beach, Dec. 13, 1979, coll. J.N. Pott, 4(4) FDA; IA, Charles City, July 14, 1939, coll. C.J. Drake, 1(5) USNM; MD, Salisbury, Jan. 3, 1941, coll. unknown 1(5) USNM; Baltimore, July 6100 Wirt Ave., Aug. 11, 1958, coll. MK, 1(4); Baltimore, Slide No. MD 24, 1(2) VPI; Baltimore, June 19, 1958, coll. MK, 1(5) VPI; Baltimore, Wayne St. (Mrs. Cohen), June 19, 1958, coll. MK, 1(2) VPI; College Pk., Nov. 24, 1974, coll. JAD, 1(2) VPI; Glenn Dale, July 21, 1976, coll. SN, 1(2) USNM; MI (fr. FL), Dec. 11, 1979, coll. J.N. Pott, 4(4) FDA; MT, Billings, June 21, 1927, coll. S. Lockwood, 1(2) USNM; Corvallis, May 24, 1912, coll. RAC, Cooley No. 777, 2(9) USNM; Corvallis, May 24, 1912, coll. RAC, Cooley No. 88, 1(2) USNM; Corvallis, May 24, 1912, coll. RAC, Cooley No. 458, 1(2) USNM; NE, Omaha, let. Apr. 13, 1925, coll. H.J. Ninman, 1(4) USNM; NJ, Princeton, let. Mar. 13, 1950, coll. S.W. Bromley, 1(5) USNM; Medford Leas, Oct. 6, 1986, coll. MK, 1(3) VPI; OH, Rock House State Pk., Hocking Co., Apr. 24, 1960, coll. MK, 1(3) VPI; PA (fr. CANADA), Dec. 18, 1938, coll. A.B.

Wells, 1(5) USNM; TN, Elizabethton, let. Aug. 26, 1938, coll. G.M. Bentley, 1(5) USNM; SD, Custer (front of Forest Service Bldg.), Aug. 23, 1969, coll. E. & M. Kosztarab, 3(10) VPI; UT, Duchesne, let. Apr. 25, 1932, coll. A.W. Clemans, 1(6) USNM; VA, VPI campus, Blacksburg, May 20, 1969, coll. R.G. Blackman, 1(2) VPI; VPI Duck Pond, Blacksburg, Jan. 29, 1979, coll. MK, 1(2) VPI; Monterey, Mar. 21, 1976, coll. MK, 2(3) VPI; Blacksburg, 701 Barrlinger Drive, May 31, 1985, coll. MK, 1(5) VPI; Rockingham Co., Nov. 11, 1980, coll. L. Norcross, 1(2) VPI; Charlottesville, Univ. of Virginia campus, May 20, 1978, coll. MK, 2(2) VPI; Staunton, Dec. 6, 1963, coll. E.M. Morse, 2(4) VPI; WI, Iron Co., Oct. 30, 1947, coll. R.D. Shenegelt, 1(2) USNM; WV, Camp Creek State Pk., Camp Creek, July 19, 1985, coll. M. & B. Rhoades, 2 (6) VPI; Pipestem State Pk., Slide No. C 27, Aug. 21, 1985, coll. JL, 1(2) VPI; WY, Rock Springs, let. may 26, 1952 (fr. H.S. Beaudoin), 1(4) USNM; CANADA, Dec. 4, 1959, coll. S. Ferguson, 1(3) USNM.

*Pinus engelmannii* , AZ, S Fork Camp Cave Crk., Chiricahua Mts., July 11, 1940, coll. GFF, 4(4) AU; Cave Creek, Chiricahua Mts., July 11, 1940, coll. GFF, 1(3) UCD.

*Pinus ponderosa* var. *arizonica*, DC (fr. AZ), Feb. 6, 1929, coll. P.G. Cogswell, 1(3) USNM.

*Pinus attenuata*, CA, Glenn Co., July 7, 1917, coll. A.A. Heller, 1(2) USNM.

*Pinus ayachuite*, **MEXICO**, Mazatlan, Sinalca, Jan 1923, coll. J.G. Ortega, 1(4) USNM;

*P. ayachuite* var. *brachyptera*, **MEXICO**, near El Salto, Durango, July 12, 1898, coll. E.W. Nelson, 1(1) USNM.

*Pinus banksiana*, **OH**, Wooster, July 26, 1917, coll. PRL, 2(9) USNM; **MA**, Harvard Botanic Garden, Cambridge, July 26, 1921, coll. H.E. Morrison, 1(2) USNM.

"*P. californica*", **CA**, Santa Clara, Aug. 1903, coll. O.E. Bremner, 4(10) UCD.

*Pinus canariensis*, **CA**, Piedmont, Alameda Co., May 15, 1931, coll. F.J. March, 1(13) CDA; Santa Barbara, Aug. 2, 1973, coll. OT/Davidson, 1(6) CDA.

*Pinus cembra*, **IN**, W side of Hawkins Grad. House, Purdue Univ., W Lafayette, Jan. 9, 1986, coll. M. Shour, 1(4) VPI; **NY**, Long Island, July 20, 1953, coll. G.R. Nielsen, 1(4) USNM.

*Pinus cembroides*, **AZ**, Nogales towards Fort Huachua, Feb. 6, 1929, coll. S.D. McKelvey, 1(3) USNM; **TX**, Chisos Mts., 3(5) UCD; Davis Mts., 1921, coll. GFF, 2(3) UCD; **MEXICO**, La Laguna, Sierra La Laguna, lower California, Jan 26, 1906, colls. Nelson & Goldman, 1(2) USNM; La Laguna, Baja California, Aug. 1919, coll. GFF, 3(6) UCD; Sierra Juarez, Baja California, Mar. 16, 1968, coll. unknown 1(4) CDA.

*Pinus contorta*, CA, Lassen Natl. Forest, turn off to Willow Spring, Aug. 20, 1978, coll. CHR & RG, 20 (22); Berkeley, Oct. 30, 1939, coll. C.D. Michener, 2(13) AMNH.

*P. contorta* var. *latifolia*, ID, Ketchum, Sep. 7, 1938, coll. J.C. Evendon, 1(6) USNM; CA, Myers, Lake Tahoe, coll. Keifer, 4(20) CDA; OR, Santiana Pass, Aug. 29, 1964, coll. M. Stimmann, 1(1) CDA; Corvallis, Nov. 25, 1963, coll. M. Stimmann, 1(3) UCD; WY, Wyoming Forest, Afton, May 1, 1911, coll. J.E.Ingram, 1(2).

*P. coulteri*, CA, Stanford campus, 1937, 1(6) USNM.

*Pinus edulis*, AZ, Grand Canyon, Aug. 13, 1978, coll. L.R. Ray, 6( ) AU; Grand Canyon, June 7, 1978, coll. RJB, 1(1 AU; Flagstaff Rd., 11 mi. beyond Clemenceau, Apr. 27, 1936, coll. H. Morrison, 1(1) AU; Flagstaff Rd., 15 mi. beyond Clemenceau, Apr. 27, 1936, coll. H. Morrison, 1(1) USNM; CA, Wrightwood, Oct. 3, 1964, coll. W. Dyer, 1(2) USNM; CO, Mesa Verde Natl. Park, May 16, 1928, coll. H.E. Burke, 1(2) USNM; Glade Park, Colorado Natl. Monument, Nov. 1934, coll. E.O. Essig, 1(2) USNM; Howard, Aug. 24, 1978, coll. CHR & L.R. Ray, 6(11) AU; Mesa Co., Sep. 4, 1977, coll. K. Phillips, 1(1) UGAES; NM, Los Montoyas, San Miguel Co., July 2, 1970, coll. DRM, 2(3) USNM; San Juan Co., 10 mi. N Aztec, Aug. 13, 1981, coll. DRM & J.F. Miller, 2(4) USNM; near Hanover, Grant Co., Oct. 9, 1939, coll. E.L. Little, Jr., 1(7) USNM; near Patil, July 1918, coll. GFF, 1(2) UCD; El Paso, June 14, 1972, coll. G.R. Dunn, 1(3) USNM.

*Pinus flexilis*, **MT**, Absaroka Natl. Forest, Livingston, May 18, 1922, coll. E.P. White, 1(3) USNM.

*Pinus greggii*, **MEXICO**, Alonza, Oct. 11, 1974, coll. S. Kendall, 1(1) USNM.

*Pinus halepensis*, **AZ**, Douglas, Feb. 19, 1935, coll. W.W. Jones, 2(18) UCD; **CA**, San Diego, Mar. 26, 1940, coll. J.W. Dixon, 1(2) CDA.

*Pinus jeffreyi*, **CA**, South Tahoe, El Dorado Co., Nov. 6, 1968, coll. RFW, 2(4) CDA.

*Pinus lambertiana*, **CA**, Hat Creek, Shasta Co., Sep. 8, 1938, coll. HLM, 1(1); Nevada City, May 25, 1912, coll. EOE, 1(3) USNM; Chowchilla Mt., Mariposa Co., June 14, 1940, coll. C.R. Quick, 1(5) USNM; **MA**, Arnold Arboretum, Boston, Nov. 1960, coll. A. Rehder, 1(4) USNM.

*Pinus leiophylla*, **DC** (fr. **AZ**), Feb. 25, 1929, coll. R.G. Cogswell, 1(1) USNM; **MEXICO**, near Eslava, Sep. 17, 1903, coll. Rose & Painter, 1(3) USNM.

*Pinus michoacanae*, **MEXICO**, Uruapan, Michoacanae, Jan. 1981, coll. R. del Rio M., 4(8) USNM.

*Pinus monophyllae*, **AZ**, Tonto Natl. Forest near Payson, Aug. 11, 1978, coll. CHR & L.R. Ray, 6(6) AU; Prescott, Aug. 12, 1978, coll. CHR & L.R. Ray, 3(3) AU; **CA**, Kelso Valley, Sequoia Natl. Forest, Kern County, Mar. 7, 1963, coll. F. Raney, 8(28) UCD.

*Pinus montezumae*, **MEXICO**, near Plateado, Zacatecas, Sep. 3, 1897, coll. J.N. Rose, 1(2) USNM.

*Pinus monticola*, **ID**, Priest River, May 12, 1920, 1(5) USNM.

*Pinus mugo*, **CA**, Univ. of California at Davis, Feb. 2, 1960, coll. HLM, 3(10) UCD; **DC** (from MD), 1936, coll. unknown, 1(3) USNM; **ID**, Buhl Nursery, Buhl, May 24, 1961, coll. Toute, Wood, Shafer, 1(5) USNM; **IL**, Skokie, let. Apr. 13, 1958 fr. Corinne Millen 1(4) USNM; **KY**, Paducah, coll. Mrs. Leo Keiler, 1(2) USNM; **OH**, Lakewood, let. Apr. 28, 1923, coll. Mrs. Wilson G. Smith, 1(2) USNM; **OR**, Santiana Pass, Aug. 29, 1964, coll. M. Stimmann, 1(1) CDA; **UT**, Logan, Sep. 20, 1955, coll. GFK, 1(3) USNM; **VA**, Harrisonburg, June 4, 1981, coll. C.L. Morris, 2(6) VPI.

*Pinus nigra*, **MD**, Clifton Park, Baltimore, Nov. 1920, coll. J.F. Collins, 1(3) VPI; Same, 1(3) USNM; **OH**, Cincinnati, May 13, 1932, coll. J.N.R. Adams, 2(4) VPI; Same, 1(3) USNM; **PA**, Ancoyd, June 18, 1906, coll. W.M. Edwards 2(5) VPI.

*Pinus parviflora*, **MA**, Arnold Arboretum, Jan. 1904, coll. G.R. Shaw, 1(3) USNM.

*Pinus patula*, **MEXICO**, H.N.Y.B.G., 1(3) USNM.

*Pinus ponderosa*, **AZ**, Tonto Natl. Forest, Aug. 11, 1978, coll. CHR & L.R. Ray, 7(8) AU; Copper Basin Rd., Prescott Natl. Forest, Aug. 12, 1978, coll. CHR & L.R. Ray, 10(15) AU; Groom Cr., Prescott Natl. Forest, Aug. 13, 1978, coll. CHR & L.R. Ray, 9(13) AU; Peterson area,

Prescott Natl. Forest, Feb. 17, 1936, coll. R.W. Davidson, 1(4) USNM; Copper Basin area, Prescott Natl. Forest, Feb. 17, 1936, coll. R.W. Davidson, 2(7) USNM; Grand Canyon, July 9, 1972, coll. RB, 1(1) UGAES; Thumb Butte area, Prescott Natl. Forest, Feb. 17, 1936, coll. R.W. Davidson, 1(3) USNM; Groom Cr. Camp area, Prescott Natl. Forest, Feb. 17, 1936, 1(5) USNM; Jcn. & Sen. & up. Groom Cr. Rds., Prescott Natl. Forest, Feb. 17, 1936, coll. R.W. Davidson, 1(2) USNM; S Rim, Grand Canyon Natl. Park, May 19, 1961, coll. D.A. Pierce, 1(3) USNM; CA, Nevada City, Nevada Co., Aug. 18, 1978, coll. CHR & RJG, 13(20) AU; Hat Cr., Lassen Natl. Forest, Aug. 19, 1978, Coll. CHR & RJG, 42(53) AU; July 23, 1934, coll. G.E.P. & G.H.G., 2 (5) USNM; Susanville, May 3, 1923, coll. F.P. Keen, 1(4) USNM; Mt. St. Helena, May 6, 1939, coll. HLM, 1(2) USNM; Glass Mt. Unit, Modoc Natl. Forest, July 20, 1926, coll. F.C. Craighead, 1(3) USNM; Placerville, Oct. 20, 1918, coll. F.B. Herbert, 2(3) AU; Timber Mt., Modoc Co., Mar. 16, 1940, coll. J.W. Johnson, 3(5) AU; CO, Black Forest, 12 mi. N Colorado Springs, May 16, 1936, coll. C.R. Donaldson, 1(2) USNM; ID, Priest River, Aug. 1912, coll. J.R. Weir, 1(4) USNM; Moscow, Jan. 5, 1932, coll. J.C. Evenden, 1(4) USNM; Pondo, Oct. 13, 1941, coll. J.C. Evenden, 1(6) USNM; MT, Miles City, Oct. 19, 1918, coll. J.R. Weir, 1(3) USNM; ND, Wind Cave Game Preserve, Hot Springs, Oct. 25, 1931, coll. Mr. Hoyt, 1(5) USNM; SD, Harney Natl. Forest, E of Wyoming-S Dakota state line, July 16, 1938, coll. E.E. Carter, 1(1) AU; Same, 1(4) USNM; WA,

Cashmere, Oct. 22, 1915, coll. E.J. Newcomer, 1(4) USNM; Columbia Co.,  
Mar. 25, 1922, 1(3) USNM; Spokane, Apr. 10, 1920, coll. J.R. Weir, 3(9)  
USNM; Spokane, let. Dec. 9, 1911, coll. M.E. Estep, 1(2) USNM; S of  
Echo, June 3, 1929, coll. G.C. Hedcock, 1(4) USNM; Pullman, let. Feb.  
10, 1913, coll. M.A. Yothers, 1(3) USNM.

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