Reprint

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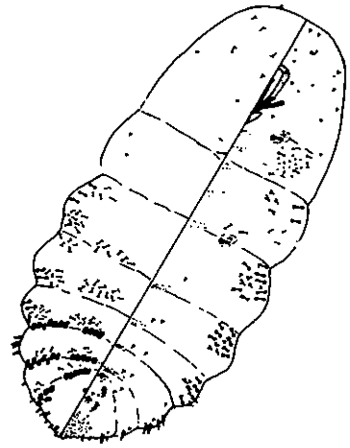
Studies on the
Morphology and Systematics of Scale Insects -- No. 15

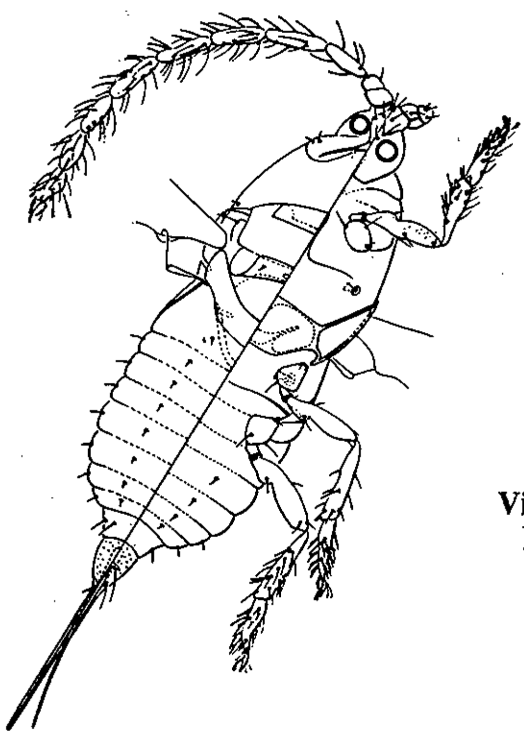


I. Biosystematics of the Adult Females of the Genus *Chionaspis* (Homoptera: Coccoidea: Diaspididae) of North America, with Emphasis on Polymorphism

Tong-Xian Liu, Michael Kosztarab, and Mary Rhoades

II. Adult Males of the Genus *Chionaspis* (Homoptera: Coccoidea: Diaspididae) in North America

Stephen W. Bullington, Michael Kosztarab, and Guang-Zao Jiang



Contribution No. 2 to the
National Biological Survey

Bulletin 88-2
Virginia Agricultural Experiment Station
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061 June 1989

James R. Nichols, Dean and Director
College of Agriculture and Life Sciences
Virginia Agricultural Experiment Station
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061-0402

The Virginia Agricultural and Mechanical College came into being in 1872 upon acceptance by the Commonwealth of the provisions of the Morrill Act of 1862 "to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life." Research and investigations were first authorized at Virginia's land-grant college when the Virginia Agricultural Experiment Station was established by the Virginia General Assembly in 1886.

The Virginia Agricultural Experiment Station received its first allotment upon passage of the Hatch Act by the United States Congress in 1887. Other related Acts followed, and all were consolidated in 1955 under the Amended Hatch Act which states "It shall be the object and duty of the State agricultural experiment stations . . . to conduct original and other researches, investigations and experiments bearing directly on and contributing to the establishment and maintenance of a permanent and effective agricultural industry of the United States, including the researches basic to the problems of agriculture and its broadest aspects and such investigations as have for their purpose the development and improvement of the rural home and rural life and the maximum contributions by agriculture to the welfare of the consumer . . . "

In 1962, Congress passed the McIntire-Stennis Cooperative Forestry Research Act to encourage and assist the states in carrying on a program of forestry research, including reforestation, land management, watershed management, rangeland management, wildlife habitat improvement, outdoor recreation, harvesting and marketing of forest products, and "such other studies as may be necessary to obtain the fullest and most effective use of forest resources."

In 1966, the Virginia General Assembly "established within the Virginia Polytechnic Institute a division to be known as the Research Division . . . which shall encompass the now existing Virginia Agricultural Experiment Station . . . "

Contribution No. 2 to the

NATIONAL BIOLOGICAL SURVEY

Studies on the Morphology and Systematics of Scale Insects - No. 15

I. BIOSYSTEMATICS OF THE ADULT FEMALES OF THE GENUS *CHIONASPIS* (HOMOPTERA: COCCOIDEA: DIASPIDIDAE) OF NORTH AMERICA, WITH EMPHASIS ON POLYMORPHISM

by

Tong-Xian Liu, Michael Kosztarab, and Mary Rhoades

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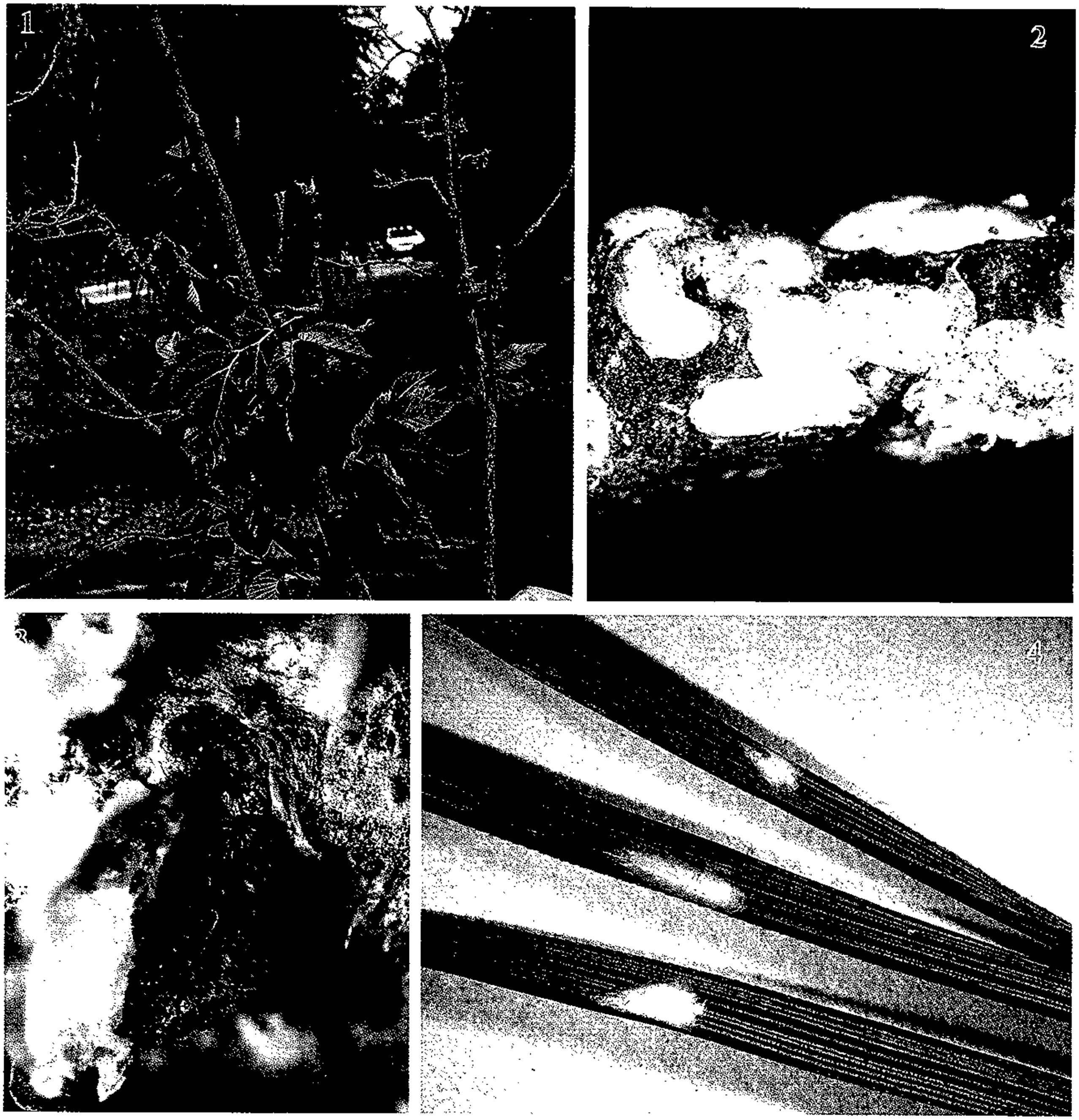
The authors are offering this publication as a contribution to a National Biological Survey, a project proposed by M. Kosztarab for the United States (Science 1984, 223:443). The survey, when initiated, will provide needed identification manuals for the animals and plants of this country.

Manuscripts for this series of bulletins are published as they become available from this university's Coccidology Laboratory in the Department of Entomology. The publisher of these bulletins is the Virginia Agricultural Experiment Station, Virginia Polytechnic Institute and State University.

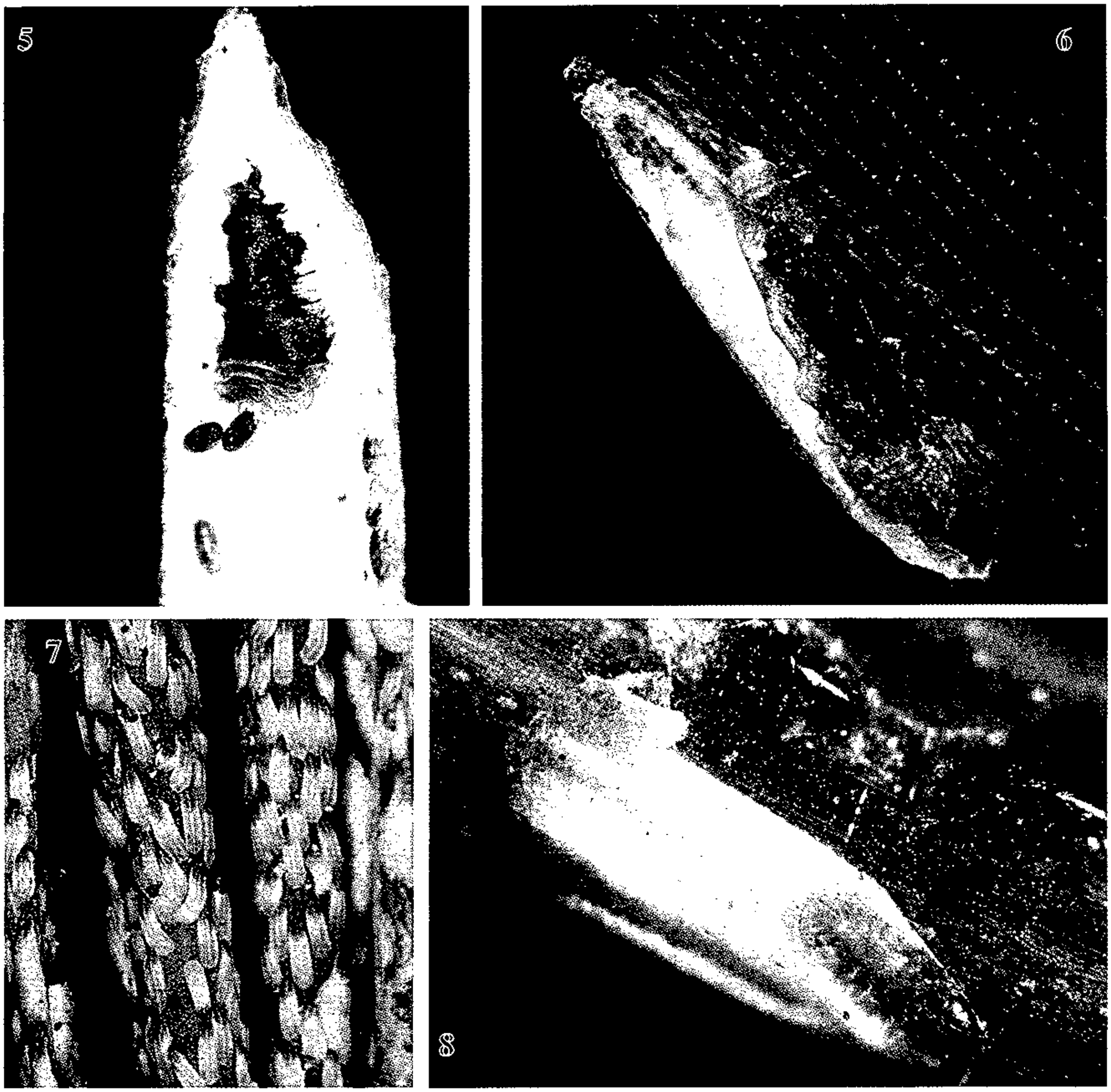
Only unpublished findings of original research dealing with the morphology, systematics, and biology of scale insects are published. Before publication, as a rule, each manuscript is reviewed by scientists familiar with the subject matter. Reviewers are named under Acknowledgments in each bulletin.

Throughout the world, scale insects are among the most important pests of agricultural, silvicultural, ornamental, and greenhouse plantings. More than 6,000 species are known; and adequate descriptions, illustrations, and keys that could enable scientists to make identification before attempting control are lacking even for the more common species. It is difficult to detect scale insects on plants because they are extremely small and often hidden. Therefore, this series of bulletins was initiated to expand our knowledge of scale insects.

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



Figs. 1-3: *Chionaspis americana* Johnson - 1, heavy infestation on young elm tree; 2, enlargement of elm twig to show female tests; 3, adult female with test removed. Fig. 4: *Chionaspis heterophyllae* Cooley - three female tests showing differences in size and shape.



Figs. 5-8: *C. heterophyllae* - 5, female laying eggs; 6, adult female with parasite inside; 7, male test on pine needles; 8, tests of an adult male and two second instar nymphs.

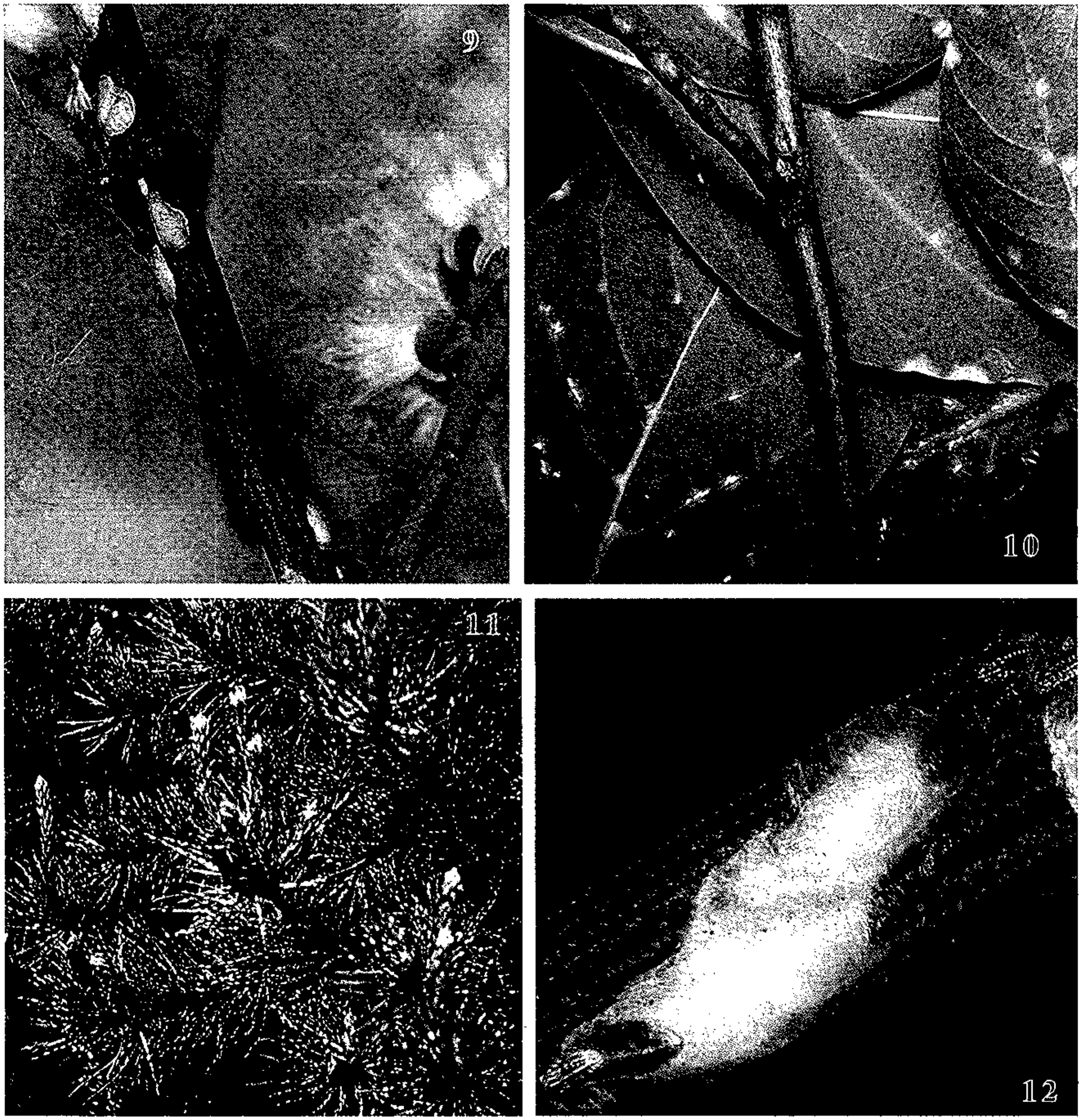
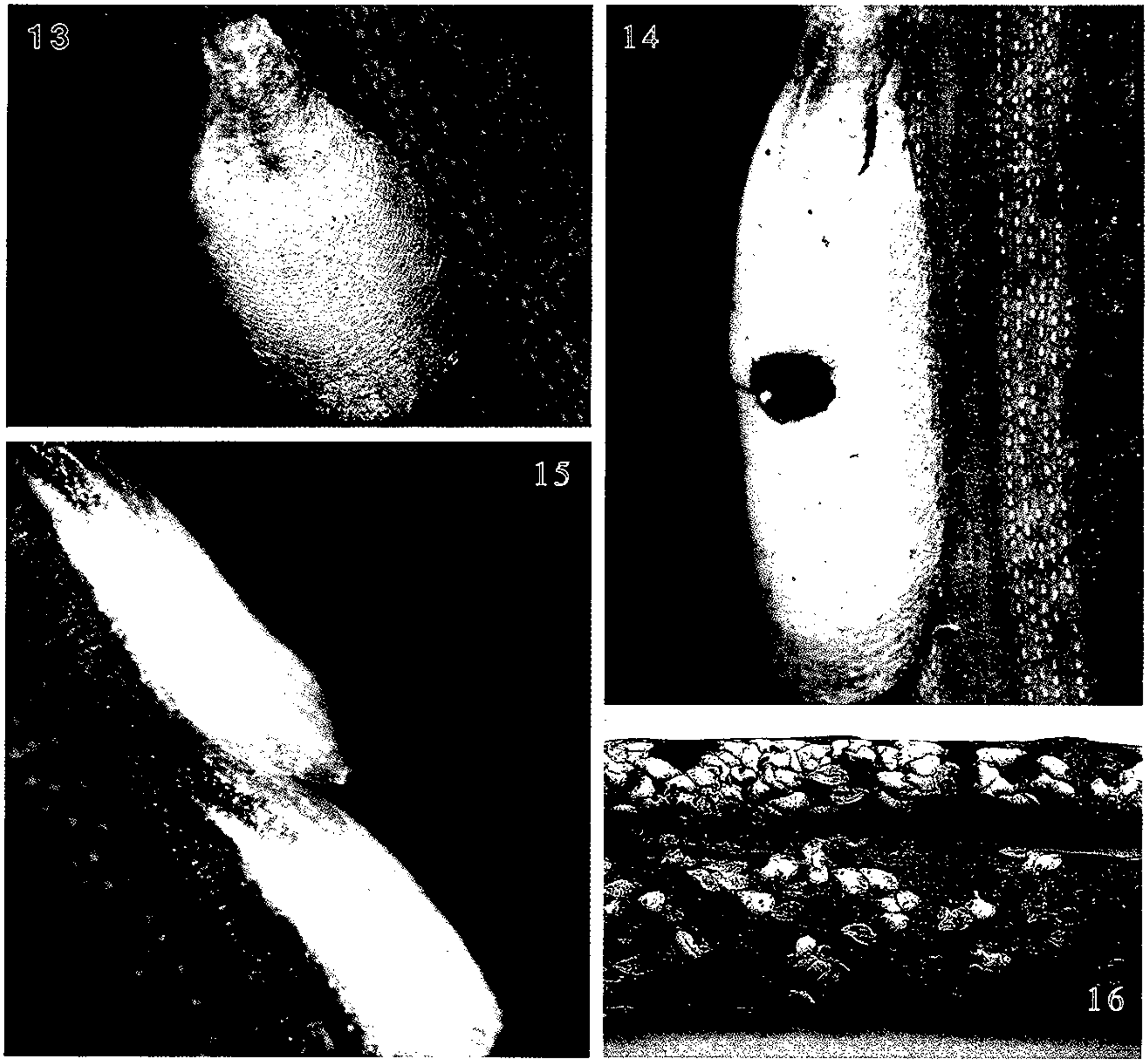


Fig. 9: *Chionaspis longiloba* Comstock on willow twig. Fig. 10: *Chionaspis nyssae* Comstock, male tests on underside of black gum leaves causing discoloration. Figs. 11 & 12: *Chionaspis pinifoliae* (Fitch) - 11, heavy infestation on needles of Scotch pine; 12, adult female tests on pine needle.



Figs. 13-15: *Chionaspis pinifoliae* - 13, adult female test on Canadian hemlock; 14, same as 13 but with emergence hole made by chalcid parasite; 15, two adult male tests on hemlock. Fig. 16: *Chionaspis salicisnigrae* (Walsh), adult female tests on willow twigs.

I. BIOSYSTEMATICS OF THE ADULT FEMALES OF THE GENUS *CHIONASPIS* (HOMOPTERA: COCCOIDEA: DIASPIDIDAE) OF NORTH AMERICA, WITH EMPHASIS ON POLYMORPHISM*

by

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CONTENTS

ABSTRACT

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

The present review includes all the 23 species in this genus from North America, with special emphasis on the polymorphism associated with feeding sites. 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 three species that have been recently redescribed--*C. americana, 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, three new species have been discovered: *Chionaspis gilli* Liu and Kosztarab, *C. hamoni* Liu and Kosztarab, and *C. styracis* Liu and Kosztarab. *C. styracis* is described here for the first time. This publication also includes many new distribution and host records for several species.

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 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 result in different morphs in first or second generations. Two keys were prepared: one for the genera of the subtribe *Chionaspidina* and another for the determination of the species of *Chionaspis* in North America.

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

ACKNOWLEDGMENTS

We would like to express our deepest thanks to Mary C. Holliman for reviewing and editing our manuscript before publication, also to Dr. F. William Ravlin of our department who advised us on the cluster analysis. Dr. Marvin L. Bobb of Charlottesville, Virginia, also reviewed the manuscript and suggested corrections.

We also thank the following persons for providing information and specimens: Drs. J. M. Cox, E. M. Danzig, A. B. Hamon, J. O. Howell, M. A. Ivie, A. Kaltenbach, D. R. Miller, T. M. Peters, R. O. Schuster, S. Takagi, and M. L. Williams, Mr. R. J. Gill, and Ms. R. J. Beshear. Institutional affiliations for these persons are given in the section "Collections and Collectors."

R. C. Knipscher, D. R. Miller and J. A. Davidson provided Plates 18 and 19; P. A. Willoughby Plates 3 and 15. Color figures were prepared from photographs by the following people: 1 and 11 by John M. Weidhaas; 2 and 3 by Daniel J. Hilburn; 4 and 5 by Mary H. Rhoades; 6, 8, 13, 14, and 15 by Joan A. Lasota; 7 and 9 by personnel of the Florida Department of Agriculture and Consumer Services, Division of Plant Industry; 10 by John M. Amos; 12 by Raymond J. Gill; 16 by personnel at Virginia Polytechnic Institute and State University.

INTRODUCTION

Signoret (1869a) established the genus *Chionaspis* based mainly on the characters of the tests of both sexes, and assigned 10 species to it. Unfortunately, of Signoret's species, only one, *Chionaspis salicis*, is still considered a 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* from North America. Of these, 6 species are accepted as members of this genus today, all of which are included in the present study. A more comprehensive work was completed by Cooley (1899). He gave descriptions and figures, and listed synonyms for all species found in North America. Nine of his species are still valid and included in this work. He also designated the European species, *Coccus salicis* Linnaeus, 1758, as the type of this genus. 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* , and chose *Chionaspis nyssae* as its type. He characterized the new genus as having the median lobes more or less sunken into the body, and having their inner margins 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 1950s, even though Ferris (1937) mentioned that there 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 is rare, and because *Chionaspis* is primarily Holarctic, while *Phenacaspis* is principally Oriental in distribution. Therefore, he rejected Takahashi's proposal, insisting that no genuine species of *Chionaspis* occurs 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 a 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 of the same host. 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 of 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). 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. Most species are extremely similar to one another in general appearance. The pygidial margin bears the characters most useful for identification. But identification is not simply a matter of discerning differences between specimens. 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, depending on association with different feeding sites on the same host tree. 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 is 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, three new species, *gilli*, *hamoni*, and *styracis*, have been described, bringing the total number of species presently included to 23 for North America.

A separate section 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 the discoveries made during the present study.

After the description of each species, the diagnostic characters revealing similarities and differences among related species are presented. 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 the genera related to *Chionaspis* and one for the species of *Chionaspis* in North America. Use of these keys depends on quality slide-mounted specimens.

The phylogenetic relationships of the species included in this study are discussed. Ward's Minimum Variance Cluster Analysis method (SAS, 1985) was used to generate a dendrogram for the 20 species with 24 forms utilizing 23 numerical characters.

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 some other countries. These institutions and individuals are listed under "Collections and collectors" and are recognized in the "Acknowledgments" section. We also collected some additional material and mounted the specimens on slides.

Collection and preservation. Most adult females occur on leaves or leaf petioles, and on bark of twigs. They are easily recognized because of the white color of their tests, 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 either into 15 x 7.5 cm cellophane envelopes with collecting information, and/or into 70% ethyl alcohol (EtOH) in 4 dram glass vials. It was our experience that if we placed the live specimens in warm EtOH, heated either with an electric hot plate in the laboratory or simply with 1 or 2 matches held under the vials in the field, we obtained better fixed specimens for mounting.

Preparation of material. All specimens were slide-mounted using a compound microscope. Live, dry, or alcohol-preserved specimens were all suitable for slide mounting. The traditional slide mounting procedure used in our laboratory is modified from Wilkey (1977), as follows:

1. If the insect was alive, we killed it in 70% EtOH (preferably warm), and left it for at least 2 hours.
2. If the insect was dead (dried on twig or stored in alcohol), we placed it in 10% KOH in a small glass dish for at least 2 hours, then tested to see if the body contents were soft by gently pressing the body with a spatula. If body fluid did not come out easily, we left the specimen longer in KOH, or heated it (below boiling) for a few minutes over an electric hotplate, and checked it again.
3. When soft enough and thus ready, we pressed out the body contents with a spatula until the specimen was clear (transparent, or nearly so). We then transferred it to 70% alcohol for about 10 minutes.

4. Next the specimen was placed in Essig's Aphid Fluid and 2 drops of Wilkey's Double Stain were added. It was left for 2 hours and checked for the intensity of staining by putting the specimen in alcohol. If it was sufficiently pink, we left it in 70% alcohol for about 10 minutes. If not, we placed it back in the stain.
5. From the 70% alcohol, we transferred the insect to 100% EtOH and left it for about 5 minutes.
6. It was then transferred to clove oil for further clearing for about 20 minutes. The insect can be stored in this for weeks.
7. To prepare a slide, we placed a drop of Canada balsam (fairly thin) diluted with xylene on the center of a slide and placed the specimen in the center of the drop, pressing it to the bottom of the balsam to keep it from drifting when the cover slip was added. A round cover slip (12, 15 or 18 mm in diameter) was placed over the specimen, and the slide was labeled with the preparator's initials, date, and an identification number and placed on a slide tray in a drying oven (40° C) for two weeks. We usually placed 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 microscrope were used for measuring. When available, 10 specimens were described and measured for each species or morph. 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 of measurements and quantitative data were chiefly based on selected and measured specimens, while the descriptions were 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 morphs, 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 morph.

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 specimens were available (e. g., *C. floridensis* and *C. triformis*), while for other species there were thousands. Host and distribution 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 number of specimens (in parenthesis), and the institutions where the material is 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 ducts are located on the three thoracic segments and on abdominal segments I-III. These ducts are generally smaller when 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. 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

Plates 3 and 15 required a different system of labeling. Legends for these special plates are as follows:

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

Abbreviations of 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 (R.T. Schuh)
AU	Auburn University, Auburn, Ala. (M.L. Williams)
BH	B. Hewitt
BM	British Museum (J. M. Cox)
CC	C. Cheliman
CDA	California Dept. of Agriculture, Sacramento (R.J. Gill)
CHR	C.H. Ray
CK	C. Kamelhair
CKL	T.D.A. Cockerell
CL	C. Lieberman
COY	C.O. Youtsey
CR	C. Riherd
CRW	C.R. Willey
CW	C. Webb
CWC	C.W. Collins
CWH	C.W. Hale
CWM	C.W. McComb
DC	D. Clinton
DGN	D.G. Nielsen
DR	D. Reese
DRM	D.R. Miller
ERS	E.R. Sasscer
EWC	E.W. Campbell
FDB	F.D. Bennett
FJM	F.J. McHenry
FSCA (or FDA)	Florida State Collection of Arthropods, Gainesville (A.B. Hamon)
FWH	F.W. Howard
GFF	G.F. Ferris
GFH	G.F. Halstead
GHP	G.H. Plumb
GTS	G.T. Smith
GWD	G.W. Dekle
HHT	H.H. Tippins
HEM	H.E. Morrison
HLM	H.L. McKenzie
HM	H.L. Morrison
HMV	H.M. VanPelt
JAD	J.A. Davidson
JEB	J.E. Bennett
JF	J. Felty
JGS	J.G. Sanders
JL	J. Lasota
JNP	J.N. Pott
JOH	J.O. Howell
KB	K. Bedat
KRL	K.R. Langdon
KS	K. Stolley
LEM	L.E. Myers
LJC	L.J. Chambliss
LRH	L.R. Hanning
LSW	L.S. Woodford
McC	H.S. McConnell
MK	M. Kosztarab
MLW	M.L. Williams
MM	M. McCullock

MOSU	Montana State Univ. (M. Ivie)	SES	S.E. Simpson
MR	M. Redfield	SN	S. Nakahara
MS	Mark Shour	SPB	S.P. Beidler
NFJ	N.F. Johnson	TES	T.E. Snyder
PANS	Philadelphia Academy of Natural Sciences, Pa. (W.W. Moss)	TLK	T.L. Kipp
PAW	Phyllis A. Willoughby	TLW	T.L. Ware
PF	P. Freytag	UCD	Univ. of California, Davis (R.O. Schuster)
PRL	P.R. Lowry	UGAES	Univ. of Georgia Agricultural Experiment Station (J.O. Howell)
PSH	P.S. Herrmann	UM	Univ. of Maryland (J.A. Davidson)
QCA	Q.C. Anglin	USNM	U.S. National Museum (Natural History) Washington, D.C., and Beltsville, Md. (D.R. Miller)
RB	R. Beshear	VDA	Virginia Dept. of Agriculture (D. Kludy)
RBM	R.B. McKee	VPI	Virginia Polytech. Inst. & State Univ., Blacksburg (M. Kosztarab)
RCW	R.C. Wilkinson	WJS	W.J. Shirley
REW	R.E. Woodruff	WRR	W.R. Rodgers
RFD	R.R. Denno		
RFW	R.F. Wilkey		
RHP	R.H. Phillips		
RJG	R.J. Gill		
RS	R. Saar		
RTB	R.T. Buchholz		

Abbreviations of states. Names for states and countries in the material studied sections of the species descriptions are capitalized and in boldface type. State names are abbreviated as given below.

AL	Alabama	MS	Mississippi
AR	Arkansas	MT	Montana
AZ	Arizona	NC	North Carolina
CA	California	ND	North Dakota
CO	Colorado	NE	Nebraska
CT	Connecticut	NH	New Hampshire
DC	District of Columbia	NJ	New Jersey
DE	Delaware	NM	New Mexico
FL	Florida	NV	Nevada
GA	Georgia	NY	New York
HI	Hawaii	OH	Ohio
IA	Iowa	OK	Oklahoma
ID	Idaho	OR	Oregon
IL	Illinois	PA	Pennsylvania
IN	Indiana	RI	Rhode Island
KS	Kansas	SC	South Carolina
KY	Kentucky	SD	South Dakota
LA	Louisiana	TN	Tennessee
MA	Massachusetts	TX	Texas
MD	Maryland	VA	Virginia
ME	Maine	VT	Vermont
MI	Michigan	WI	Wisconsin
MN	Minnesota	WV	West Virginia
MO	Missouri	WY	Wyoming

Other abbreviations.

C	Centigrade or Celsius	coll.(s).	collector
ca.	about	Comp.	company
Co.	County	Cr.	Creek

det.	determined	N	North
dia.	diameter	Natl.	National
E	East	NE	northeast
elev.	elevation	no.	number
fig.(s).	figure(s)	Pk.	Park
fr.	from	Rd.	Road
Ft.	fort	ref.	reference
Gar.	Garden	Rt.	Route
Hwy.	Highway	S	South
KOH	Potassium hydroxide	St.	Saint
let.	letter	Sta.	Station
mi.	miles	Str.	Street
min.	minutes	Univ.	University
Mt.(s).	Mount or mountain(s)	W	West

Literature citations. Original species descriptions, major references on *Chionaspis*, and articles cited in the general part are included in the Cited References list. Often articles of lesser importance (marked with an asterisk), usually 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), Russell et al. (1974), and Kosztarab and Kosztarab (1988).

THE SUBTRIBE CHIONASPIDINA

The taxon was recognized by Balachowsky (1954) as Chionaspiformes with 18 genera included and by Ghauri (1962) as Chionaspidina. Borchsenius (1966) included 21 genera in the Chionaspidina, while Chen (1983) treated 5 genera. Some inclusions are now questionable, based on Takagi's (1985) revised concept of *Chionaspis.*

The ancestral characters of Chionaspidina are well expressed in the recently described new genus, *Narayanaspis* of Takagi (1985) and its type species *N. eugeniae* Takagi. In this genus all three pairs of pygidial lobes are well developed and all the lobules are similar in shape and size to the median lobes, the latter being non-zygotic and parallel. *N. eugeniae* also possesses the largest number of large dorsal macroducts and the largest number of small dorsal macroducts along the body margin. Similar primitive morphological characters were found in two other species, also from Eastern Asia, *Chionaspis trochodendri* Takahashi and *C. syzygii* Takagi. Based on this evidence and the large number of genera and species in that area, we believe that the Chionaspidina subtribe originated in Eastern Asia. The following key is included to the eight North American genera to assist with their separation.

KEY TO THE GENERA OF THE SUBTRIBE CHIONASPIDINA IN NORTH AMERICA

1. Dorsal macroducts on abdomen definitely assymetrically distributed; only on grasses . . . . *Duplachionaspis*

-- Dorsal macroducts on abdomen more or less symmetrically distributed; normally on plants other than grasses 2

2(1). Median lobes well separated 3

-- Median lobes fused into a single lobe or at least mesal margins or median lobes closely appressed 5

3(2). Median lobes united basally, zygotic 4

-- 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*

4(3). Prosoma swollen, more or less quadrate, wider than the rest of body; median lobes forming a distinct notch in apex of pygidium; *Rubus* and *Rosa* preferred hosts . . . . *Aulacaspis*

-- Prosoma not swollen, and not quadrate; body spindle-shaped, widest at metathorax or first abdominal segment; median lobes widely divergent or close together . . . . *Chionaspis*

5(2) Median lobes fused into single lobe without division; submedian macroducts present . . . . *Quernaspis*

-- Median lobes closely appressed; submedian macroducts absent . . . . *Pinnaspis*

THE GENUS *CHIONASPIS* SIGNORET, 1869

Synonymy.
Phenacaspis - Cockerell, 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).

Major literature. Signoret 1869b:442; Cooley, 1899:1-57; Ferris 1937:13, 91; 1955:42; 1956:67; Takahashi 1952:7; 1953:48; Balachowsky 1954:317; Borchsenius 1966:1-449; Takagi and Kawai 1967:31; Chen 1983:1-175; Takagi 1985:1-77.

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.

Morphology. Plate 1 provides an illustration of the morphology of the type species of the genus, *C. salicis*. For further details on specific structures, the reader is referred to the plates of other included species.

GENERAL MORPHOLOGY OF ADULT FEMALES

Plate 1

Test of adult female (fig. A). Usually oystershell-shaped, pear-shaped or teardrop-shaped; elongate, nearly parallel-sided, or plainly broadened posteriorly, or bent to right or left side immediately beyond the second exuviae; 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 sometimes grayish white when there are some dust particles mixed in; two exuviae terminal, varying from colorless to brown or yellowish-brown, occupying about one-third or 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 tests 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, gland spines, and macroducts. Median lobes vary greatly, usually well-developed; often 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 zygosis 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 thicker and longer posteriorly.

Anal area. Anal opening circular or somewhat oval, located about middle of pygidium. In some species its location either midway between segments V and VI, or close to base of median lobes (*C. etrusca* and *C. gilli*), help with separation of species.

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 and 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 sclerotized bar and oval rim support atrium of spiracles; anterior spiracle on prothorax, laterad of mouthparts, usually somewhat larger than posterior one located between mesothorax and metathorax; anterior spiracle with 0-41 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.

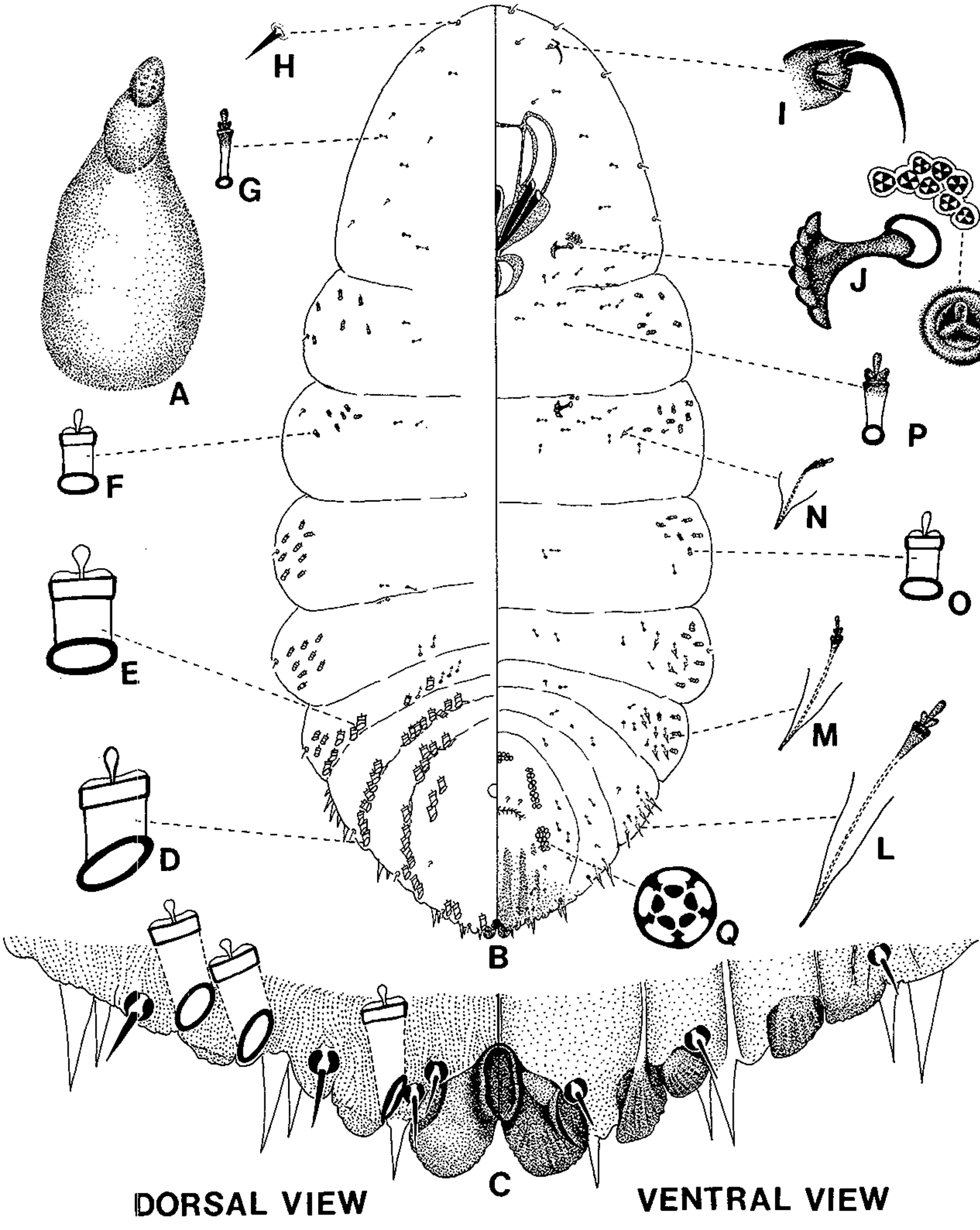

Plate 1. - General Morphology of *Chionaspis* (*C. salicis*)

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 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), always in 5 groups; usually median group smallest in number, anteriolateral group largest, and posteriolateral group between the other two in number of pores.

Note. Some coccidologists, such as Takagi and Kawai (1967), and Tang (1984), noted that there are not two prominent but small setae at the inner corner of the median lobe bases as depicted in Ferris' (1937, 1955) illustrations. Ferris considered these 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 that 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, we have checked many slide-mounted specimens at 1000-1500x magnification, and found 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 using a scanning electron microscope is recommended.

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

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, p. 74

-- 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*, p. 22

-- 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*, p. 22

-- Several dorsal submedian macroducts on abdominal segment VI; usually more than 60 dorsal macroducts on abdominal segments III-VI; on *Fraxinus*; Plate 7 . . . . *floridensis*, p. 35

5(1). Median lobes more or less elongate, their width less than half their length; usually completely separated and strongly divergent; on needles or leaf petioles of trees 6

-- Median lobes usually broad, wider than half their length; often close together at base, and not strongly divergent (except *gilli* which has 2 spines and 1 seta overlapping each median lobe) 12

6(5). Two dorsal submarginal macroducts on abdominal segment VI; commonly on leaf of *Nyssa*; Plate 19 . . . . *nyssae* , leaf form, p. 74

-- 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*, p. 78

-- 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*, p. 57

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, p. 87

-- Less than 4 dorsal submedian macroducts on most 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, p. 50

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, p. 108

-- 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, p. 114

12(5). About one-half or more of dorsal submedian duct 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*, p. 91

-- Only a few of the dorsal submedian duct groups on abdominal segments II-V very small; so small ducts or only a few in submedian group on abdominal segment VI; never with 3 dorsal marginal macroducts on abdominal segment VI, or with toothlike projections between bases of median lobes; on a variety of hosts 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; not known from *Tamarix* (except *ortholobis*) 15

14(13). Median lobes relatively long and semicircular at apex, not notched, strongly divergent and poorly sclerotized; with 2 gland spines and 1 long seta overlapping median lobes, and protruding beyond apex of median lobe; Plate 9 . . . . *gilli*, p. 43

-- Median lobes short and broad, notched on both sides, well sclerotized basally, close to each other; gland spines and setae only laterad of median lobes; Plate 6 . . . . *etrusca*, p. 31

15(13). No dorsal submedian macroducts or rarely 1 on abdominal segment III and VI on each side of body 16

-- One, but normally 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, without notches or serrations on margins, close to each other; a distinct sclerotized horizontal bar at base of median lobes; common on apples and other Rosaceae; Plate 8 . . . . *furfura*, p. 38

-- Median lobes not wider than long, not semicircular, with notches or serrations on margin, well separated; without horizontal bar at base of median lobes 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*, p. 19

-- 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 fewer than 6 from abdominal segments III-VI; on *Betula*; the southeast U.S.; Plates 27 & 30, fig. A . . . . *triformis*, bark form, p. 105

-- Dorsal submedian and submarginal macroducts totaling at least 7 or more from abdominal segments III-VI; not known from *Betula*; of wide distribution in North America 19

19(18). Ventral microducts on prosoma not clustered in two large groups laterad of anterior spiracles; outer lobule of second lobes indistinct triangular; on *Fraxinus* and *Ostrya*; Plate 15 . . . . *kosztarabi*, p. 62

-- Ventral microducts on prosoma clustered in two large groups; laterad of anterior spiracles; outer lobule of second lobes well developed, broad semicircular; commonly on *Gleditsiae*; Plate 10 . . . . *gleditsiae*, bark form, p. 47

20(15). Divergent inner margins of triangular median lobes much longer than outer margins; commonly on *Cornus*; Plate 5 . . . . *corni*, p. 27

-- Median lobes not matching above characters, on a variety of host plants 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; in western U.S. only 27

22(21). Median lobes distinctly pointed and with fingerlike tip; on *Platanus*, Plate 23 . . . . *platani*, bark form, p. 84

Median lobes without fingerlike tip 23

23(22). Several dorsal submedian macroducts on abdominal segment II 24

-- No dorsal submedian macroducts on abdominal segment II 25

24(23). Median lobes semicircular with a sclerotized bar at their base; 3-9 trilocular pores associated with each anterior spiracle; on *Salix* in Florida; Plate 12 . . . . *hamoni*, p. 54

-- Median lobes pointed, triangular, without a sclerotized bar at their base; 14-36 trilocular pores associated with each anterior spiracle; on a variety of hosts in the eastern U.S. to Texas; Plate 16 . . . . *lintneri*, p. 64

25(23). Median lobes with notch on both inner and outer margin; both inner and outer lobules of second pair of lobes with 1-3 distinct notches; 15-41 trilocular pores associated with each anterior spiracle; on *Styrax* in SE coastal states; Plate 28 . . . . *styracis*, p. 101

-- Median lobes with notch; lobules of second pair of lobes without distinct notches; 4-20 trilocular pores associated with each anterior spiracle; not known from *Styrax* 26

26(25). Median lobes acutely rounded and long; most pygidial lobes dentate or with obvious serrations; 4-10 trilocular pores associated with each anterior spiracle; on *Populus* & *Salix*; Plate 17 . . . . *longiloba*, p. 68

-- Median lobes semicircular; pygidial lobes without serrations on margin, except median lobes; 10-20 trilocular pores associated with each anterior spiracle; on *Wistaria* only; Plates 31, 32 . . . . *wistariae*, bark form, p. 111

27(21). Median lobes distinctly broad and rounded, widely separated basally; margin of 3rd lobes usually smooth; found in west coast area of U.S.; Plate 27 . . . . *sassceri*, p. 98

-- Median lobes rounded apically but close to each other with a very narrow separation; 3rd pair of lobes distinct, margins usually finely serrate; Plate 20 . . . . *ortholobis*, p. 74

CHIONASPIS ACERICOLA HOLLINGER

Plate 2

Suggested common name. Maple scurfy scale

Literature. *Chionaspis acericola* Hollinger, 1923: 20; Ferris, 1937: 14, 23, 24; 1942: 222; Sleesman, *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 (fig. B). Spindle-shaped, expanding toward posterior end, abdominal margins prominently lobed laterally; broadest at abdominal segment I or II, 637-1206 long and 464-574 wide.

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 zygosis. Second pair of lobes well-developed, inner lobule elongated and serrated on outer margin, outer lobule much smaller and slightly serrated. Third pair bilobed, somewhat reduced, both lobules with fine serrations.

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; 1-3 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. F): 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 low 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 (located on venter) 8.40-11.9 in diameter; distance from the anterior margin of anus to mid-point of the line between abdominal segments V and VI, 49.4-88.9; distance from posterior margin 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 fleshy seta, 12.7- 25.7 long; 2 short hairlike sensory setae, 2.44-4.28 long. Distance between antennal bases 49.8-79.7.

Clypeolabral shield. Shape typical of genus, 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 sclerotized atrial rim, 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&M). 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 (fig. 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 surface.

Setae (fig. H). Very few, short, small hairlike 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. McC, 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*, in Gentry Co., Missouri, in 1919. According to Ferris (*1937), it is also distributed in Texas.

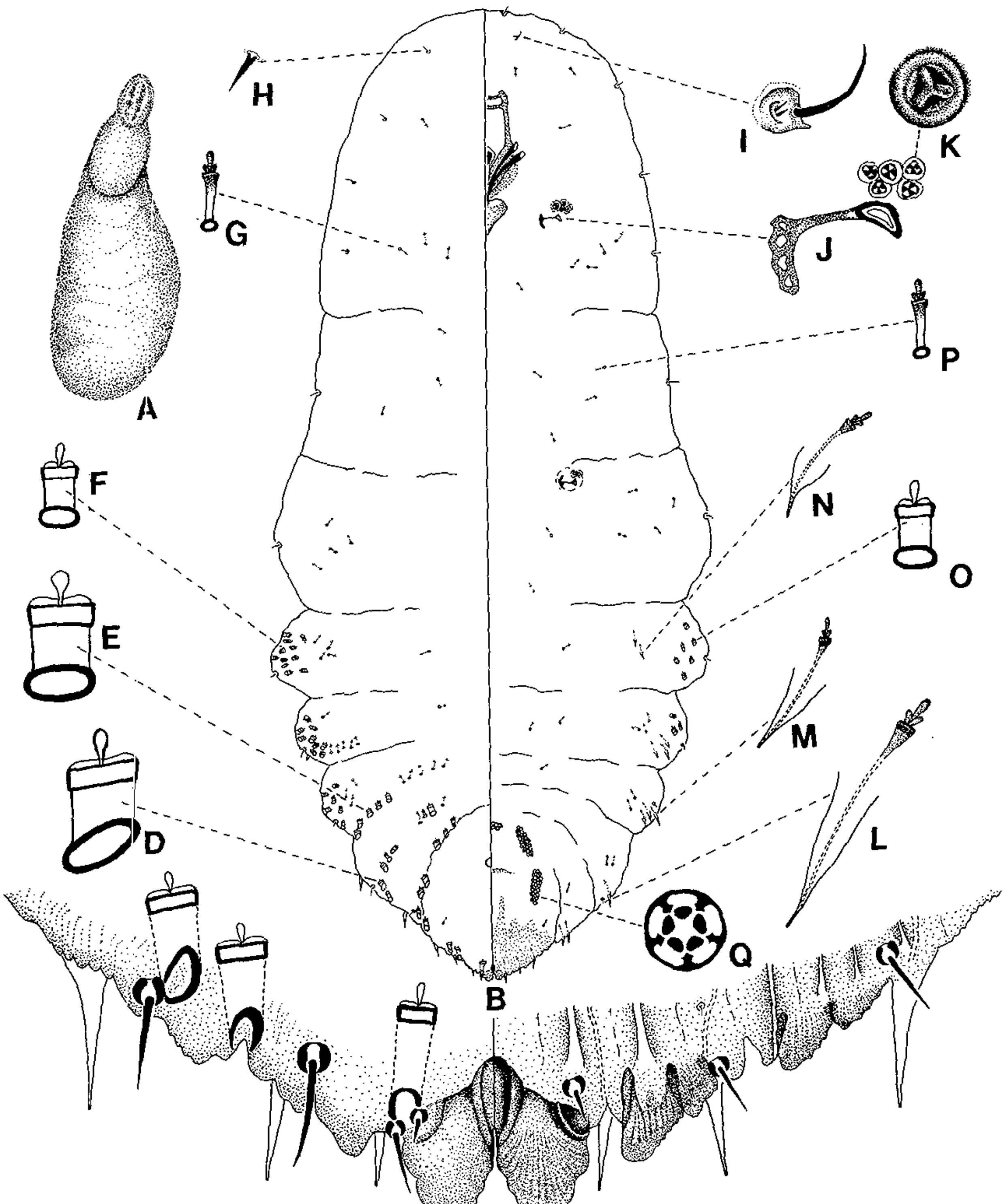

Plate 2. - *Chionaspis acericola* Hollinger

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*, *platani* and the bark form of *triformis*. We also noted that it was misidentified on several slides as *C. sylvatica*, a synonym of *C. nyssae*.

One character distinguishing *acericola* from *C. gleditsiae* is the absence of gland tubercles on three thoracic segments. The characters of *acericola* differentiating it from *C. platani* are: (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. Characters applying to *acericola* which separate it from the bark form of *C. triformis* are: (a) median lobes laterally notched; (b) several small macroducts on abdominal segments III and IV. *Acericola* differs from the bark form of *C. nyssae* in having median lobes parallel and close together at base and for about half their length, then diverging markedly.

CHIONASPIS AMERICANA JOHNSON

Color figs. 1-3. Plate 3

Common name. Elm scurfy scale.

Literature. *Chionaspis americana* Johnson, 1896:150; *1896a:380.

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 (1921).

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. Willoughby and Kosztarab (1974) gave details on morphology and biology.

This species most often infests the bark of *Ulmus*. The accompanying illustration was modified from Willoughby and Kosztarab (1974) by the first author.

CHIONASPIS CARYAE COOLEY

Plate 4

Suggested common name. Hickory scurfy scale

Literature. *Chionaspis caryae* Cooley, 1898:86; 1899: 40; Sanders, 1904: 94; Smith, *1909:126; Dietz and Morrison, 1916b: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:SIV-386; Sleesman, *1945:46; Lindinger, *1958:366; Kosztarab, 1963:65, 66; Takagi and Kawai, 1967:30, 37; Westcott, *1973:407; Willoughby and Kosztarab, 1974:5; Nakahara, 1975:201; Dekle, 1976:48; Nakahara, 1982:17; Howard and Oliver, 1985:47; Takagi 1985:38.

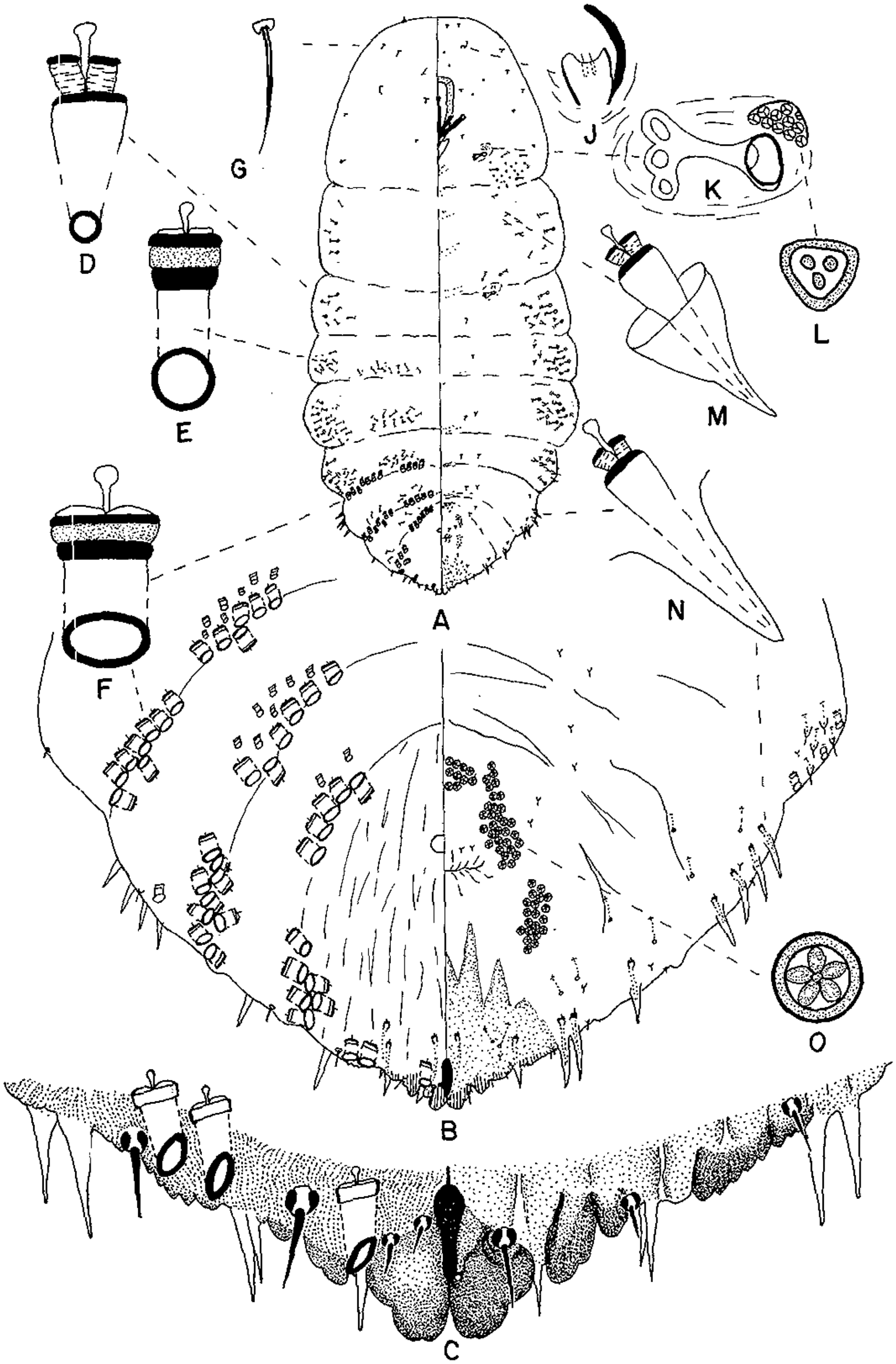

Plate 3. - *Chionaspis americana* Johnson

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.

GENERAL DESCRIPTION

Body of adult female (fig. B). Elongate spindle-shaped, 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 for about half their length, then divergent, forming a distinct apical notch; zygosis 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.

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-V, 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, hairlike, 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 margin of anus to mid-point on the line between abdominal segments V and VI, 47.3-75.1; distance from the posterior margin of the anus to the base of median lobes, 109-138.

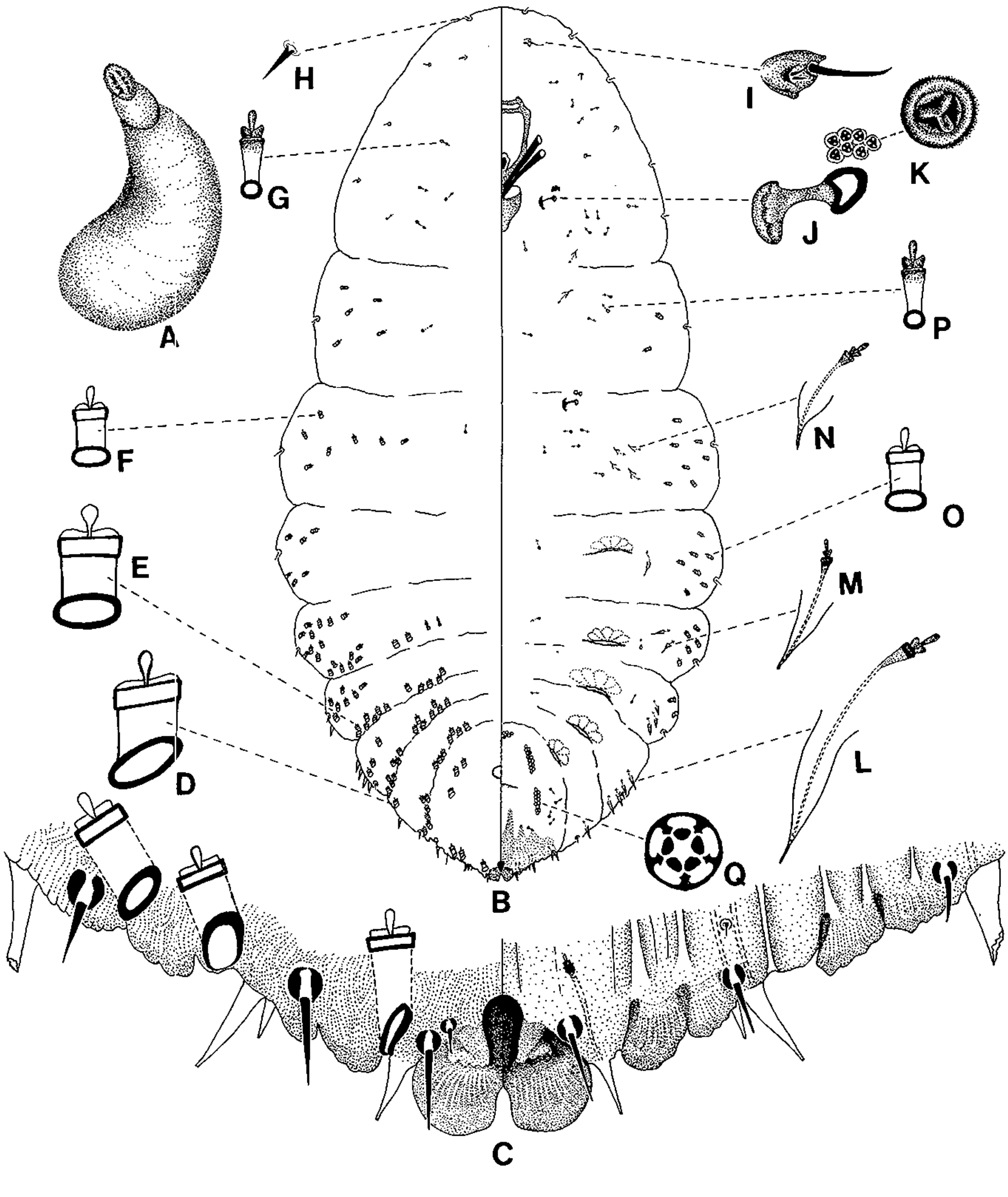

Plate 4. - *Chionaspis caryae* Cooley

Ventral Surface

Antennae (fig. I). Rudimetary, 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 one, and slightly smaller, 17.8-25.7 long, each with 0-4 associated trilocular pores.

Gland spines (figs. L&M). 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. 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 hairlike, 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. Lectotype from *Carya* sp., **DC**, Washington, Sept. 27, 1896, coll. unknown, 7(13) USNM; coll. unknown, 1(1) USNM. Paralectotypes: same data as lectotype, 6(12) USNM; 2(2) MOSU; Washington, date & coll. unknown, slide No. 7241, 1(1) USNM, 1(1) MOSU; Washington, Cooley No. 19, 3(3) USNM; April 15, 1895, coll. Pergande, 1(4) USNM; April 15, 1895, coll. unknown, 1(1) 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. 23, 1977, coll. AEG, 6(6) FSCA. *Carya illinoensis*, **FL**, Monticello, Feb. 19, 1964, coll. GWD and R.H. Miller, 5(5) FSCA; Monticello, March 30, 1965, coll. R.H. Miller, 5(5) FDCA, 3(3) CDA; Monticello, Apr. 8, 1965, coll. R.H.

Miller, 5(5) FSCA, 2(5) CDA; Monticello, Oct. 11, 1968, coll. R. H. Miller, 4(4) FSCA; Live Oak, April 19, 1979, coll. AEG & C. Webb, 3(3) FSCA; **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) FSCA; same only May 10, 1921, 2(4) FSCA; Anthony, March 23, 1962, coll. AEG 4(4) FSCA; Blichton, April 6, 1967, coll. AEG, 5(5) FSCA; Anthony, May 8, 1968, coll. E. W. Holder, 5(5) FSCA; Indrio, Jan 14, 1980, coll. E.W. Campbell, 1(1) FSCA. **OH**, Flint, Sept. 28, 1917, coll. PRL, 1(4) USNM.

Host and distribution. This species was first described from the bark of hickory, *Carya* sp., at Washington, DC, in 1883. Since then it has been collected from the same host genus in FL, LA, OH, NC, and recorded in the literature from IA, MO, 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 distinguishable 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 fused for only 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 are 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 zygosis 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 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 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: 269; Severin and Severin, *1909:297; Smith, *1909: 126; Douglass, *1911: 187; Dietz and Morrison, 1916b (1914-1915): 267; Hartman, *1916: 101; Lawson, *1917: 264; Houser, *1918: 290; McGillivray, 1921: 331; Britton, *1923: 363; Felt and Morrison, *1928: 198; Trimble, *1928: 45; Ferris, 1937: SI-16; Ferris, 1942: SIV-446; McKenzie, 1956: 93; Kosztarab, 1963: 66, 67; Takagi and Kawai, 1967: 30, 38; Harrison, *1972: 74; Swan and Papp, *1972: 165; Nakahara, 1975: 201; English, *1976: 20; Nakahara, 1982: 17; Takagi, 1985: 39.

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 (fig. B). 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.

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 zygosis. 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.

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, hairlike, 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 margin of the anus to the mid-point of line between abdominal segments V and VI, 49.4-74.1; distance from posterior margin 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.

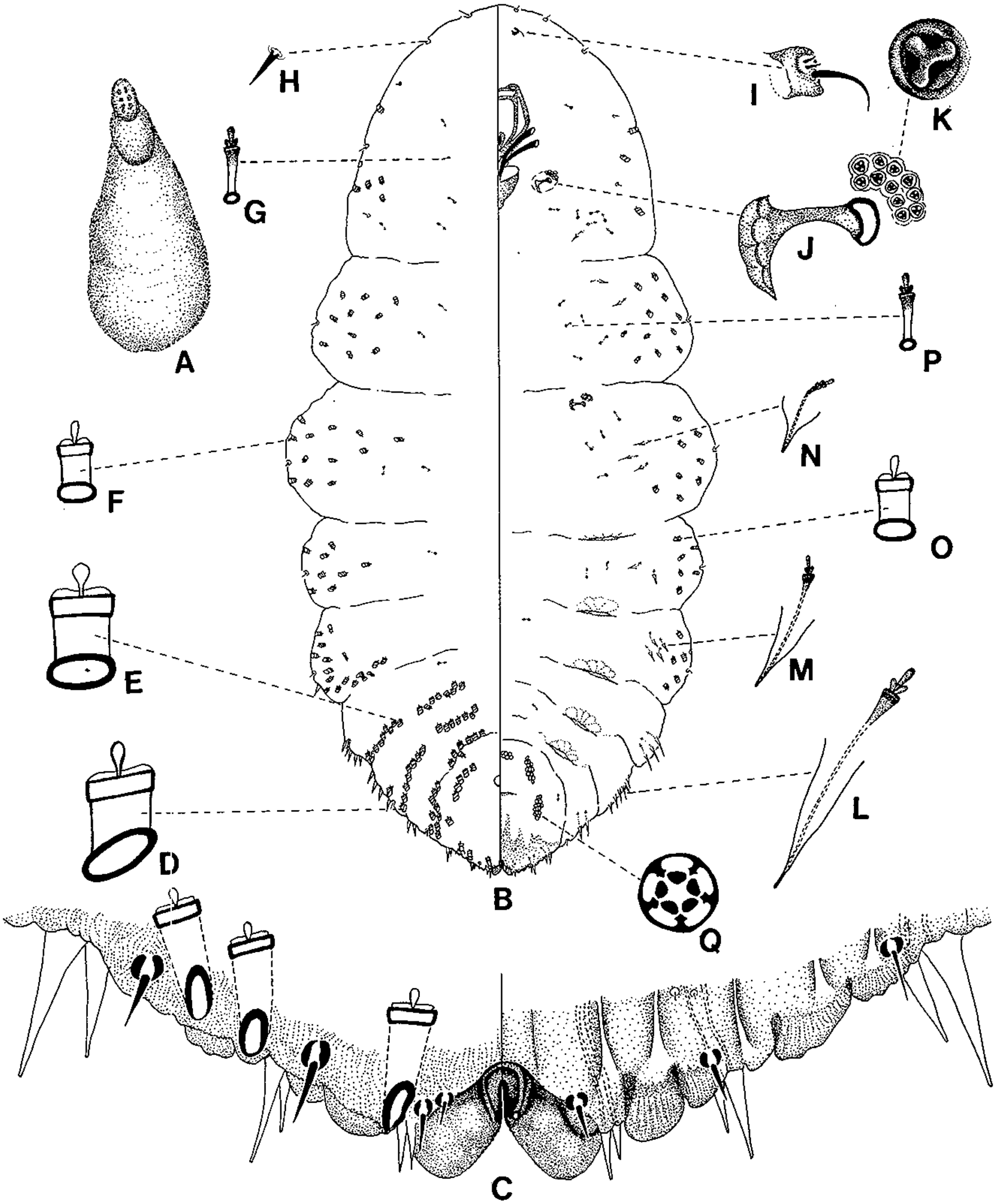

Plate 5. - *Chionaspis corni* Cooley

Spiracles. Anterior (fig. J) 22.2-34.0 long and atrium 7.6-9.5 wide; 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 (figs. L&M). 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. 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 on 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 on 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; usally more numerous near spiracles and in submarginal areas of basal segments.

Setae (fig. H). Very few slender and hairlike, 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. Lectotype from *Cornus paniculata*, **MA**, Reading, no date, coll. CKL, 1(4), including 3 paralectotypes, USNM. Paralectotypes, no date, coll. A.H. Kirkland, 1(7) [also 1 slide with ca. 18 tests] USNM; no city, 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, 2(4) BM, 1(7) USNM; **PA**, Presque Is. Erie, Oct. 5, 1922, coll. F.M.Trimble, 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.W. 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; **VA**, 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. Geo. G. Atwood, 2(9) 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. W of Woodfords, Sept. 9, 1960, coll. RFW, 2(9), CDA, 1(3) USNM; 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, 1(15) USNM; **OH**, Flint, May 30, 1917, coll. PRL, 4(15) USNM; **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 descibed from the bark of *Cornus paniculata* and *C. alternifolia*, Reading, MA. It has been found in 10 states and is widely distributed in North America where its hosts are available.

Note. A rare *Septobasidium* was noted with the colonies of this scale insect on *Cornus stolonifera* in Michigan (Harrison, *1972). Further studies on its potential as a biological control agent are suggested.

Affinity and discussion. Among the North Amerian 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, 1908:184; *1918: 212; *1920: 234; Ferris, *1921: 93; MacGillivray, 1921: 332; Kuwana, *1928: 24; Ferris, 1937; SI-17; Lupo, *1938: 272; Essig, *1941: 590; Ferris, 1942: SIV-387, SIV-446; Borchsenius, *1950b: 194; Takahashi, 1952: 10; Bodenheimer, 1953: 12; Balachowsky, 1954: 320, 330, 334; McKenzie, 1956: 97; Gomez-Menor, *1967; 127; Nakahara, 1975: 201; Gill, 1982:1; Nakahara, 1982: 17; Hadzibejli, *1983: 180, 181, 274; Takagi, 1985: 39.

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

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 (fig. B) 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.

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 zygosis. Second pair of lobes bilobed, heavily sclerotized; 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.

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 hairlike, 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 sclerotized atrial rim; 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 (figs. L&M). 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 (fig. 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.

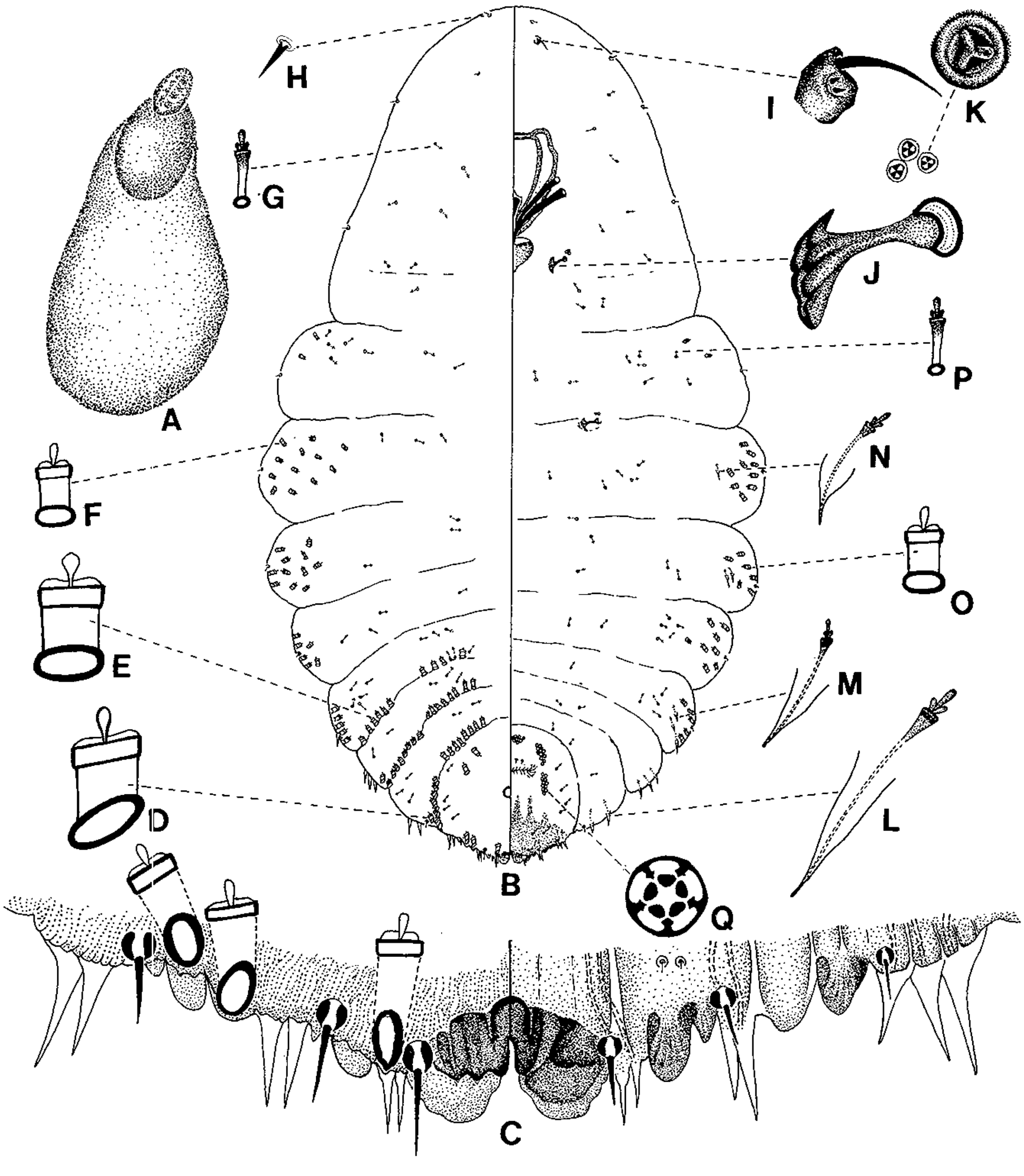

Plate 6. - *Chionaspis etrusca* Leonardi

Setae (fig. H). Short and hairlike, 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. Lectotype from *Tamarix* sp., **ITALY**, Cecina, (Toscana), 1908, coll. Leonardi?, 1(1) USNM. Paralectotypes, 10(10), same data as lectotype; from *Tamarix* sp., **ITALY**, Cecina, Toscana, Sept. 26, 1923, Let. F. Silvestri, 1(2) USNM; Tuscany, coll. unknown, Chermotheca Italica IV #88, 1(3) USNM.

Other material studied. *Salix* sp. (Probably a host misidentification), **AZ**, Phoenix, Mar. 9, 1935, coll. R.H. Caldwell Jr., 1(6) USNM. *Tamarix aphylla*, **AZ**, Sacaton, at DC, Nov. 22, 1944, coll. H.Y. Gouldman, 1(3) USNM; no city, at DC, Dec. 13, 1945, coll. Wood, 1(3) USNM; **CA**, Coachella, Near High School, Jan. 7, 1924, coll. Harry Blom, 7(30) USNM. *"Tamarix articulata"*, **AZ**, Tucson, April 20, 1929, 5(9) UCD; Tucson, Feb. 7, 1925, coll. LPW, 5(51) UCD; no city, 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. Nichol, 2(6) UCD; Salt River Valley, Phoenix, Aug. 8, 1923, coll. Perry Glick, 3(8) USNM, 1(2) UCD, 2(4) VPI, 1(2) UCD, 1(2) CDA, 1(2) FSCA; **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 parviflora*, **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, 3(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, Stickney Coll., rec'd 1937, 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, no date coll. unknown, 3(13) UCD; Coachella, 1921, coll. R.C. Fleury, 1(5) USNM; Coachella, May 5, 1919, coll. Sharp, 1(2) UCD; Coachella, May 5, 1919, fr. Chamberlin, 1(2) 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.McDaniel, 1(2) UCD; San Bernarding 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; Stanislaus 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; Indio River Co., Feb. 5, 1963, coll. M.K. Hess, 1(5) CDA; **NM**, Hildago Co., 5.3 min. N Cotton City, July 26, 1969, coll. D.R. Liesner, 1(1) CDA; **TX**, Vinton, Aug. 7, 1939, coll. Joe Chrisler, 1(3) USNM. **ITALY**, No location, Chermotheca Italica, Mar. 11, 1925, no collector, 1(2) BM; no location, Chermotheca Italica 88, from R.S. Woglum, 1920, 3(10) UCD; Tuscany, Chermotheca Italica IV, #88, no date, no collector, 1(4) USNM; **MEXICO**, Juarez, Mar. 14, 1973, coll. L. Holquin, 1(1) USNM.

Host and distribution. This species was first described from the bark of *Tamarix* sp. (family Tamaricaceae) in Italy. Since then it has been collected and recorded from several localities in the world including the Canary Islands, Corsica, France, Japan, Mexico, North Africa, Spain, Turkey, United Soviet Socialist Republic, and the United States. 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 *etrusca*.

While checking the specimens from CA, AZ and Mexico, we found that some of them had very different median lobes. In order to make sure whether 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 authors 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; Dekle, 1976:49.

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

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 margins; basal zygosis 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 hairlike 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 margin of the anus to mid-point of the line of abdominal segments V and VI, 51.87-83.98; distance from the posterior margin 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 (figs. L&M). 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 (fig. 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, and meso- and metathorax on both sides of body;

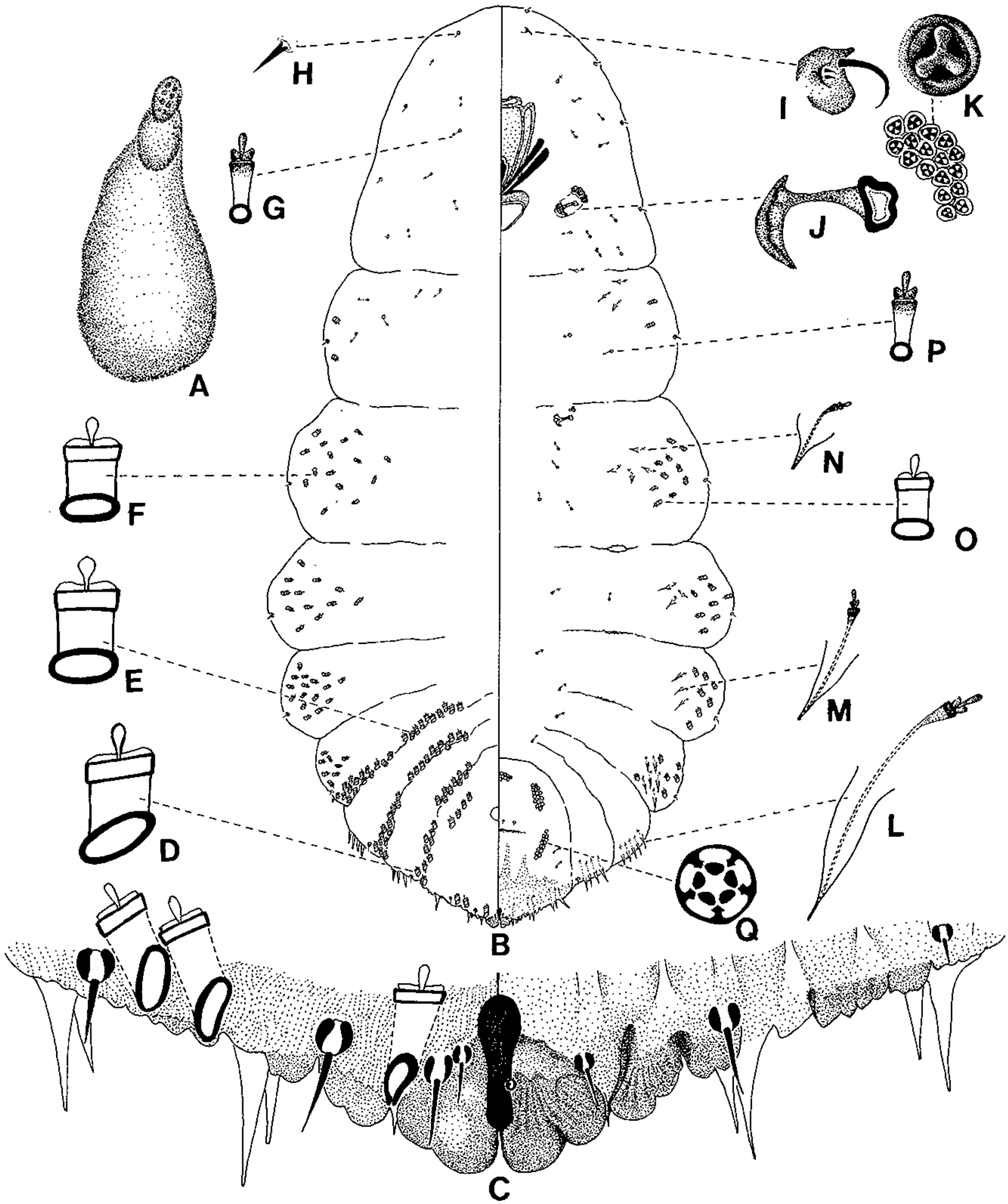

Plate 7. - *Chionaspis floridensis* Takagi

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, hairlike, 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. Lectotype from *Fraxinus* sp., **FL**, O'Leno St. Park, July 19, 1961, coll. GWD, 1(1) FSCA. Paratypes, same data as lectotype, 2(2) FSCA.

Other material studied. *Betula nigra* **FL**, Cracker Bend, April 10, 1969, coll. AEG, 6(6) USNM. *Betula* sp., **FL**, 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 the bark of *Betula* and *Fraxinus* in Florida.

Affinities and discussion. This species differs from the related *C. americana* by having: (1) the dorsal submedian macroducts present on segment VI, and (2) the dorsal macroducts more numerous (over 60).

CHIONASPIS FURFURA (FITCH)

Plate 8

Common name. Scurfy scale

Selected literature and synonymy. *Aspidiotus furfurus* Fitch, 1857: 352.
Aspidiotus cerasi - Fitch, *1857a:358;
Coccus harrisii - Walsh, *1866:31.

Chionaspis furfura - Comstock, *1880: 315; Cooley, 1899: 23; Dietz and Morrison, 1916b:270; Hollinger, 1923: 23; Ferris, 1937: SI-18; 1941: 343; 1942: SIV-386; Hill, 1952:1; McKenzie, 1956:97; Kosztarab, 1963: 68, 69; Takagi and Kawai, 1967: 30, 38; McComb and Davidson, *1969: 1; Herting and Simmond, *1972: 178; Swan and Papp, *1972: 165; Beshear et al., 1973: 9; Bobb, *1973: 16; Willoughby and Kosztarab, 1974: 2; Nakahara, 1975: 201; 1982: 18; Howell and Tippins, *1976: 179; Howell and Williams, *1976: 188; Johnson and Lyon, *1976: 322; Dekle, 1976:50; Schuder, *1979: 1; Knight and Heikkenen, *1980: 281; Lambdin and Watson, 1980: 80; Takagi, 1985: 39.

Chionaspis furfura var. fulvus - King, *1899: 334.

Before 1910 the species name 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 by other workers.

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 zygosis; a distinct and very narrow transverse sclerotic bar at the base of each 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.

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 II; in some individuals, 1-5 microducts mixed with or in lieu of submedian macroducts on abdominal segment V.

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.

Anal area. Anal opening circular, 9.88-12.4 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, 61.8-86.5; distance from posterior margin of anus to base of median lobes, 109-148.

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 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 (figs. L&M). 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 (fig. 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 segments 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. G. 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. *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; **PA**, Philadelphia, Mar. 14, 1906, coll. H.A. Surface 1(6) USNM. *Cotoneaster* sp., **CA**, Fresno, Henderson's Exp. Gar., Mar. 17, Apr. 13, and Aug. 17, 1939, coll. J.W. Dixon, 3(7) CDA; **IN**, Vincennes, Old Cathedral, Nov. 3 1941, from Paul T. Ulman, 1(6) USNM; **OH**, Lake Co., Sept. 27, 1967, coll. P. Kohankie, 7(8) CDA. *Crataegus "ageralus"*, **MD**, Yarrow, Jan. 3, 1921, coll. F.H.B., 1(3) USNM. *Crataegus crus-galli*, **PA**, Nov. 15, 1943, coll. W.B. Wood 1(3) USNM; *Crataegus oxyacantha*, **DC**, Washington, Botanical Gardens, July 16, 1909, coll. ERS, 1(4) USNM. *Crataegus pinnatifolia*, **MD**, Yarrow, Dec. 17, 1921, coll. F.H.B., 1(1) USNM. *Crataegus* sp., **CT**, New Haven, Jan. 27, 1919, coll. PRL, 2(8) USNM; **DC**, July 16, 1909, coll. ERS, 1(3) USNM. **GA**, Richmond Co., May 18, 1972, coll. RB, 2(3) UGAES; Eatonton, Oct. 26, 1975, coll. S. Smith, 1(1) UGAES; Macon Co., Sep. 10, 1976, coll. RB, 1(1) UGAES; Putnam Co., Feb. 24, 1976, coll. D.J. Kinard, 1(1) UGAES; **LA**, Baton Rouge, coll. GFF, 1(6) UCD; **MD**, Yarrow, Jan. 11, 1921, coll. H.Y. Gouldman, 1(7) USNM; **NY**, Medina, N.Y. Insecticide Co. Inc., let. July 31, 1926, coll. unknown, 1(4) USNM; **OH**, East Harbor State Park, Lot # A-7, Sept. 6, 1960, coll. MK, 1(4) VPI; Tuscarawos Co., Near Newcomb, Sept. 5, 1961, coll. MK, 1(2) VPI; **TX**, no city, coll. Marshall, T-856, 2(4) UCD; Dekalb, Sep. 30, 1970, coll. Sue Smith, HHT-190-70, 1(1) UGAES; College Station, July 6, 1916, coll. unknown, #T311-13, 1(1) UCD; College Station, 1921, coll. GFF, #T220, 1(2) UCD. *Cydonia* sp., **MD**, Baltimore, Greenmount Ave. Cemetery, March 10, 1943, collrs. Spessard & Vinzant, 1(5) USNM. *Juglans cinerea*, **OH**, Wooster, Aug. 13, 1920, 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, 1(2) VPI. *Malus pumila*, **OH**, Hocking Co., Neotoma, April 16, 1960, coll. MK and

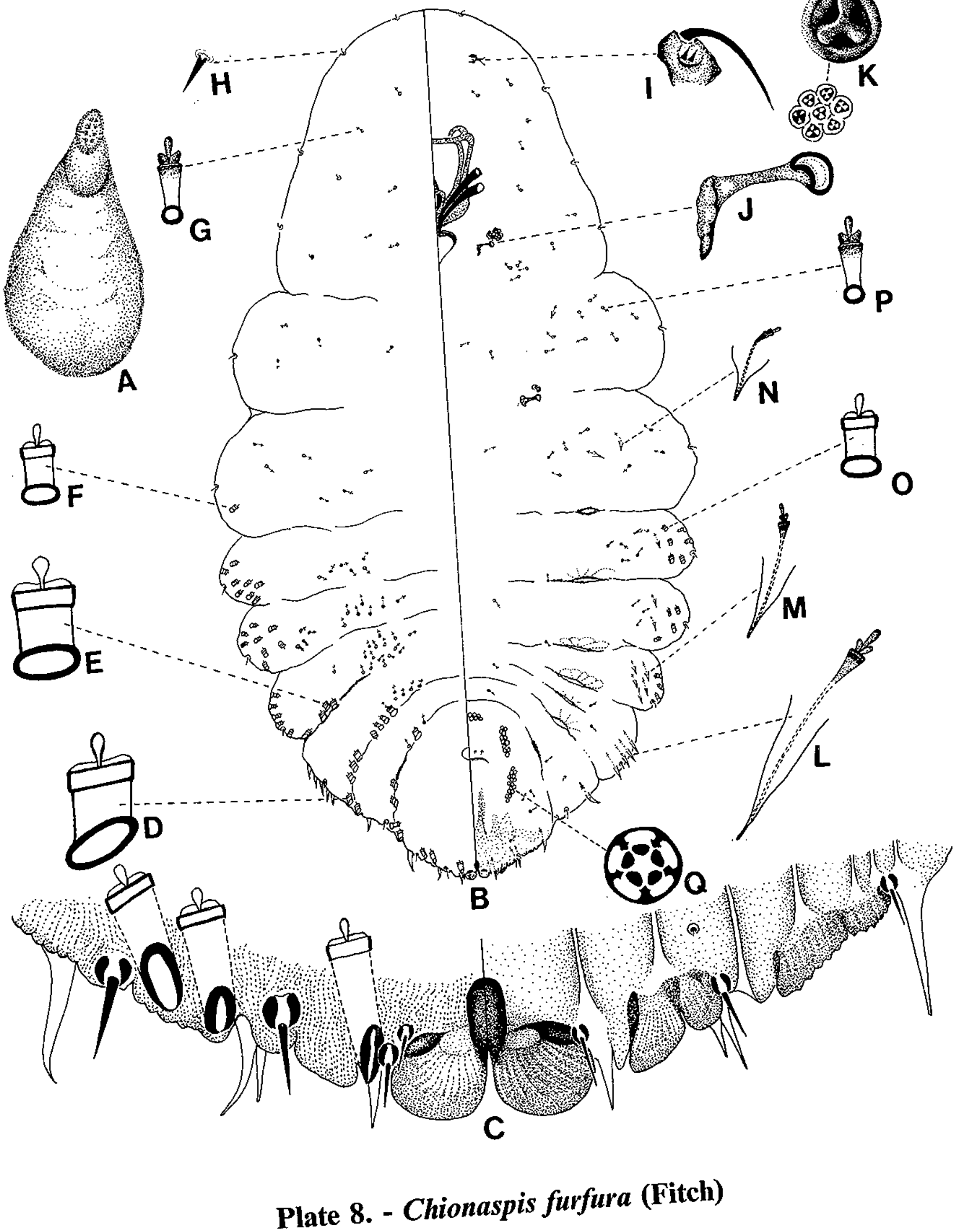

Plate 8. - *Chionaspis furfura* (Fitch)

P. Freytag, #02, 1(4) VPI; **VA**, James Madison College, Harrisonburg, May 8, 1975, coll. MK, VA 1292, 2(4) VPI; **OH**, Logan Co., July 9, 1961, coll. MK, #O221, 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; **DC**, Washington, Oct. 13, 1908, coll. ERS, 1(1) USNM; June 25, 1936, coll. LPW, 9(129) UCD; **GA**, Spalding Co., Nov. 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. More, #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; no city, 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. unknown, #ACC.3169, 2(3) 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; **MA**, Jamaica Plains, July 29, 1910, coll. ERS, #225, 2(4) USNM; Lawrence, coll. G.B. 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.W. Deane, 1(2) UCD; **NY**, Staten Island, 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; **PA**, Pittsburg, Oct. 6, 1957, coll. W.F. Brown, 1(2) UCD; **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; Winchester, let. Dec. 21, 1949, coll. J.H. Knode, Jr., 1(4) USNM; **WV**, Shepherdstown, let. Mar. 17, 1921, coll. C. Wysong, 1(7) USNM; Charleston, Kanawha Co., Mar. 11, 1980, coll. C.C. Coffmen, 1(1) USNM; Reedsville, Preston Co., May 29, 1982, coll. G.W. Gibson, 82-5465, 3(7) USNM; **CANADA**, Ontario, Glanford, let. May 13, 1907, coll. J. Fred Smith, 1(5) 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, 3(3) FSCA. *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 persica*, **GA**, Ft. Valley, Feb. 15, 1906, coll. A.L. Quaintance, 2(12) USNM; 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. *Prunus* sp., **MO**, Louisiana, Nov. 1899, coll. Stark Bros., 1(4) USNM; **OH**, Columbus, July 2, 1917, coll. PRL, 1(6) USNM. *Pyracantha coccinea*, **MD**, Yarrow, Dec. 18, 1921, coll. F.H.B., 1(2) USNM; **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, 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, 1(12) USNM; St. Louis, Dec. 1, 1941, fr. Howard Baker, 1(4) USNM. *Pyrus communis*, **VA**, Montgomery Co., Cambria, Sep. 22, 1973, coll. MK, VA 1289, 2(3) VPI. *Pyrus japonica*, **PA**, Philadelphia, let. Mar. 14, 1906, coll. H.A. Surface, 1(6) USNM. *Pyrus pyrifolia*, **MD**, Bell Station, Nov. 21, 1928, coll. H.L. Sanford, 1(3) USNM. *Pyrus ussuriensis*, MD, Bell, Mar. 14, 1922, coll. H.Y. Gouldman, 1(3) USNM. *Pyrus* sp., **FL**, Chattahoochee, Apr. 10, 1933, coll. W.L. Kersey, 45203, 2(3) FDA; **GA**, Henry Co., Oct. 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) FSCA; Bell. Sta., Aug. 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, 6(12) FDA; **VA**, Abingdon, Yard, Extension Bldg., July 8, 1980, coll. MK, 3(7) VPI. *Rhamnus cathartica*, **MA**, Lawrence, no date, coll. GBK, 1(2) USNM. *Ribes* sp., **IA**, Mechanicsville, March 22, 1921, coll. Gist and Mowry, 8816, 4(8) FDA; **IN**, Indianola, March. 11, 1922, coll. Mowry and Thos., 3(6) 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 aucuparia*, **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; **PA**, Rickerts Nursery, Morrisville, Aug. 26, 1943, coll. G.B. Sleesman, 2(9) VPI. *Sorbus* sp., **NC**, Top of Mt. Leconte, Great Smoky Mountains July 2, 1968, coll. MK, 1(3) VPI. *Xanthoxylon 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 & Dec. 20, 1943, coll. J. Brann, 2(12) USNM; **PA**, Pittston, let. April 1, 1918, coll. W.C. Sutherland, 1(5) USNM; **VA**, Plot 53I, c, Blacksburg, May 13, 1969, coll. M. Williams, 1(3) VPI. **Canada**, Ontario, Rec'd May 7, 1914, coll. L.A. Hamkirso, 1(4) USNM.

Host and distribution. This species was originally collected from the bark of apple trees in New York. Since then it has been collected throughout the United States and Canada. It has a wide range of hosts belonging to the following plant families: Betulaceae, Juglandaceae, Rosaceae, Rutaceae, Saxifragaceae. In the early literature it was also recorded from *Cornus* sp.

Biology. The biology was studied in detail in Virginia by Hill (1952), who also described several developmental stages.

Affinities and discussion. This species is unique in the genus in that the zygosis at the base of the median lobes is greatly elongated, each median lobe has a 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. Gill's tamarix scale

Literature. *Chionaspis gilli* Liu and Kosztarab, 1987:512.

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

Body of 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 without, or rarely with, irregular notches; base of lobes connected by a short, broad, and well-developed zygosis. 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.

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 hairlike 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 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 (figs. L&M). 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 median lobe, protruding beyond apex of lobe; these last two gland spines give the species a distinct appearance.

Gland tubercles (fig. 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.

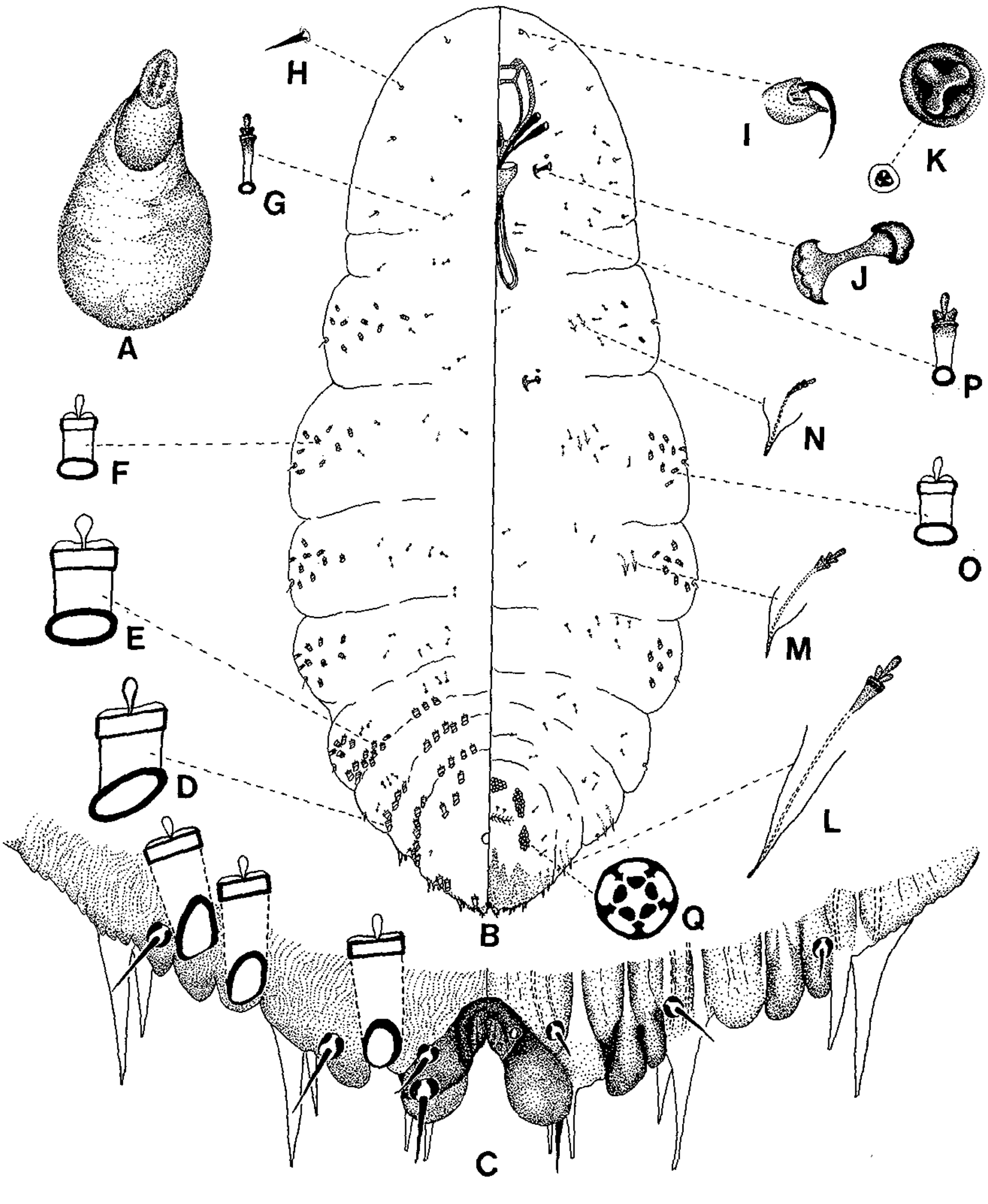

Plate 9. - *Chionaspis gilli* Liu & Kosztarab

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.

Type material studied. 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 articulata*, **AZ**, Salt River Valley, Phoenix, Aug. 8, 1933, coll. P. Glick, 1(2) VPI. on *Tamarix chinensis*, **AZ**, Grand Canyon Natl. Pk., Colorado River, Coconino Co., Aug. 23, 1984, coll. L. E. Stevens, 4(5) USNM. *Tamarix gallica*, **AZ**, Safford, Sep. 13, 1943 from L. P. Wehrle Collection (about 20 specimens on these slides are considered to be *C. etrusca*), 6(80) UCD; *Tamarix* sp., **AZ**, Phoenix, Nov. 21, 1953, coll. F. F. Bibby et al., 1(5) USNM; **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, Bernallillo Co., Nov. 20, 1979, coll. by D. C. Heninger, 3(6) UGAES; 5.3 mi N Cotton City, Hidalgo, Aug. 26, 1969, coll. D. R. Liesner, 1(1) FSCA; Dona Ana Co., New Mexico State Univ. campus, Jul. 30, 1968, coll. D. R. Liesner, 2(4) VPI. **MEXICO**, Nogales, July 16, 1955, coll. Spitzer, 1(2) USNM.

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

Host and distribution. This species has so far been found only on the bark of *Tamarix* in the southwestern United States and Mexico.

Affinities and discussion. This new species is very similar to *C. etrusca* but the combination of morphological characters on the 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 preferences, and are somewhat similar in their external morphology. In a 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

Suggested common name. Honey-locust scurfy scale

Literature and synonymy. *Chionaspis gleditsiae* Sanders, 1903: 413; *1904a: 48; Dietz and Morrison, 1916b:271; Lawson, *1917: 266; Houser, *1918: 293; MacGillivray, 1921: 328; Ferris, 1937: SI-14, SI-19, SI-23; 1942: SIV-386, 446; McKenzie, 1956:99; Kosztarab, 1963: 70; Takagi and Kawai, 1967: 29; McComb and Davidson, *1969: 6; Tippins and Beshear, 1970: 1023; McDaniel, 1971: 275; Willoughby and Kosztarab, 1974: 83; Nakahara, 1975: 201; Knipscher et al., 1976: 1; Dekle, 1976: 35; Howell, *1980: 92; Lambdin and Watson, 1980: 80; Nakahara, 1982: 18; Takagi, 1985: 39.

Phenacaspis spinicola - Dietz and Morrison, 1916a: 101-102; Hollinger, 1923: 36; 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 *P. 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, 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.

Pygidial margin (fig. C). More or less triangular, rounded at apex, 165-192 long and 264-375 wide at base. Median lobes obviours and well-developed, 15.3-23.2 long and 9.26-12.4 wide; inner margins parallel and fused together for more than half their length; lobes broad at their base, then sharply tapering, serrated on both inner and outer margins; basal yoke with a small elongated zygosis. 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.

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 hairlike, 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 (located on venter). Distance from anterior margin of anus to mid-point of line between abdominal segments V and VI, 38.6-61.3; distance from the posterior margin 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 (figs. L&M). 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 (fig. 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.

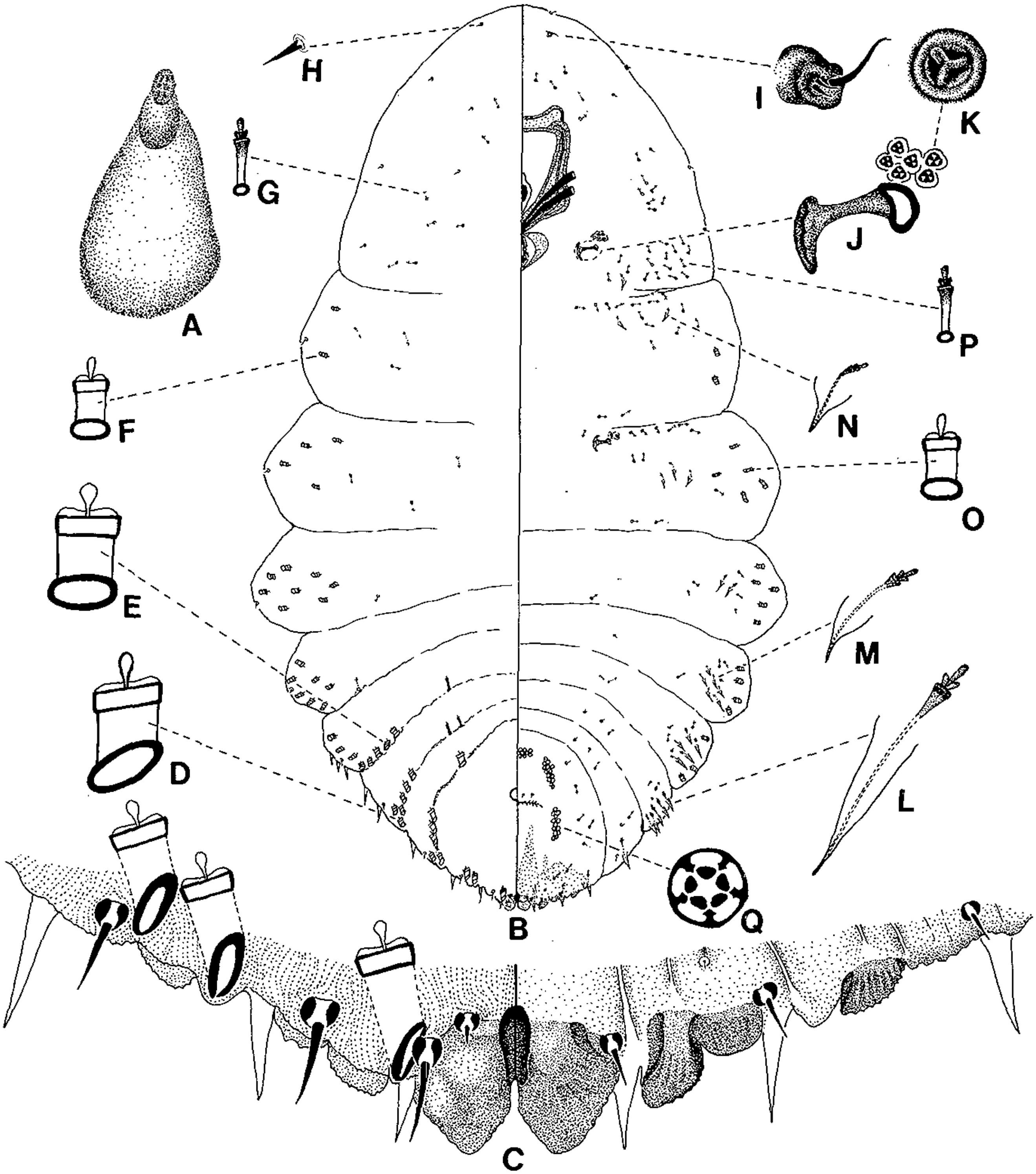

Plate 10. - *Chionaspis gleditsiae* Sanders, bark form

Setae (fig. H). Few very small and slender, hairlike, 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; inner lobule more or less triangular and rounded at apex; outer lobule wide, with serrated margin.

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 fewer 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.

Setae (fig. H). Few small, and slender hairlike, 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.

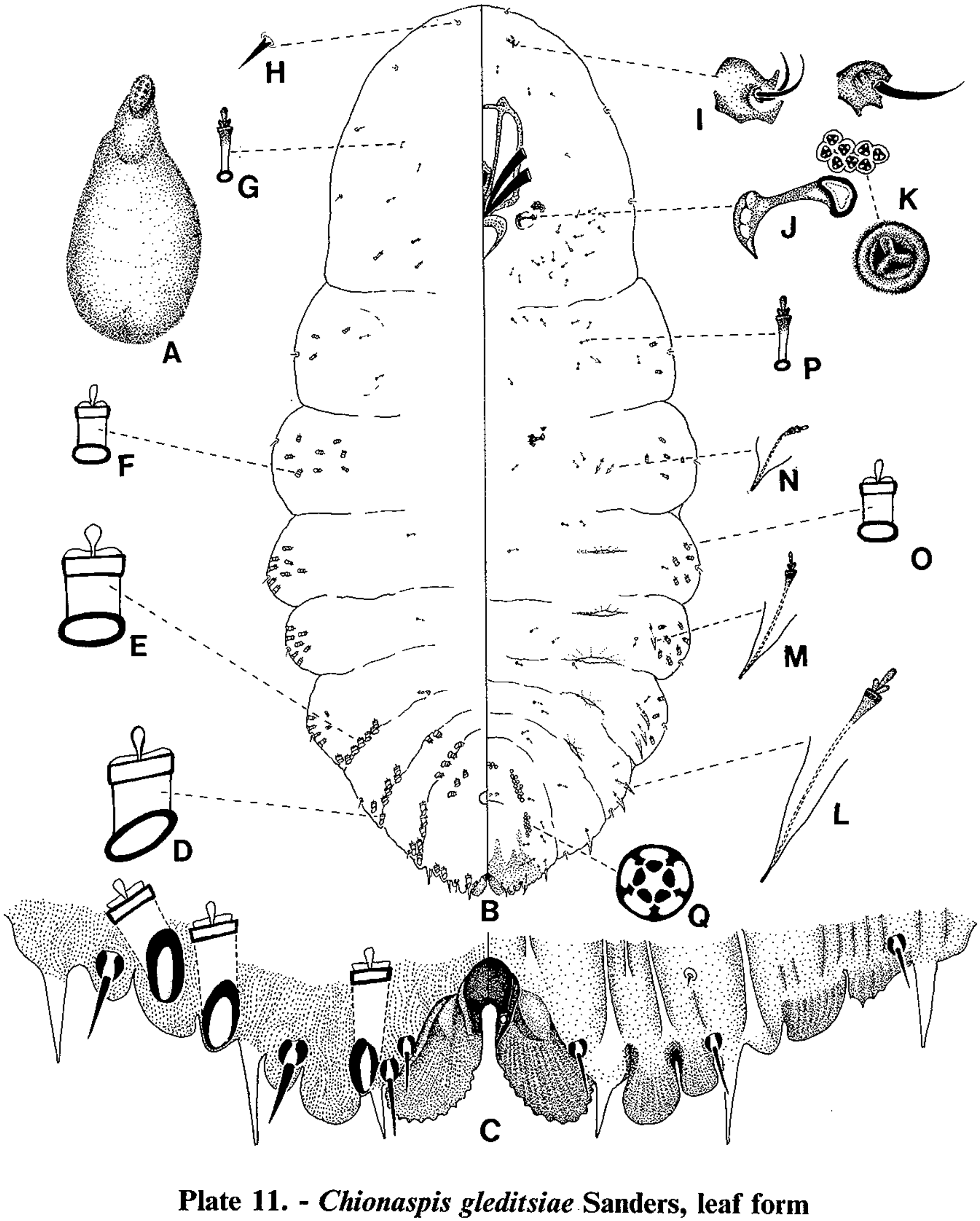

Plate 11. - *Chionaspis gleditsiae* Sanders, leaf form

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

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 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 (fig. K), 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 (figs. L&M). Well-developed, 7.72-12.4 long, each with 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 (fig. 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 those 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 those 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. Lectotype from *Gleditsia triacanthos*, Columbus, Ohio, Oct. 10, 1902, coll. unknown, 1(1) UCD. Paralectotypes: from Columbus, Ohio, Jan. & Feb. 28, 1902, coll. JGS, 3(14) USNM; May 30, 1902, coll. JGS, 1(5) USNM; Oct. 10, 1902, coll. unknown, 2(4) UCD, 1(2) CDA.

Other material studied. *Albizzia*, **MO**, St. Louis, Nov. 25, 1941, from Howard Baker, 1(4) USNM. *Carpinus americana*, **MA**, Preists Bridge, May 21, 1939, coll. McC, 14(14) (only few specimens are good.), USNM. *Carpinus caroliniana*, **FL**, Ft. Green, Sept. 19, 1986, coll. G. Johnson and Z. Smith, 3(3) FSAC. *Fraxinus americana*, **NC**, Chapel Hill, New Raleigh Road, Nov. 11, 1928, coll. J.N. Couch, 1(2) USNM; by Beokers Creek, Chapel Hill, Raleigh Road, March 14, 1929, coll. Rhodes &

J.N. Couch, 1(5) USNM; Chapel Hill, Jan. 10, 1929, J. N Couch, 1(4) USNM. *Fraxinus* sp., **VA**, VPI campus, Blacksburg, Montgomery Co., May 13, 1969, coll. JOH, 2(3) VPI. *Gleditsia aquatica*, **FL**, Limestone W., Oct. 9, 1981, coll. J. Felty, 3(3) FSAC; Sandy Point, May 12, 1977, coll. AEG, 6(6) FSAC. *Gleditsia triacanthos*, **IL**, Midlothian, August 6, 1938, coll. G. L. Pierce, 1(2) USNM; **IN**, Bluffton, Wells Co., Sept. 28, 1973, RFW, 6(17) CDA, 1(3) USNM; Battleground, July 18, 1956, coll. DLS, 2(5) VPI; Vincennes, August 31, 1915, coll. H. Morrison & H.F. Dietz, 2(2) UCD, 2(2) MOSU; Indianapolis, Sept. 24, 1915, coll. H. Morrison & H.F.Dietz, 1(1) BM; **KS**, Lawrence, Feb. 16, 1934, coll. L. R. Penner, 3(9) VPI; Lawrence, Feb. 15, 1947, coll. E. L. Todd, 1(3) USNM; Lawrence, Apr. 18, 1926, coll. L.R. Penner, 1(2) VPI; **MO**, Shaw Bot. Garden, St. Louis, August, 1921, coll. W.B. Wood, 1(2) USNM; St. Louis, Nov. 13 & Nov. 22, 1941, from Howard Baker, 2(8) USNM; Columbia, July 27, 1973, coll. J. Franaka, 3(5) USNM; **MS**, Columbus, July 5, 1931, coll. L.E. Myers, 4(5) UCD; Agric. College, March 16, 1908, coll. Cooley, 1(1) USNM; Let. August 16, 1915, coll. R. W. Harned, 1(3) USNM; **NY**, Manhattan, Collegiate School, Feb., 1981, coll. A. Freundel, 4(11) VPI; **OH**, Columbus, Jan. 20, 1902, coll. JGS, 1(5) USNM; same, Mar. 11, 1903, 1(6) USNM; same Oct. 10, 1912, 1(4) USNM; Columbus, Ohio State Univ., Feb. 9, 1961, coll. MK, 1(1) VPI; South of Findlay, Hancock Co.,July 9, 1961, coll. MK, 2(2) CDA, 1(1) VPI; Hocking Co., June 11, 1961, coll. MK, 1(3) VPI; Stanley Rose Arboretum, 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; Columbus, May 22, 1917, coll. PRL, 2(6) USNM; **TX**, Dallas, Coccidae of Texas T-704, date & coll. unknown, 1(1) UCD; Brazas Co., July 28, 1932, coll. F. F. Bibby, 2(5) UCD; College Station, Coccidae of Texas T-703, date & coll. unknown, 1(2) UCD; Bryan, April 19, 1919, Coccidae of Texas T-638, coll. unknown, 3(7) UCD; Apr. 19, 1919, coll. Hollinger, Coccidae of Texas T-62, 2(4) UCD; August, 1918, coll. Hollinger, 1(2) UCD; Dallas, Feb. 1, 1918, Coccidae of Texas T-563, coll. unknown, 1(2) UCD; Dallas, date unknown, coll. Hollinger, Coccidae of Texas T-704, 1(4) UCD; Fort Worth, May 5, 1918, Coccidae of Texas T-326, coll. unknown, 1(1) UCD; Walluce, August 31, 1919, coll. Hollinger, 1(1) UCD; McKinney, August 15, 1927, coll. F. F. Bibby, 1(5) USNM. *Gleditsia* sp., **CA**, Los Angeles, Dec. 1, 1954, coll. K. C. Stephens, 2(6) CDA, 1(4) UCD; **IN**, Whitewater St. Park, 1 mi. S Liberty, Oct. 10, 1983, coll. RFW, 2(3) VPI; Dayton, April 27, 1950, coll. R. B. Keiswander, 2(4) USNM; **KS**, Lawrence, Locust Central Park, May 7, 1934, coll. LBP, 1(6) VPI; *Ostrya virginiana*, **NC**, 5 mi W of Wilmington, Dec. 30, 1921, coll. J.N. Couch, 3(10) BM; Chapel Hill, Sep. 25, 1927, coll. J.N. Couch, 1(30 USNM; Chapel Hill, Meeting-of-the-Waters, Sep. 25, 1927, coll. J.N. & E.R. Couch, 1(3) USNM; *Robinia pseudoacacia*, **TN**, Fayettesville, May 2, 1918, coll. Cooley, 1(5) USNM. *Rubus* sp., **MD**, Patapsco State Pk., Ellicott City, May 10, 1959, coll. MK, 3(7) VPI.

Host and distribution. This species was originally collected on the bark of honey locust, *Gleditsia triacanthos*, in Ohio. Since then, it has been found and collected on several species of hosts belonging to 4 families: Corylaceae, Oleaceae, Fabaceae, Rosaceae. It has been found in 15 states ranging from the northern U.S. to Florida and to the west coast.

Affinities 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 both 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 zygosis 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 usually found 1 or 2 dorsal submedian macroducts (as in figure) 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 zygosis 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 of median lobes, or exceeding the apices of these lobes. The leaf form differs from the leaf form of *C. platani* in that dorsal submedian macroducts are completely absent on abdominal segment III, and only appear on IV-VI, and the number is reduced to less than 5 on each segment; the median lobes form an acute notch; and the inner lobule of the second pair of lobes is quite long and prominent.

CHIONASPIS HAMONI LIU AND KOSZTARAB

Plate 12

Suggested common name. Florida willow scale

Literature. *Chionaspis hamoni* Liu and Kosztarab, 1987:512.

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, 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.

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

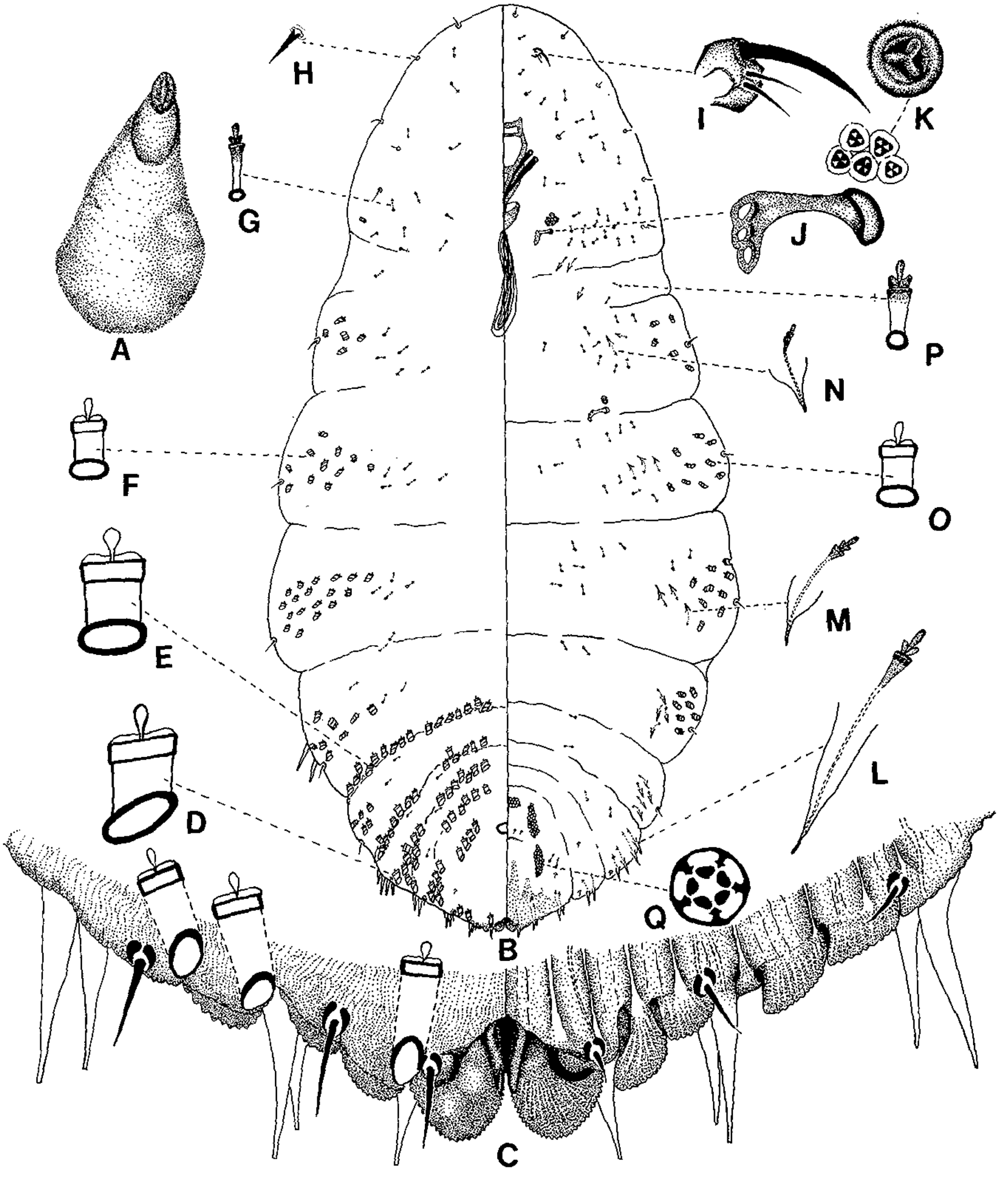

Plate 12. - *Chionaspis hamoni* Liu & Kosztarab

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. 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 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 it difficult to count their number.

Gland spines (figs. L&M). 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 (fig. 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). Similar to those on dorsum, but greater in number.

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, Nov. 5, 1980, coll. F. McHenry, on *Salix* sp., FSCA.

All specimens listed below are paratypes. *S. babylonica*, **FL**, Pembroke Pines, Mar. 6, 1980, coll. D. Phillips, 4(4) FSCA; *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 & A.L. Bentley, 4(4) FSCA; Ft. Lauderdale, Mar. 7, 1984, coll. M. McDonald, 4(4) FSCA; Plant City, Nov. 27, 1981, coll. C. H. Ray, Jr., 7(7) USNM; Port St. John, Feb. 3, 1983, coll. R. Burns, 4(4) FSCA; *S. discolor*, **FL**, North of Cross City, Feb. 16, 1967, coll. A. E. Graham, 2(2) FSCA; Orange Lake, Dec. 15, 1961, coll. A. E. Graham, 3(3) FSCA; *S. nigra*, **FL**, Horseshoe Beach, Aug. 12, 1982 coll. F. McHenry, 3(3) FSCA; Lehigh Acres, Dec. 17, 1986, coll. Z. Smith, 3(3) FSCA; Moore Haven, Dec. 16, 1982, coll. Z. Smith, 4(4) FSCA; Palatka, June 17, 1980, coll. K. Elliott, 4(4) FSCA; Steinhatchee, Dec. 2, 1981, coll. F. McHenry, 5(5) FSCA; Weaver's Sta., Collier Co., no date, coll. Z. Smith, 1(1) FSCA; *Salix* sp., **FL**, Gainesville, Mar. 30, 1965, coll. GWD, 8(8) FSCA; Homeland, Apr. 11, 1968, coll. J.M. McLeod, H.G. Schmidt & GWD, 4(4) FSCA; Micranopy, Mar. 30, 1965, coll. G. W. Dekle, 3(3) FSCA; Miramar, Apr. 12, 1967 coll. K. Hickman, 6(6) UGAES; N. Port, Dec. 20, 1982, coll. J. Felty, 3(3) FSCA; Orange Lake, Jan. 26, 1962, coll. G. W. Dekle, 2(2) BM, 1(1) UCD; Palatka, Jul. 29, 1980, coll. K. Elliott, 3(3) UCD; Stuart, Feb. 28, 1978, coll. E. W. Campbell, 2(2) FSCA; Welaka, May 6, 1961, coll. GWD, 2(2) CDA; Steinhatchee, Nov. 5, 1980, coll. F. McHenry, 2(2) FSCA; 10 mi E Ochopee, Collier Co., May 1, 1975, R.F. Denno et al., 1(2) USNM.

The accompanying illustration is based on the holotype.

Host and distribution. This species occurs on the bark of various species of *Salix* in Florida.

Affinities and distribution. The new species is very similar to *Chionaspis longiloba*; 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 a 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)

Color figs. 4-8. Plates 13, 14

Suggested common name. Pine scurfy scale

Literature and synonymy. *Chionaspis pinifoliae heterophyllae* Cooley, 1897: 281; Ferris, 1942: SIV-406; 1956:70, 73.

Chionaspis heterophyllae - Takagi and Kawai, 1967: 30, 38; Tippins and Beshear, *1970a: 8; Luck and Dahlsten, 1974: 310; Nakahara, 1975: 201; Dekle, 1976: 49; 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; Kosztarab, 1963: 91; McDaniel, 1972: 337; Beshear et al., 1973:9; Dekle, 1976:51; Lambdin and Watson, 1980:80; 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 about one third to one fourth of whole length of test. Ventral test white and very thin.

GENERAL DESCRIPTION

Body of adult female (fig. B). 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.

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 zygosis, 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.

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, hairlike, 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.

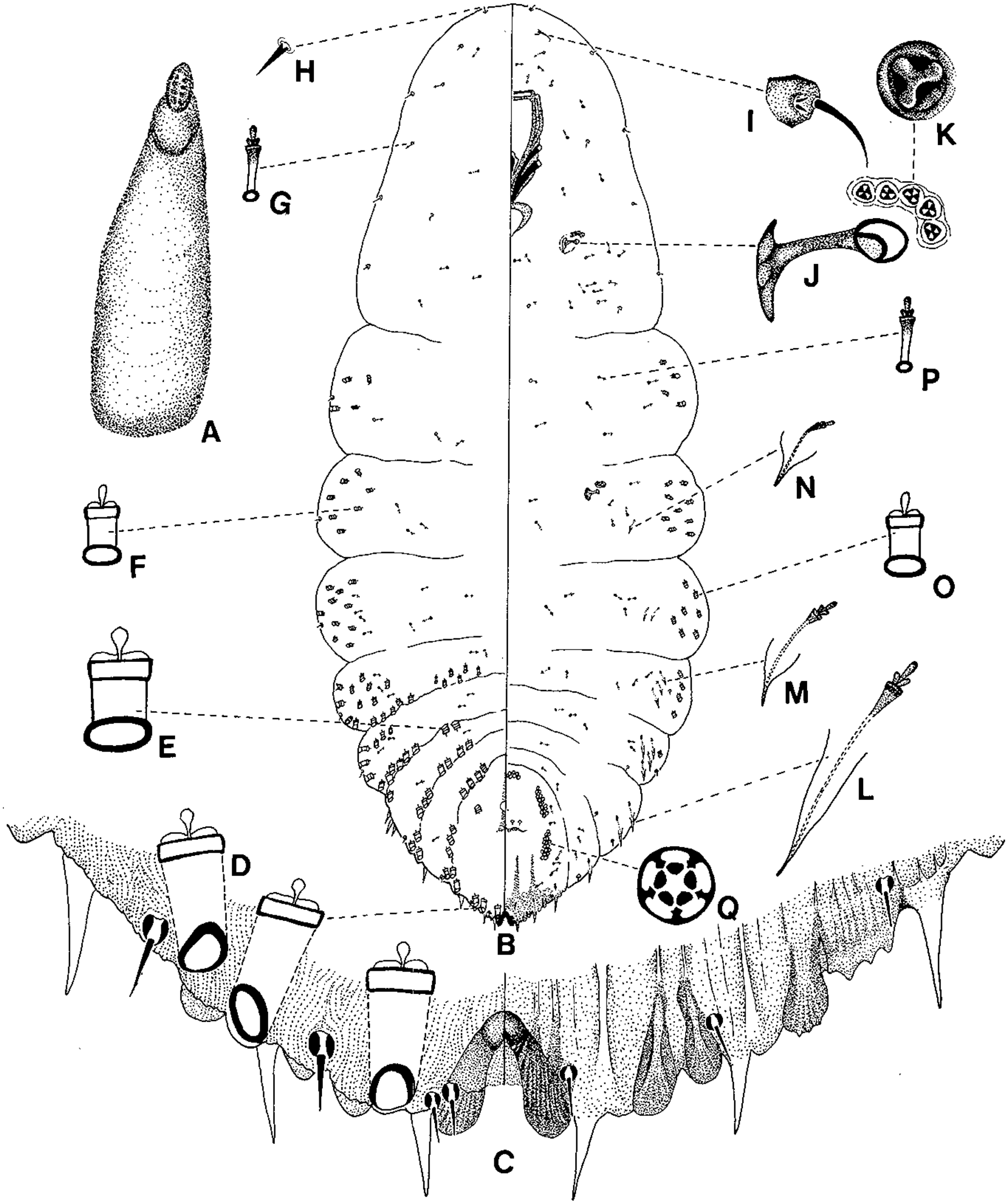

Plate 13. - *Chionaspis heterophyllae* Cooley

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 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. Sclerotized atrial rim; 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 (figs. L&M). 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 (fig. 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 hairlike, 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. The authors have not included the thousands of North American host and distribution records because these are printed in the first author's thesis (Liu, 1987).

Host and distribution. This species was originally described from needles of *Pinus heterophyllae* in Florida as a subspecies of *C. pinifoliae*. Since then, it has been collected from *Abies balsamea*, *Picea abies* and *P. pungens*, and 16 species of *Pinus* including: *P. caribaea, P. clausa, P. densiflora, P. echinata, P. elliottii, P. glabra, P. mugo, P. nigra, P. palustris, P. resinosa, P. rigida, P. strobus, P. sylvestris, P. taeda, P. thunbergiana*, and *P. virginiana*. All of the above hosts are in the family Pinaceae. The known distribution of *C. heterophyllae* is **AL, AR, CA, CT, DC, FL, GA, IN, KY, LA, MA, MD, MI, MO, MS, NC, NH, NJ, NY, OH, PA, RI, SC, TN, TX, VA, WA,** and **WV** in the United States, as well as Canada and Mexico.

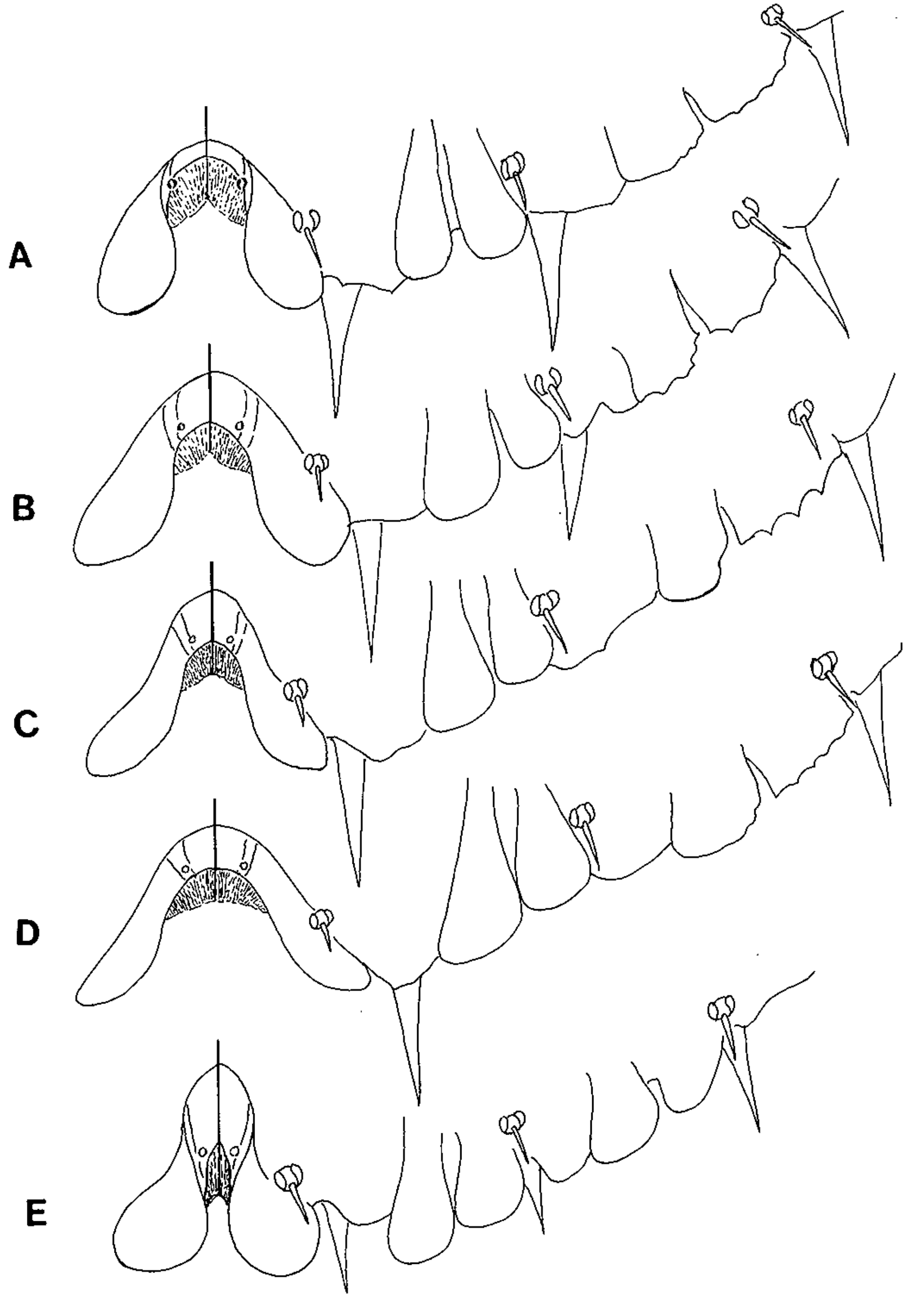

Plate 14. - *Chionaspis heterophyllae* Cooley (A-D), *Chionaspis pinifoliae* (E), variation of median lobes

Host range and geographic distribution were also compiled by Shour and Schuder (1987) and the life cycle was given by Shour (1986).

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. In contrast, *C. pinifoliae* (**Plate 14, fig. E**) has the following characters: (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 are 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* will help to identify them and help to clarify the confusion that has existed between the two related species.

CHIONASPIS KOSZTARABI TAKAGI AND KAWAI

Plate 15

Suggested common name. Ash scurfy scale.

Literature. *Chionaspis kosztarabi* Takagi and Kawai, 1967:29. Articles dealing with this species since the compilation of Willoughby and Kosztarab (1974:1) include the following: Nakahara, 1975:201, 1982:19; Knipscher et al., 1976:6, 12; Robison, *1977:42, 45, 47; Gill, S.A. et al., *1982:11, 13, 14, 17; Hamon 1983:46.

This species was recognized as distinct 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 and (2) distinct basal zygosis 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 zygosis 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 modified by the first author from Willoughby and Kosztarab (1974). The latter article provided sufficient information for this species; therefore we have omitted its redescription here. Hamon (1983) reported new distribution records from Florida.

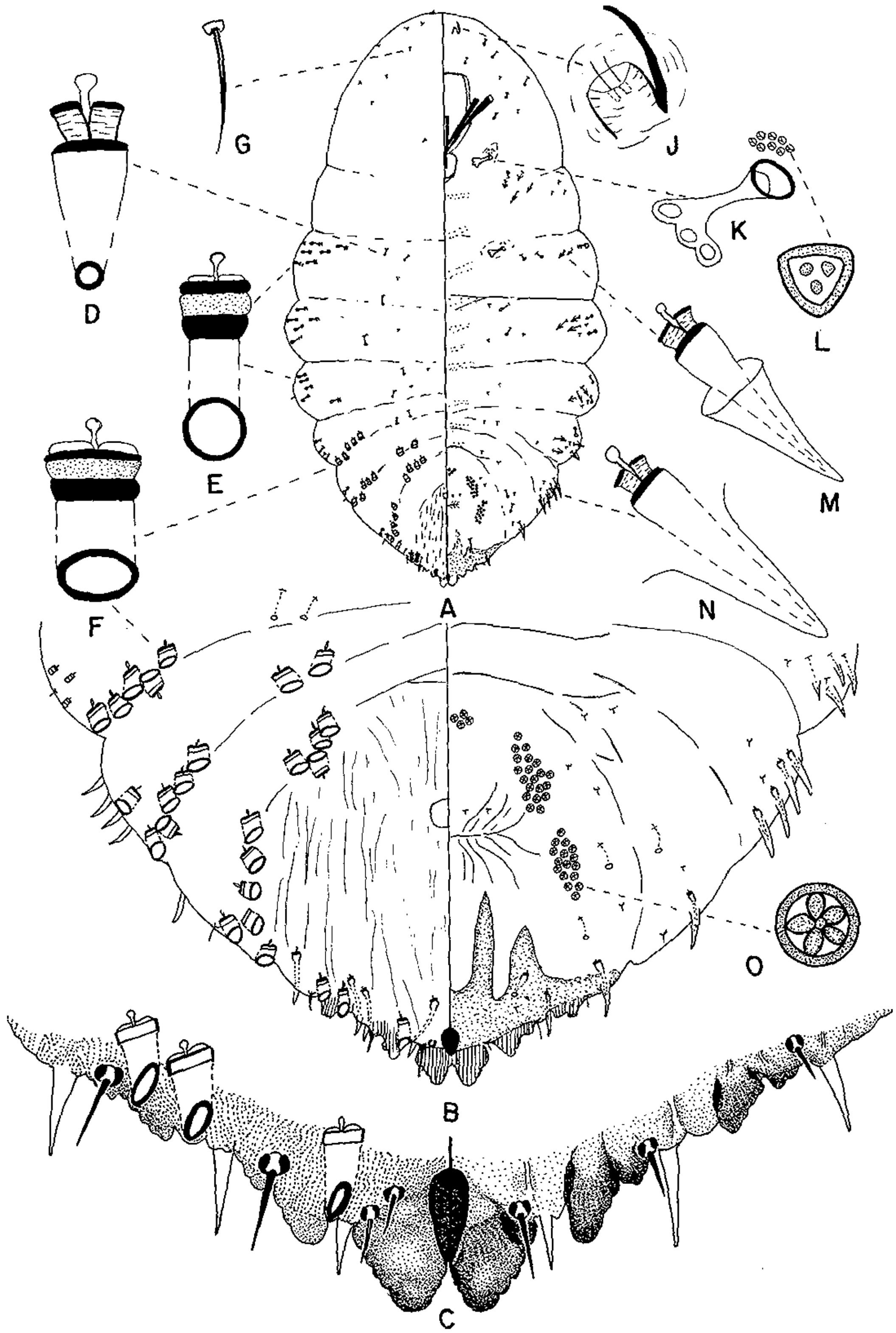

Plate 15. - *Chionaspis kosztarabi* Takagi & Kawai

CHIONASPIS LINTNERI COMSTOCK

Plate 16

Suggested common name. Lintner scurfy scale

Literature and synonymy. *Chionaspis lintneri* Comstock, 1883: 103; Cooley, 1898: 89; 1899: 22; Felt and Morrison, *1928:198; Ferris, 1937: SI-20, SI-21; 1942: SIV-446; Kosztarab, 1963: 71, 72; Martineau, *1965: 46; Takagi and Kawai, 1967: 30; McDaniel, 1971: 288; Baker, *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; 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 (fig. B). 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.

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 zygosis, 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.

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

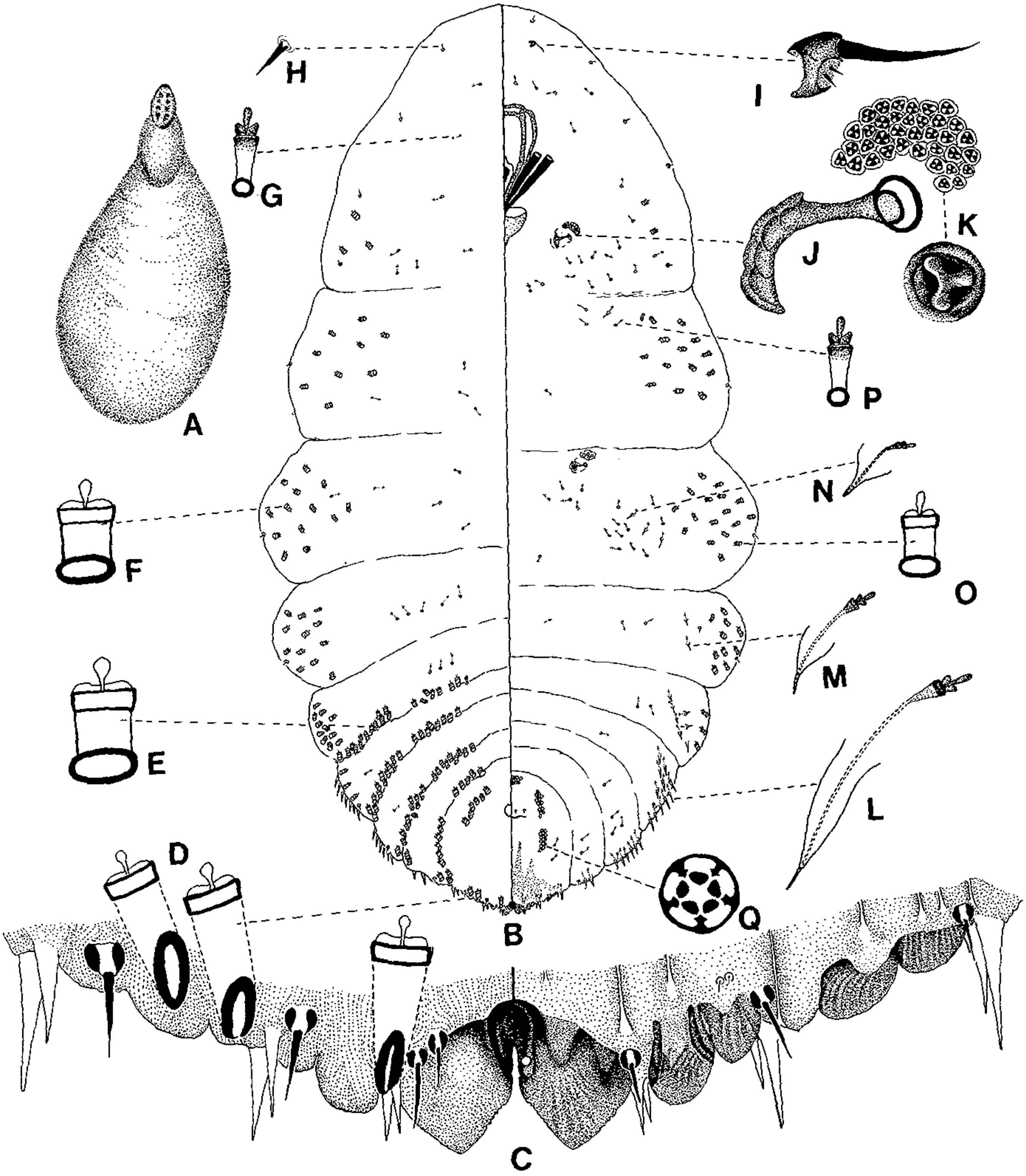

Plate 16. - *Chionaspis lintneri* Comstock

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 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 margin of anus to midpoint between abdominal segments V and VI, 59.3-79.0; distance from posterior margin of anus to base of median lobes, 141-166.

Setae (fig. H). Very short and slender, hairlike, 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 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, with sclerotized atrial rim; 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 (figs. L&M). 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 (fig. 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 hairlike, 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 lateral 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. Lectotype from *Betula papyrifera*, **CANADA**, Charlottetown, Prince Edward Island, date unknown, coll. Fletcher, 1(1) USNM. Paralectotypes: 4 on same slide as lectotype; second slide, same data as lectotpye, 1(1) USNM; no host, no date, Comstock Coll. No. 151, 1(3) USNM; no host, no date, no collector, No. 1071, 1(2) 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; Charlottetown, Prince Edward Island, no date, coll. Fletcher, 1(4) USNM. *Betula* sp., **CANADA**, Trura, Nova Scotia, Aug. 10, 1911, coll. L.B. Smith, 3(8) USNM. *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, Chateauguay, 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, G.B. King Coll. No. 236, 1(3) AMNH; **MI**, 1913, 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. PRL, 5(17) USNM; Flint, Oct. 22, 1917, coll. PRL, 1(4) UCD; Flint, 1917, coll. PRL, 1(2) UCD; Flint, date unknown, coll. PRL, 1(3) UCD. *Syringa* sp., **PA**, Harrisburg, Mar. 9, 1918, coll. F.M. Trimble, 1(6) USNM. *Viburnum alnifolium*, **NH**, Milan, Nov. 18, 1967, coll. D.W.S. Sutherland, 5(7) CDA, 1(3) VPI.

Host and distribution. This species was originally described and collected from *Viburnum "lantanoides,"* and from an unknown plant in New York. Now it has been collected from hosts belonging to 8 families: Betulaceae, Caprifoliaceae, Cornaceae, Juglandaceae, Oleaceae, Rosaceae, Salicaceae, and Thymelaeaceae. Its distribution includes **DC, IL, MA, ME, MI, NH, NY, OH, PA,** and **TX** in the United States, and Canada.

Affinities and discussion. During this study, the authors had an opportunity to check all specimens from nearly all the localities listed above including the lectotype and paralectotpye 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

Color fig. 9. Plate 17

Suggested common name. Longiloba scurfy scale

Literature. *Chionaspis longiloba* Cooley, 1899: 16; Sanders, *1904a: 47; Hollinger, 1923: 24; Ferris,1937: SI-21; SIV-446; Kosztarab, 1963: 72, 73; Takagi and Kawai, 1967: 30, 38; McDaniel, 1971: 288; Nakahara, 1975: 202; Dekle, 1976: 53; 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 zygosis. 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.

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, 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

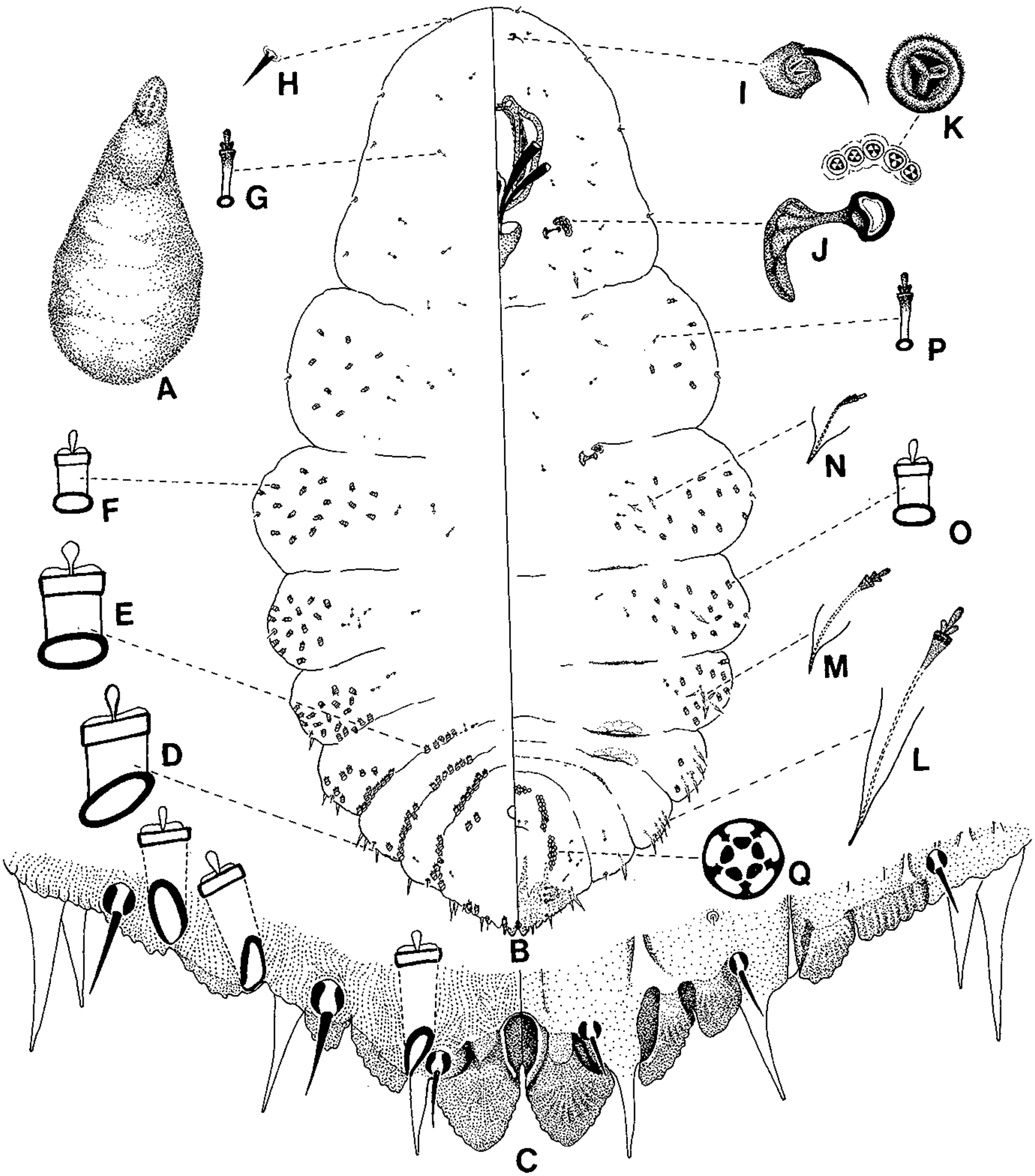

Plate 17. - *Chionaspis longiloba* Cooley

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 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 (figs. L&M). 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 (fig. 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, let. Oct. 31, 1903, coll. G.A. Lanner, 1(6) USNM; Painseville, 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; **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; **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, 1(1) UCD; Sherman, Apr. 28, 1918, coll. unknown, 1(2) UCD; Albany, 1917, coll. Hollinger, T41, 2(3) UCD. *Salix nigra* l., **AL**, Baldwin Co., Mobile Bay, Nov. 3, 1977, coll. M.L. Williams, C.H. Ray, and I. Daniels, AL-280-77, 5(5) AU; **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, 1(1) CDA, 1(1) UCD; Contra Costa Co., Feb. 9, 1954, coll. J. Simmen, 1(3) 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-78-24, 2(10) USNM; Hidalgo Co., Rio Rico Rd., June 3, 1978, coll. S. Nakahara, N-78-60, 1(9) USNM.

Host and distribution. This species was originally described from the bark of cottonwood in Texas. It has so far been collected from willow (*Salix*) and poplar (*Populus*) throughout the United States, and from Mexico.

Affinities and discussion. It appears that this species is very similar in morphological characters to *C. lintneri*, but *longiloba* 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 somewhat related to the bark form of *C. wistariae* in general appearence, but the following combination of characters present in *longiloba* can be used to separate it from *wistariae*: (1) median lobes comparatively longer and narrower, also more pointed with both mesal and outer margins finely serrate, (2) fewer dorsal microducts on submedian areas of abdominal segments I-III, (3) only 4 to 10 trilocular pores (not 10 to 20) associated with each anterior spiracle.

According to Dekle (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 having compared them with the type and cotype material, we concluded that 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 the USNM collected in MS and OR and marked *longiloba* have distinctly different median lobes and several other morphological characters that make the specimens different from *C. longiloba*.

CHIONASPIS NYSSAE COMSTOCK

Color fig. 10. Plates 18, 19

Suggested common name. Sour-gum scurfy scale.

Selected literature and synonymy. *Chionaspis nyssae* Comstock, 1881:316.
Phenacaspis sylvatica Cooley, 1903:48.
Phenacaspis nyssae (Comstock) Ferris, 1937:SI-92.

Based on the shape of median lobes, Cooley (1903) treated this species as *sylvatica* in his new genus, *Phenacaspis*. After some disagreement among scientists who published on the status of the

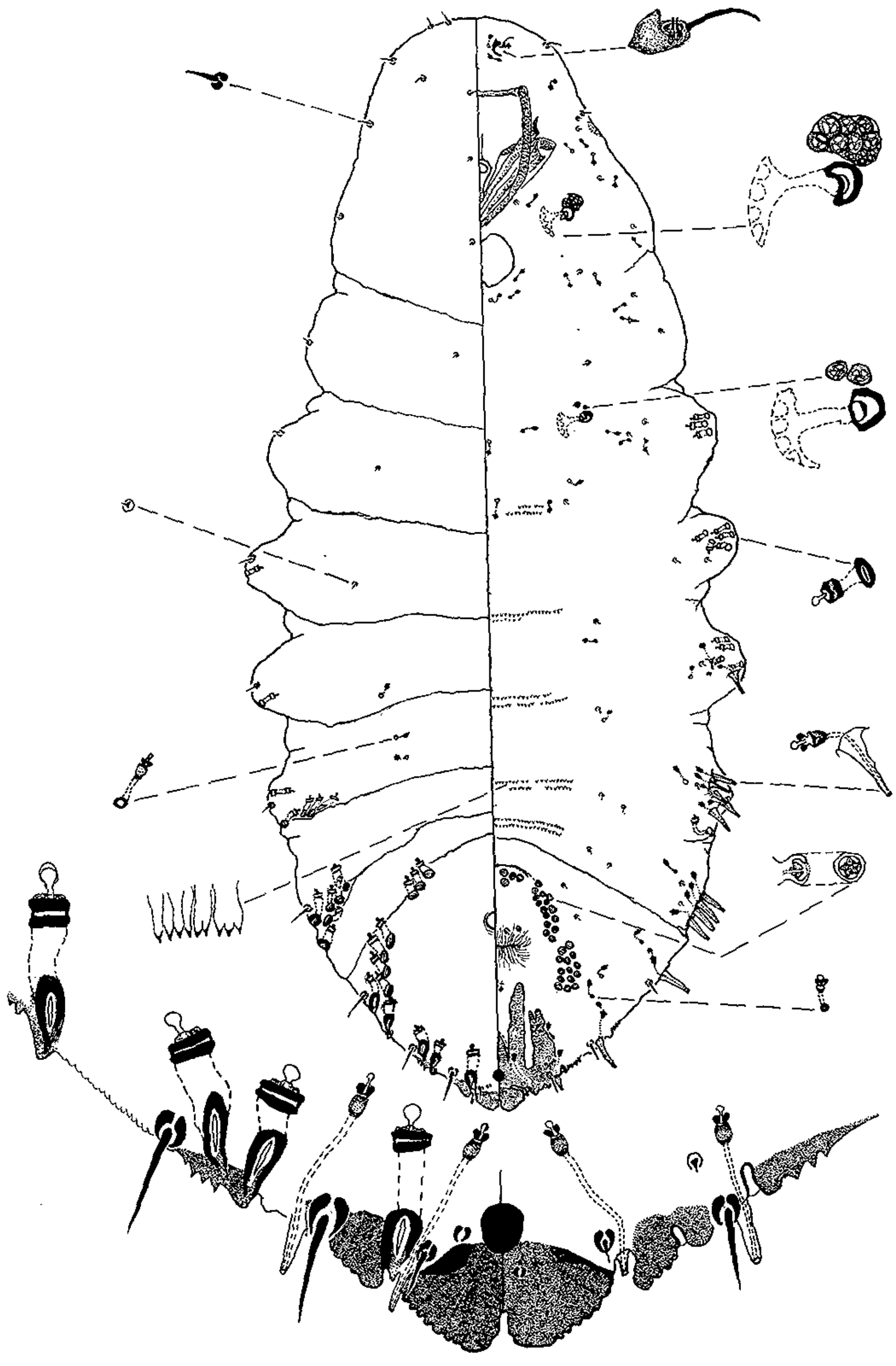

Plate 18. - *Chionaspis nyssae* Comstock, bark form

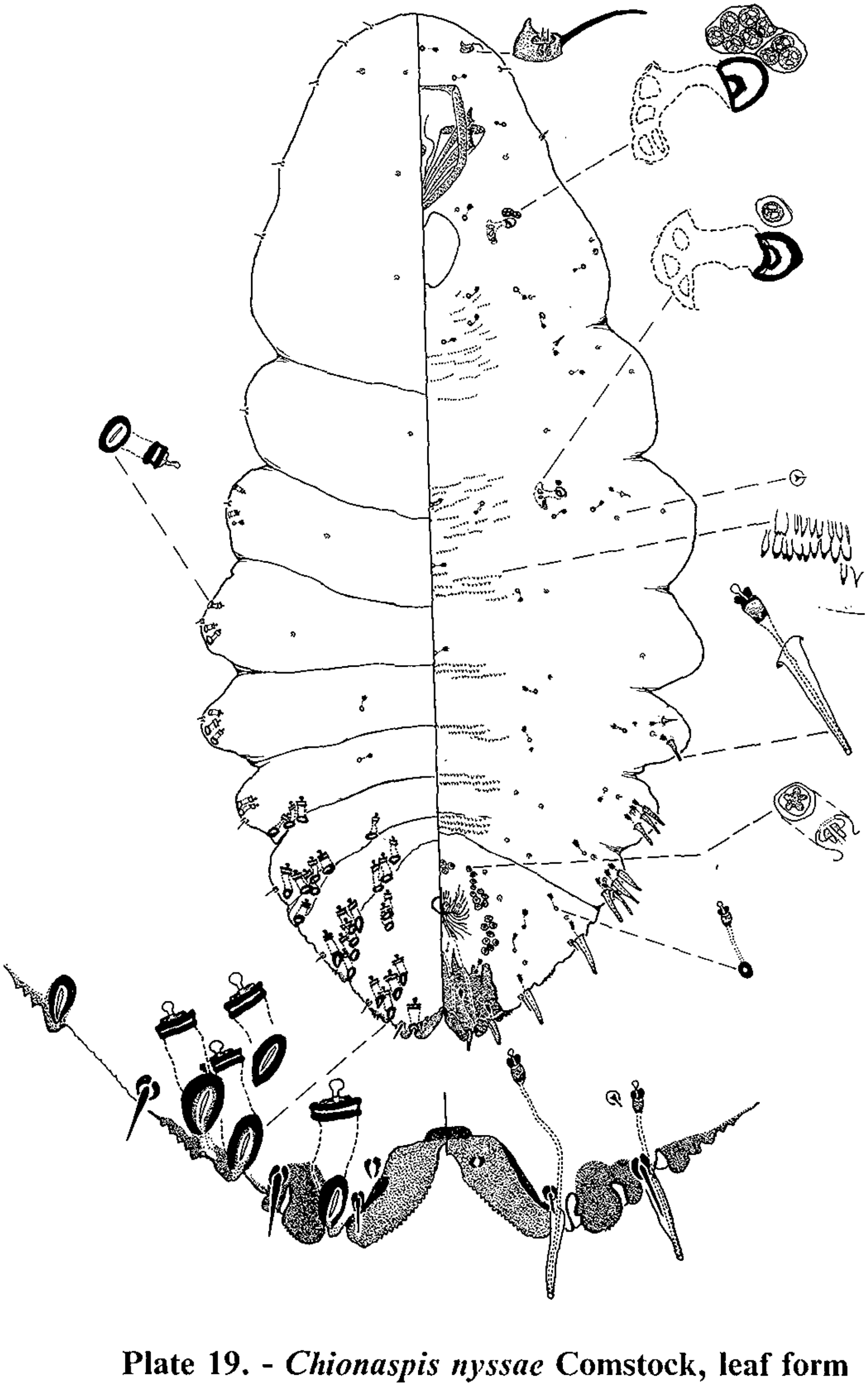

Plate 19. - *Chionaspis nyssae* Comstock, leaf form

genera *Chionaspis* and *Phenacaspis*, Takagi (1967), also 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 forms. They confirmed that these two forms belong to the same species, but are associated with the different feeding sites. 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 (Plate 18) 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 (Plate 19) 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 were obtained 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 key provided.

CHIONASPIS ORTHOLOBIS COMSTOCK

Plate 20

Suggested common name. Cottonwood scurfy scale

Literature. *Chionaspis ortholobis* Comstock, 1881: 317; Dietz and Morrison, 1916b:273; Hollinger, 1923: 35; Ferris, 1937: SI-16, SI-22, SI-23, SI-24; Ferris, 1942: SIV-387, 446; Balachowsky, 1954: 348; Kosztarab, 1963: 73; Takagi and Kawai, 1967: 30, 38; 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 (fig. B). 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.

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, indistinct, often reduced into slight prominences.

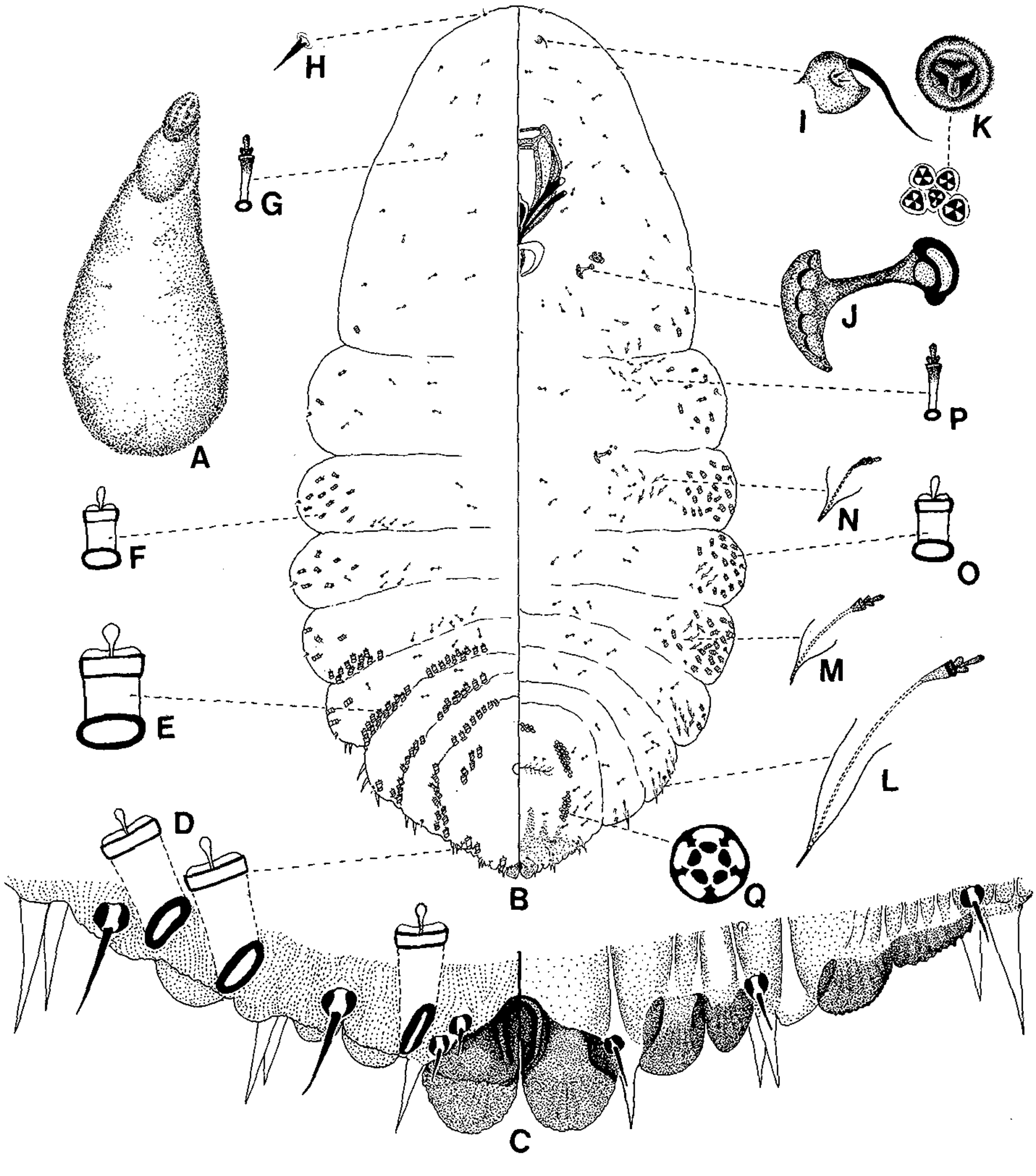

Plate 20. - *Chionaspis ortholobis* Comstock

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 submedian 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 hairlike 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 margin of anus to mid-point of line between abdominal segments V and VI, 61.8-93.9; from posterior margin 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 (figs. L&M). 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 (fig. 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, hairlike, 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. Lectotype from *Salix* sp., **CA**, San Bernadino, date and coll. unknown, VPI Slide No. C94b, 1(3) USNM. Paralectotypes: 2 on same slide as lectotype; two more slides, same data as lectotype, 1(3) USNM; 1(4) VPI.

Other material studied. *Alnus* sp., **CA**, North Fork, 1928, fr. G. Struble, 1(3) UCD. *Arbutus menziisii*, **CA**, Summit, 1907, coll. W. M. Gifford, 1(3) USNM. *Arctostaphylos patula*, **CA**, Carroll Cr., Inyo Co., 1936, 3(6) UCD. *Arctostaphylos* sp., 1975, coll. L. Davis, 1(6) CDFA. *Ceanothus cordulatus*, **CA**, Silver City, Tulare Co., August 30, 1963, coll. DRM & J.A. Froebe, 3(3) UCD; Sierra Nevada Mt., Let. July 5, 1939, coll. C. R. Quick, 1(6) USNM; Chowchilla Mt., Mariposa Co., August 13, 1940, coll. C. R. Quick, 1(5) USNM; Phillips, 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**, S Fork Atanum Cr., Yakima Co., July 26, 1920, coll. C. J. Newcomer, 1(3) USNM; *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, 2(4) UCD, 1(2) USNM; **ID**, Smith's Ferry, date unknown, coll. A. C. Burrill, 1(5) USNM; **UT**, Cache Co., near Twin Bridges, Logan Canyon, Sept. 15, 1972, coll. R. G. Krebill, 3(8) USNM. *Ceanothus* sp., **CA**, Saddlebuck Mt., Santa Cerra Mts., Sept. 23, 1912, coll. R. K. Bishop, 1(8) USNM; Midpines, Mariposa Co., Sept. 26, 1975, coll. Gilbert & Griffin, 4(10) CDA; Big Pines, 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; Kernville, Dec. 10, 1938, coll. L. E. Myers, 1(3) UCD, 1(3) CDA; Lake Tahoe, El Dorado Co., Sept. 16, 1956, coll. G. Prole, 1(3) UCD, 1(1) CDA; Lake Tahoe, June 12, 1916, coll. H. G. Dyar, 3(8) USNM; Mt. Shasta, 1911, coll. H. J. Quayle, 1(1), USNM; Fallen Leaf, Lake Tahoe, Let. June 12, 1916, coll. H.G. Dyar 1(8) 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, 3(3) BM, 2 (10) USNM, 1(4) VPI; **WA**, north of Goldendale, July, 1962, coll. Tichenor, 2(5) UCD; near Yakima, Dec. 7, 1929, coll. E.J. Newcomer, 2(4) USNM; **WY**, 5 mi. NE Ipine, Lincoln Co., August 4, 1967, coll. DRM & D.S. Horning, 3(5) UCD. *Cytisus scoparius*, **CA**, Grass Valley, April 27, 1959, coll. L. E. John & W. W. Wiard, 2(14) USNM. *Rhamnus purshiana*, **CA**, San Bernadino, May 4, 1906, coll. S. A. Pease, 1(6) USNM. *Salix* sp., **AZ**, near S. W. Res. Sta., Portal, June 19, 1958, coll. SWB, S.W. Brown, 1(2) UCD; **CA**, Mono Lake, August 20, 1922, coll. R. Hartman, 1(2) UCD; San Bernadino, July 31, 1936, coll. H. McKenzie 3(21) UCD; San Bernadino, no date, coll. A. Craw, 1(6) UCD; China, San Bernadino Co., Oct. 19, 1956, coll. G. Harper, 1(3) CDA; Ventura, April 23, 1938, coll. E. L. Smith, 3(22) CDA; San Diego Co., Nov. 18, 1974, coll. Cramer & Koide, 2(7) CDA; Chula Vista, San Diego Co., Sept. 8, 1980, coll. Kenyon & Anderson, 5(15) CDA; Chula Vista, San Diego Co., Apr. 22, 1981, coll. RJG, 1(3) CDA; San Diego, March 27, 1940, coll. J. W. Dixon, 1(3) CDA; Leevining, April 15, 1960, coll. R. Rollins, 1(4) CDA; San Fernando, Valley, March 16, 1927, coll. LEM, 1(4) UCD; Sweetwater Dam, Sunnyside, Sept. 13, 1911, coll. P. H. Timberlake, 1(6) USNM; Orange Co., Jan. 10, 1940, coll. Bumgardner, 1(2) CDA; location, collector and date unknown, ex coll. W. Cooley, 1(3) BM. Host unknown, **OR**, Freewater, Cooley Coll. 124, 1(5) USNM; No locality, date or collector, Maskell Coll. No. 317, 1(1) USNM.

Host and distribution. This species was first described from willow (*Salix* sp.) from Southern California, and has since been collected from several states, all west of the Rocky Mountains except Wyoming. Several additional hosts have been found. All specimens in the borrowed 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 (1916b), 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 from each other because *C. ortholobis* has (1) mesal margins of median lobes contiguous for part of their length, (2) the basal sclerotized zygosis narrow and elongate, and (3) the outer lobule of the third pair of lobes distinct. But it should be pointed out 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 often confused with this species is *C. longiloba*, but the combination of short and rounded median lobes and elongate and narrow basal zygosis in *C. ortholobis* will distinguish it from *C. longiloba* which has the median lobes elongate, and the basal zygosis very short and stout.

Other species, including *C. salicisnigrae*, *C. lintneri*, *C. corni*, and *C. platani*, are closely related to this species and easily misidentified. *C. ortholobis* differs from *C. salicisnigrae* in not having the characters listed at the latter species 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*: mesal margins are long and straight, and the gland spines on margin of abdominal segment IV are 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 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.

Some problems in identification may be encountered with this species. When it is collected from *Salix*, it is often easily confused 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)

Color figs. 11-15. Plates 21, 22
(Figure references are for Plate 21, unless stated otherwise)

Common name. Pine needle scale

Selected literature and synonymy. *Aspidiotus pinifoliae* Fitch, 1856: 488.

Chionaspis pinifoliae -- Comstock, *1880:318; Dietz and Morrison, 1916b: 268; Ferris, 1937: SI-13, SI-91, SI-93; 1956: 71, 74; Takagi and Kawai, 1967: 30, 38; Beshear et al., 1973: 10; Nakahara, 1975: 202; Dekle, 1976: 55; Howell and Williams, *1976: 188; Kosztarab, *1977: 185; Rosen and DeBach, *1977: 11; Miller and Kosztarab, 1979: 5; Nakahara, 1982: 20; Howard and Oliver, 1985: 51; Takagi, 1985: 41; Shour, 1986:1; Shour and Schuder, 1987: 297.

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

Chionaspis pinifolii -- Riley, *1882: 514.

Phenacaspis pinifoliae -- Ferris, 1937: SI-13, SI-93; 1942: SIV-232; Balachowsky, 1954: 354; McKenzie, 1956:149; Brown, 1958: 685; 1959: 529; Kosztarab, 1963: 95, 96; 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 (fig. B). 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.

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 zygosis 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 and shorter than the inner one; outer lobule also wider than lobules of second pair of lobes (Plate 21, fig. C; Plate 22, figs. A-E).

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 aroud 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.

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.

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.

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 (figs. L&M). 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 (fig. 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

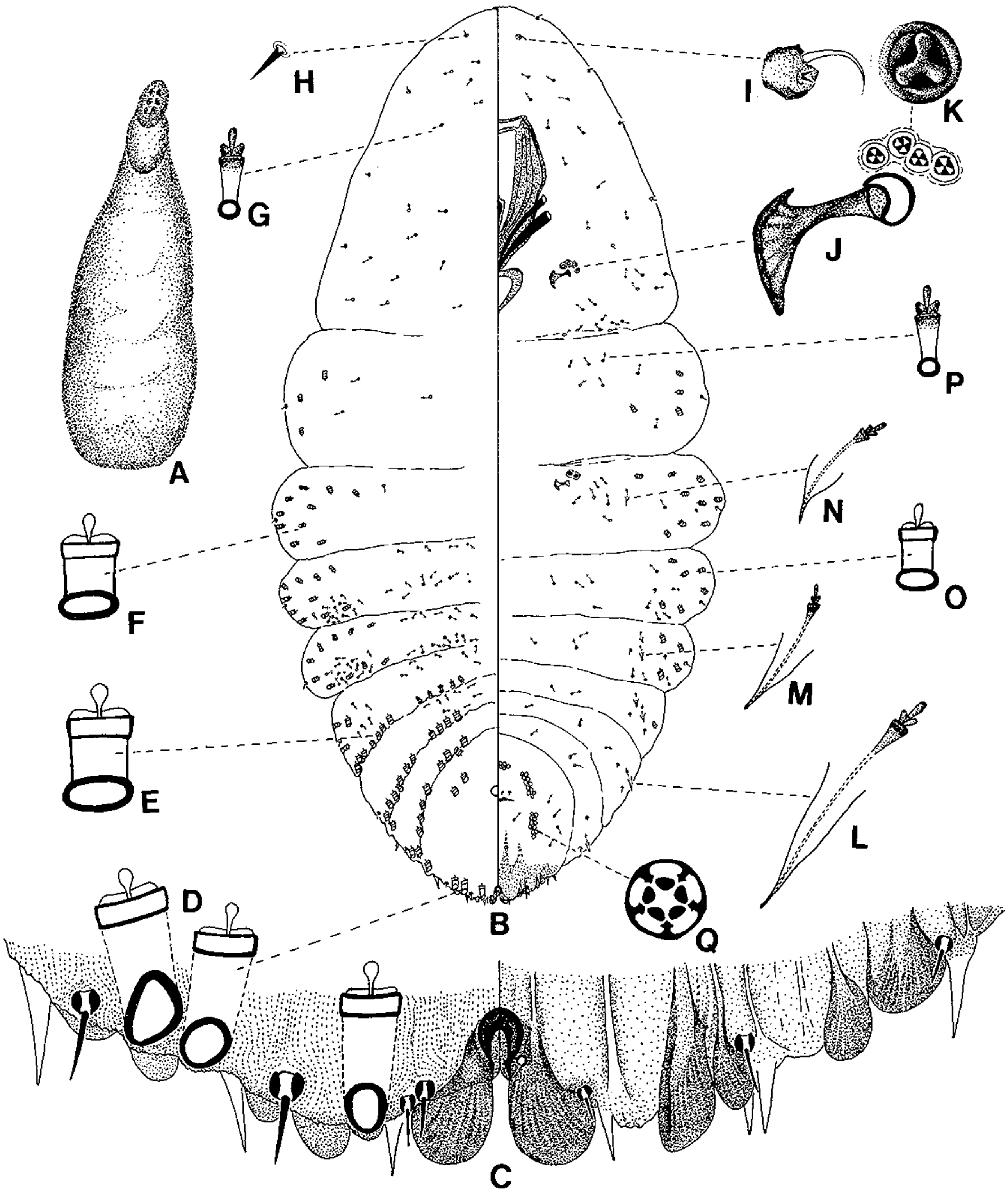

Plate 21. - *Chionaspis pinifoliae* (Fitch)

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 hairlike, 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. The authors have omitted listing the thousands of North American host and distribution records. These are available in the first author's thesis (Liu, 1987).

Host and distribution. This species was originally described from pine, *Pinus* sp., in New York. So far it has been collected from 35 species of *Pinus* (family Pinaceae): *P. attenuata, P. ayacahuite, P. ayacahuite* var. *brachyptera, P. banksiana, P. "californica," P. canariensis, P. cembra, P. cembroides, P. cembroides* var. *parryana, 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.* Six species of *Picea* (family Pinaceae) are recorded hosts: *P. abies, P. engelmannii, P. glauca, P. glauca* cv. *densata, P. orientalis, P. pungens, P. pungens* cv. Koster, *P. rubens.* It is known from four species of *Abies* (family Pinaceae): *Abies balsamea, A. bracteata, A. concolor, A. fraseri*; two species of *Tsuga* (family Pinaceae), *Tsuga canadensis* and *T. caroliniana*; and *Pseudotsuga menziesii*, also family Pinaceae. There is one unusual record on *Juniperus virginiana* which could not be verified because no dry material was available (family Cupressaceae). The collections from *Torreya californica* represent the only record from the family Taxaceae.

It has a wide distribution throughout the conterminous United States, Canada and Mexico, wherever its hosts occur. Records from the following states have been verified by examination of slide-mounted specimens: **AZ, CA, CO, DC, FL, GA, IA, ID, IL, IN, KY, MA, MD, ME, MI, MO, MT, NC, ND, NE, NH, NJ, NM, NY, OH, OR, PA, SD, TN, TX, UT, VA, WA, WI, WV, WY CANADA, MEXICO.** Host range and geographic distribution were recently summarized by Shour and Schuder (1987). Because this species is so close to *C. heterophyllae* in morphological characters and in habitats, the two are easily misidentified, and the distribution records in some older literature sources may be doubtful. For instance, Shour (1986) relates that the life history studies by Nielsen and Johnson (1973) were actually for *C. heterophyllae* when they thought they were working with *C. pinifoliae.*

Biology. Various aspects of the life history of *C. pinifoliae* have been studied by Cumming (1953), Brown (1958, 1959), Nielsen and Johnson (1973) (see note above), Luck and Dahlsten (1974), and Shour (1986).

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 adult female body 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 one-half of the width of one lobe, and mesal margins are parallel for a longer distance; (2) posterior half of each lobe is much broadened and rounded apically; (3) gland spine at laterad of median lobe is much shorter, and exceeds the apex of median lobe only for a very short distance. Otherwise in *C. heterophyllae* (Plate 13; Plate 14, figs. A-D; Plate 22, fig. F): the median lobes are much narrower, strongly divergent, and pointed apically; posterior half of

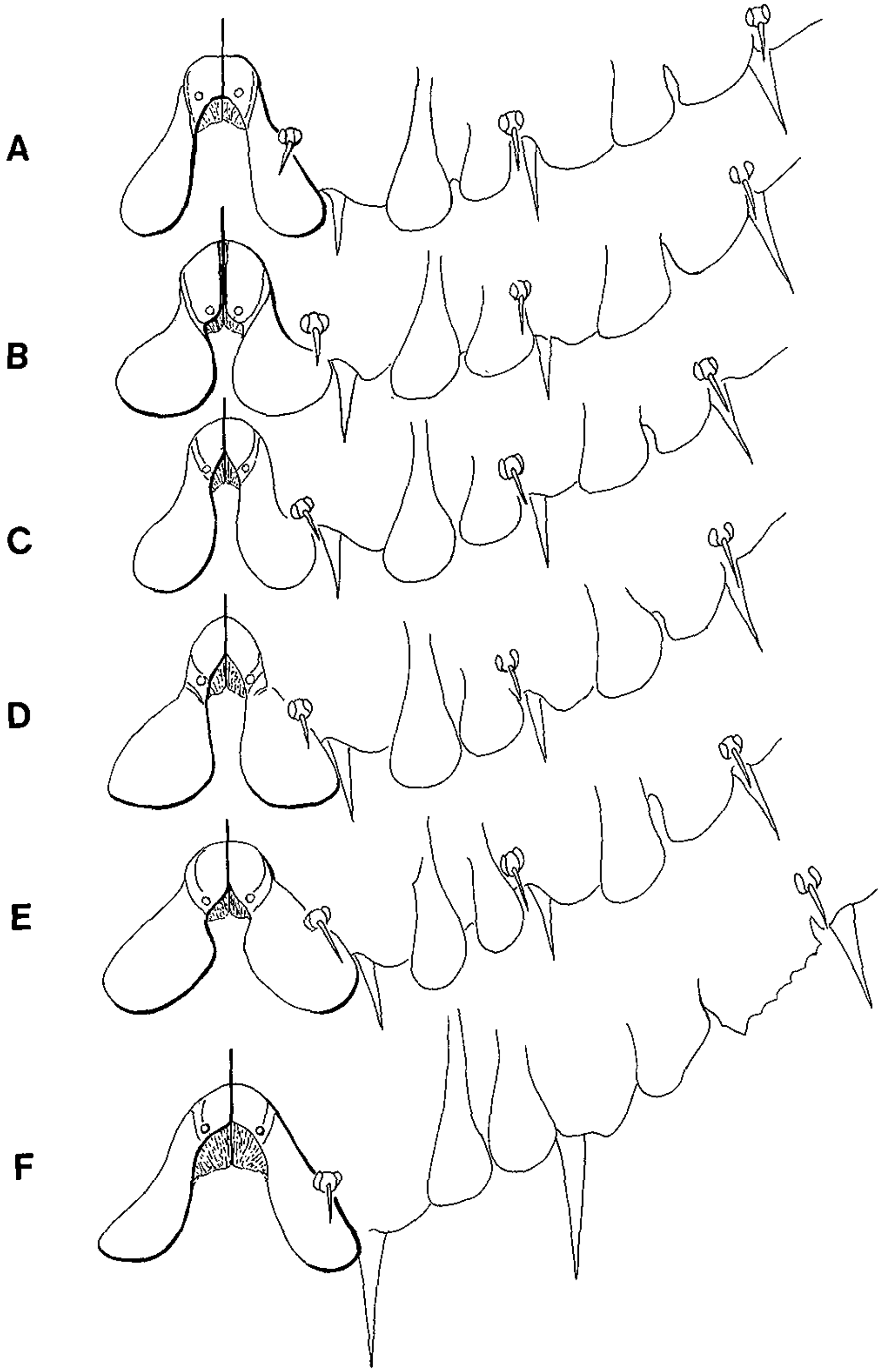

Plate 22. - *Chionaspis pinifoliae* (Fitch) (A-E), *Chionaspis heterophyllae* (F), variation of median lobes

each lobe is still narrow or only slightly widened; gland spine laterad of median lobe is noticeably longer, exceeding the apex of median lobe for about one-half of the length of a lobe.

CHIONASPIS PLATANI COOLEY

Plates 23, 24

Suggested common name. Sycamore scurfy scale

Literature and synonymy. *Chionaspis platani* Cooley, 1899:36; Hollinger, 1923: 27; 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, SIV-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: SIV-446; Balachowsky, 1954:354; Ferris, 1956:72, 74; Kosztarab, 1963: 96; 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 leaf form is under the present valid name including the individuals named *C. occidentalis* by Kosztarab (1963), whereas the bark-form used to be named *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 distinct and prominent, each lobe about 17.3-30.2 long and 14.8-19.8 wide; shape of lobes variable (fig. C), apex conspicuously pointed or rounded, inner margins divergent, notched or not, or sometime with slight irregular crenulations; base of lobes yoked by a short and stout zygosis. 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.

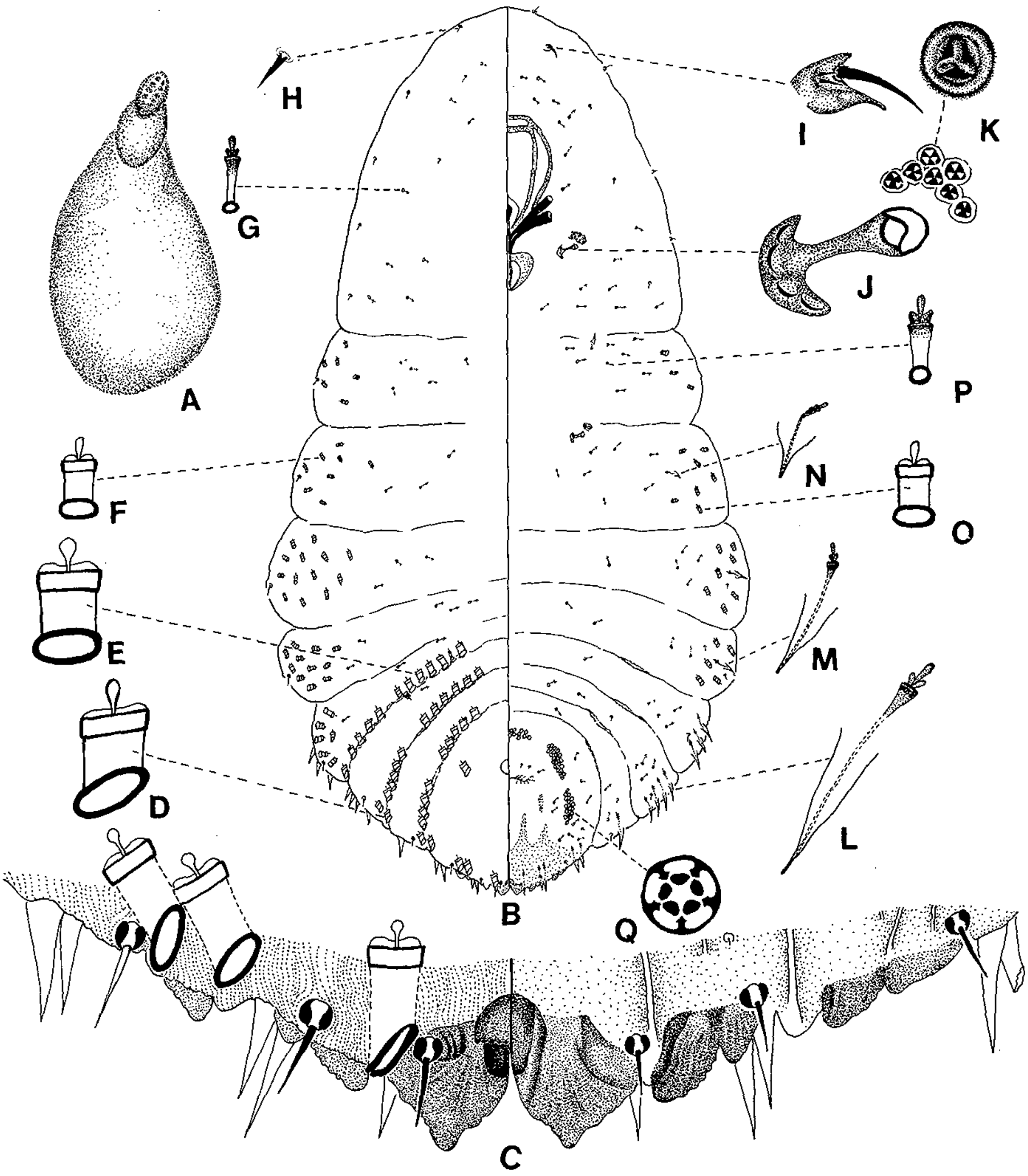

Plate 23. - *Chionaspis platani* Cooley, bark form

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.

Setae (fig. H). Short, slender, hairlike, 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.

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

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 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 occasionaly 0 associated trilocular pores.

Gland spines (figs. L&M). 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 (fig. 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 hairlike, 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; zygosis at base of the lobes short and stout. Second pair of lobes well-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.

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.

Setae (Plate 23, fig. H). Few slender or hairlike setae, scattered along margins and on cephalic region, variable in length, 4.94 to 17.3; 1 or 2 very short hairlike 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.

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.

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, figs. L&M). 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 23, fig. N). Short, spine-like, clustered on submarginal 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: 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, hairlike, 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. Lectotype from *Platanus* sp., **KS**, Riley Co., coll. CKL, 1(1) USNM. Paralectotypes from *Platanus* sp., **KS**, Riley Co., coll. P.J. Parrott, 2(7) USNM; Riley Co., coll. Cooley, #212, 1(1) USNM; Riley Co., coll. R. Cooley, 1(3) BM.

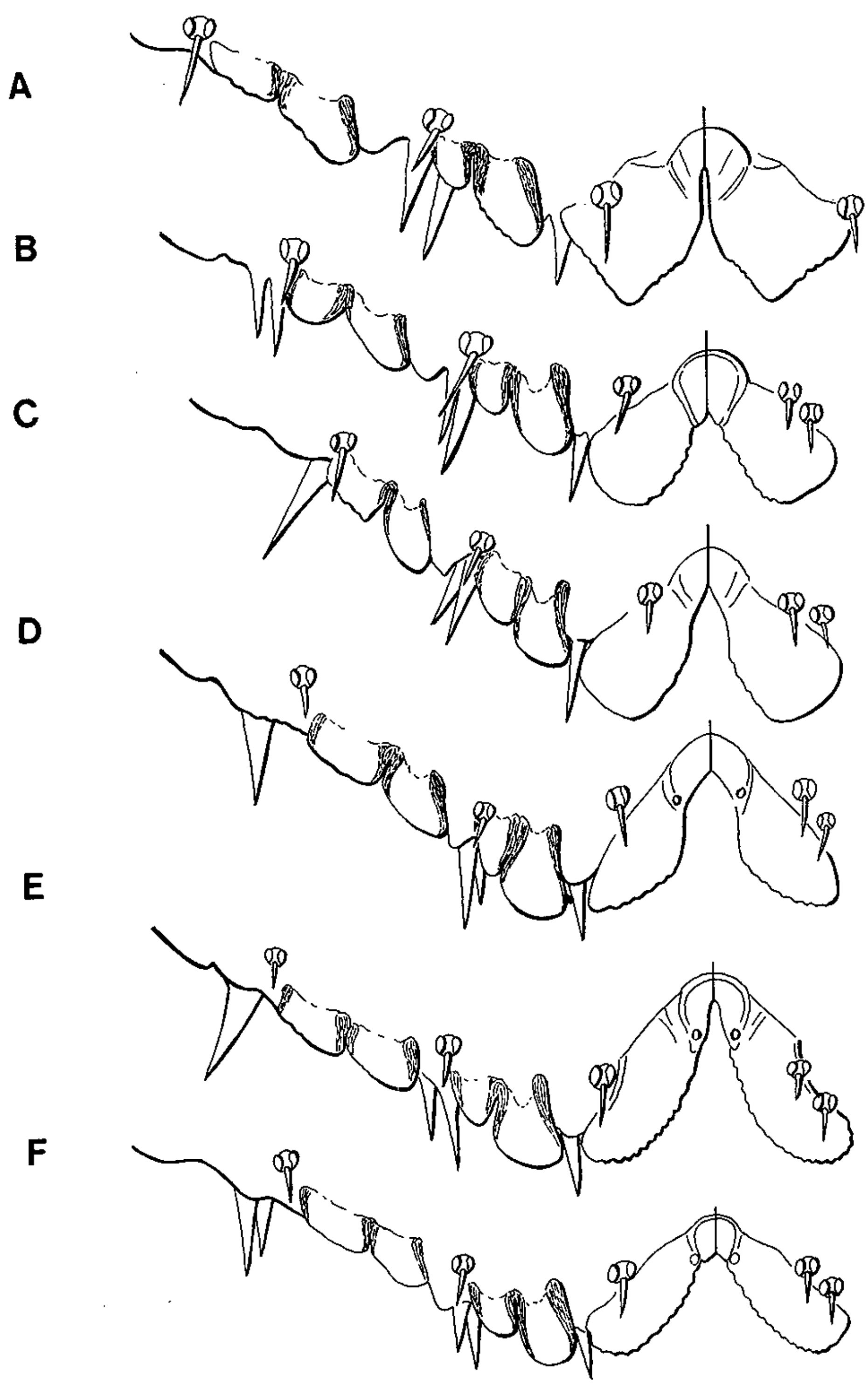

Plate 24. - *Chionaspis platani* Cooley, median lobes of different forms

Other material studied. *Platanus occidentalis*, **IN**, Indianapolis, Aug. 2, 1961, coll. MK, 1(4) VPI; 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; 2(3) VPI; Lebeau, June 8, 1971, coll. FWH, 3(3) FDA, 4(14) VPI; Near Effie, July 7, 1970, coll. FWH, 1(2) VPI; New Orleans, June 2, 1925, coll. H.K. Plank, A.#24816, 1(2) VPI; **MO**, St. Louis, Mar. 25, 1961, coll. MK, MO-105, 1(2) VPI; **NC**, S of 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. CKL, 1(2) USNM; **VA**, Presquile Wildlife Refuge, 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., 3(3) USNM, 1(3) BM; Indianapolis, Aug. 9, 1913, coll. Morrison and Dietz, Cooley coll. 77, 1(8) USNM; **TX**, Sherman, T-788, 2(4) UCD; Sherman, T-798, 1(2) 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; Dallas, Let. Aug. 16, 1908, coll. W.A. Hooker, 1(3) USNM; 40 Miles fr. Uralde, July 29, 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. JAD, 2(2) USNM; Presquile Island, Apr. 22, 1972, coll. SN, NV-184, 1(3) USNM; Chesterfield Co., Midlothian, Jan. 18, 1979, coll. Robert Bailey, VA 1476, 1(1) VPI; Cheasapeake, 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, 4(8) UCD, 1(2) VPI; Laredo, June 21, 1947, 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 is distributed in Mexico and the southern, central, and eastern United States.

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 zygosis at the base of the median lobes is elongate in *C. acericola*, whereas in *C. platani* the zygosis is short and stout. Another good character is that there are usually 1-2 dorsal submedian macroducts 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, VA, April 22, 1972, by JAD.

Plate 24. Fig. A. Same data as Plate 1;
Fig. B. Cotype of leaf form, collected on *Platanus* sp. leaf

from Riley Co., KS, 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, Aug. 1, 1961 by MK;
Fig. E. Collected on *Platanus* sp. leaf from Monterey, Mexico, June 14, 1960 by S. W. Brown and Nelson-Rees;
Fig. F. Collected on *Platanus occidentalis* leaf from Sibley, Louisiana, June 28, 1971 by F. W. Howard.

CHIONASPIS SALICISNIGRAE (WALSH)

Color fig. 16. Plates 25, 26

Suggested common name: Willow scurfy scale

Literature and synonymy. *Aspidiotus salicis-nigrae* Walsh, 1868: 40.
Mytilaspis salicis - LeBaron, 1872: 140.
Chionaspis salicis - Comstock, 1881: 320; 1883: 106.
Chionaspis salicis-nigrae - Cockerell, *1894: 107; Cooley, 1899: 19; Hollinger, 1923: 27; Ferris, 1937: SI-24; 1942: SIV-446; McKenzie, 1956:101; Kosztarab, 1963: 75; Takagi and Kawai, 1967: 30, 38; Danzig, 1970: 1018; McDaniel, 1971: 291; Kawai *1972:38; Nakahara, 1975: 202; Dekle, 1976: 56; 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 margins sometimes with several fine serrations; lobes closely united 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 zygosis 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.

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 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 (figs. L&M). 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.

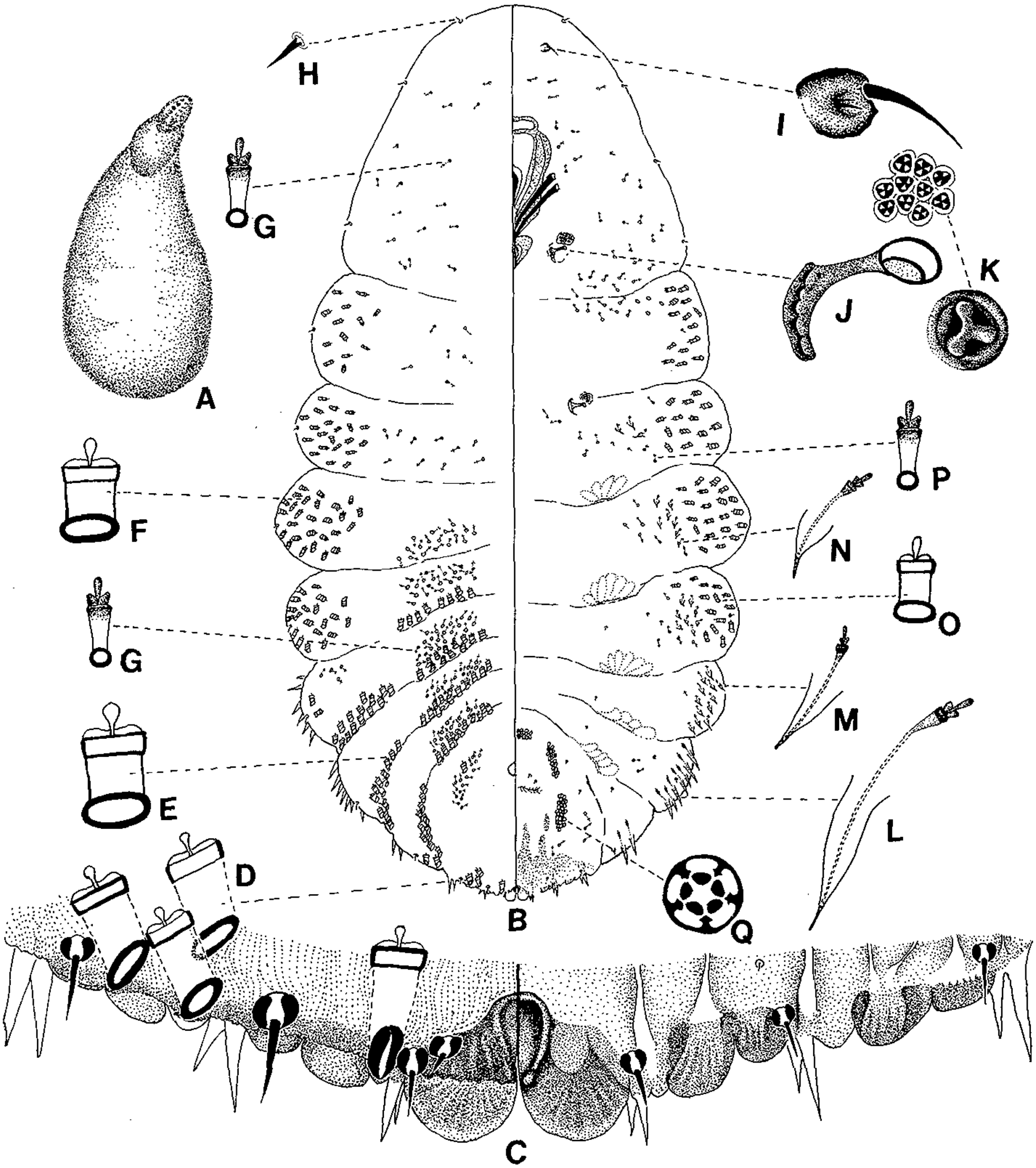

Plate 25. - *Chionaspis salicisnigrae* (Walsh)

Gland tubercles (fig. 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, we 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.

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.

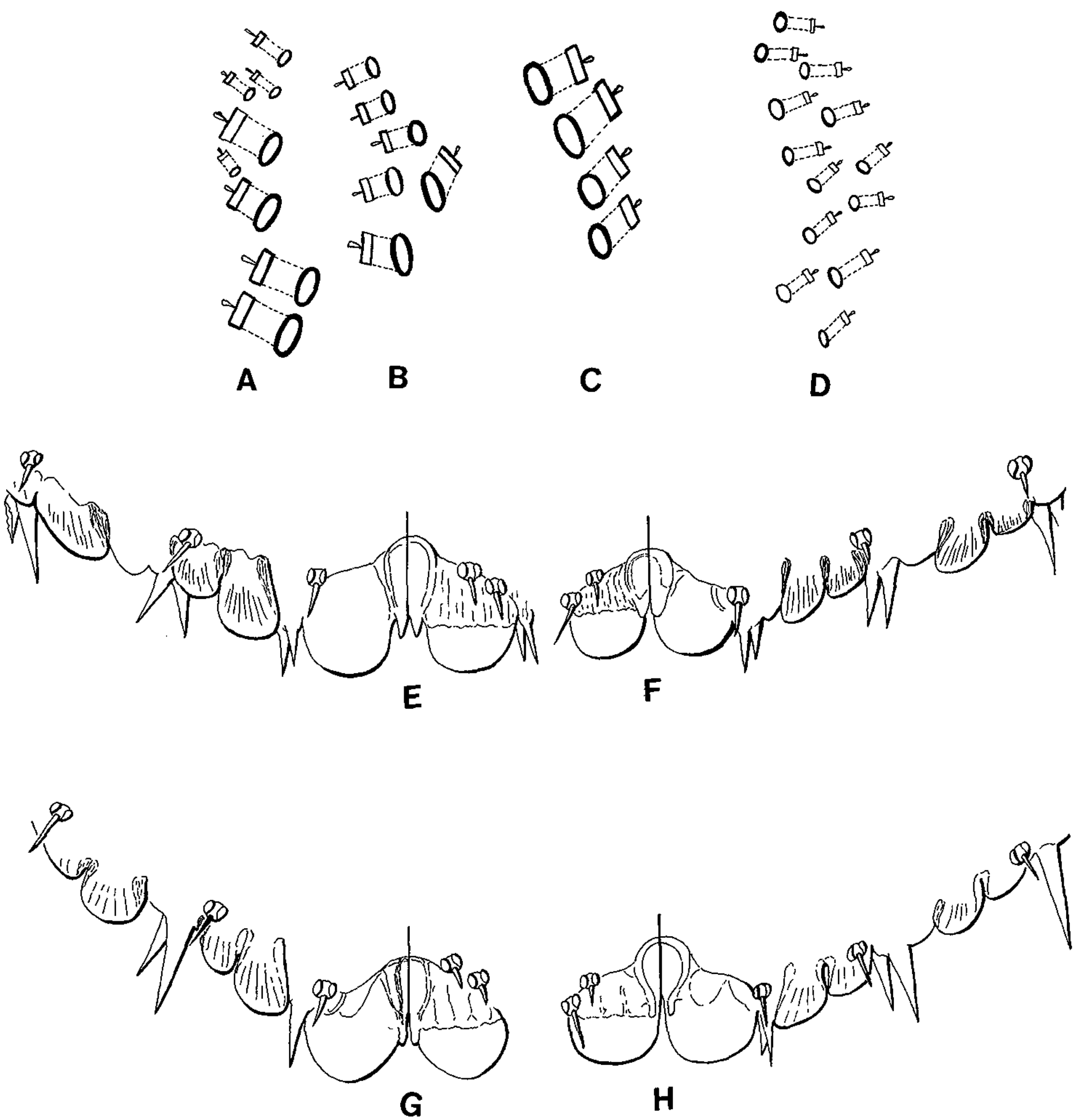

Plate 26. - *Chionaspis salicisnigrae* (Walsh), variation of main characters

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

Material studied. *Fraxinus americana*, **OH**, Hocking Co., May 19, 1960, coll. MK & D.M. DeLong, 1(6) VPI. *Populus canadensis*, **IN**, Ft. Wayne, Let. April 10, 1912, coll. unknown, 1(3) USNM. *Populus deltoides*, **MN**, St. Paul, no date, coll. Pettit; **OH**, Resthaven Wildlife Area in Castalia, Sept. 2, 1960, coll. MK, 1(2) VPI; **WI**, 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 nigra*, **WI**, Madison, 13, 1913, coll. N. F. Howard, 1(5) USNM; *Populus tremuloides*, **IA**, Ames, date unknown, coll. R. L. Webster, 1(4) USNM; **IN**, Crumstown, Aug. 27, 1920, coll. C.C. Deam, 2(6) USNM; **OH**, Lucas Co, July 9, 1961, coll. MK, 1(3) VPI; Hocking Co., May 20, 1961, coll. MK, 1(2) VPI; Wooster, March 1914, coll. J. S. Houser, 1(3) VPI; **PA**, Laceyville, date and collector unknown, 3(14) UCD; **WI**, Madison, Jan. 9, 1909, coll. H. C. Severin, 2(7) USNM. *Populus* sp., **AZ**, Flagstaff,Nov. 1937, 1(3) UCD; **IL**, Chicago, Let. Dec. 10, 1906, coll. W. L. De Wolf, 2(8) USNM; **MA**, Malden, date and coll. unknown, Cooley Coll. 497, 1(3), USNM; **MN**, St. Paul, 1898, coll. Pettit, 2(4) 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, coll. Bruner, 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. Rowland, 1(5) USNM; **OH**, Leetonia, Oct. 21, 1912, coll. H. G. Wolfgang, 1(3) USNM; Sugar Grove, June 10, 1917, coll. PRL, 2(9) USNM; **WY**, Casper, Let. 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, 14(18) 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, 5(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, 3(6) UCD; Austin, Feb. 17, 1919, coll. unknown, 1(3) UCD. *Salix* sp., **AL**, Morgan Co., date unknown, coll. K. Morris, 1(1) AU, 1(1) 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; Fort Collins, Nov. 1925, coll. G.S. Langford & CKL, 2(11) BM; Parks, Denver, March, 1933, E. Bethel, 1(2) 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 and collector unknown, 3(6) UCD; Hammond, Nov. 5, 1912, coll. E. S. Tillman, 1(5) USNM; Porter Co., Nov., 1973, coll. B. Cummings, 3(14) CDA; Valparaiso, Nov., 1973, coll. B. Cummings, 2(2) CDA; Lafayette, Rec'd March 26, 1910, through Professor Webster, 1(2) USNM; **LA**, New Orleans, March 12, 1919, coll. ERS, 1(3) USNM; New Orleans, Let. March 28, 1911, coll. T. 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, 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. L. 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, Slide No. 36372, 1(4) USNM; West Point, Aug. 2, 1930, coll. E.E. Byrd, 4(18) UCD;

NC, 1936, coll. unknown, Slide No. 36833, 1(3) USNM; Wilmington, Dec. 22, 1943, colls. Gordon & 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. Heninger, 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. JGS, 1(4) USNM; Columbus, Nov. 28, 1916, coll. PRL, 1(3) USNM; Columbus, May 10, 1903, coll. JGS, 1(6) BM, 1(5) USNM; Columbus, Oct. 13, 1919, coll. PRL, 1(4) USNM; Columbus, date and coll. unknown, Cooley Coll. 492, 1(5) USNM; Castalia, Resthaven Wildlife Area, Sep. 2, 1960, coll. MK, 1(2) VPI; Conkles Hollow, Hocking Co., 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, coll. C.A. Bower, 1(5) USNM; **SD**,Olivat, Let. Nov. 25, 1903, coll. S.M. Daboll, 1(6) USNM; Sioux Falls, let. Apr. 10, 1908, coll. R. Matheson, 1(2) USNM; **TX**, Nueses River, Uvaldo Co., Mar. 1, 1918, coll. H.B. Parks, 6(8) UCD; Sherman, Apr. 28, 1918, coll. unknown, 1(2) UCD; Sherman, Apr. 28, 1918, coll. unknown, T 309, 2(4) UCD; **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; Albany Co., Aug. 19, 1961, coll. MK, 7(13) VPI; **MEXICO**, Nov. 25, 1931, coll. A. L. Williamson, 1(3) USNM.

Host and distribution. This species was originally described from *Salix nigra* in Illinois. It has been collected from *Populus* and *Salix*, both Salicaceae, and from *Fraxinus* in the family Oleaceae. It has also been recorded on *Cornus* spp. and *Ceanothus* spp., but specimens collected from hosts of these two genera from several localities appear to have been misidentified. It has a very wide distribution in the United States and has also been collected from Canada (Nakahara, 1982) 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* has very small ducts only on the dorsal surface, and *C. montana* has microducts only 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.

Three species in North America--*C. ortholobis*, *C. longiloba*, and *C. lintneri*--are somewhat similar in morphological characters to this species. The description and the diagnostic characters above can help to distinguish them.

Walsh's (1868) short description is not sufficient for species identification at present. Comstock (1881) 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. After a study, he discarded the preoccupied name, *Mytilaspis salicis*, used by Le Baron (1872). 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 gave the morphological characters that separated this from *C. corni*, *C. lintneri*, *C. longiloba*, and *C. ortholobis.*

Danzig (1970) considered *C. micropori*, *C. montana*, *C. polypora*, and *C. salicisnigrae* as synonyms of *C. salicis* represented in Europe and parts of Asia. From the material she studied, she found two forms that are distinctly different in size and number of dorsal ducts of the pygidium in specimens from the two opposite ends of its distribution; the amount of variability increases in the specimens collected from the center of its distribution to include two additional forms, as well as intermediates. She noted that these different forms, which were previously considered different species, can occur in the same scale insect population. She concluded that the morphological diversities of these "species" are subject to individual, clinal, or seasonal variation. Kosztarab and Kozar (1978, 1988) recognized *C. salicisnigrae* as a distinct species.

In the present study, many specimens that were 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 compared with specimens studied 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 its morphological characters are distinctly distinguishable from its European and Asian relatives, and North American 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 and synonymy. *Chionaspis sassceri* Cockerell and Robbins, 1909: 105; Ferris, 1937: SI-17; 1942: SIV-387, 446; Takagi and Kawai, 1967:30, 38; Nakahara, 1975: 202; Gill, 1982: 1; Nakahara, 1982: 20; Takagi, 1985: 42.

Chionaspis etrusca Leonardi, Ferris 1937:SI-17 (a misidentification).

Test of adult 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, 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 zygosis and with very narrow separation. Second pair of lobes well-developed and obviously bilobed, inner lobule rounded at apex and as wide as half the 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.

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; submarginal: II, 5-18; III, 9-15; IV, 6-19 and V, 4-9; 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.

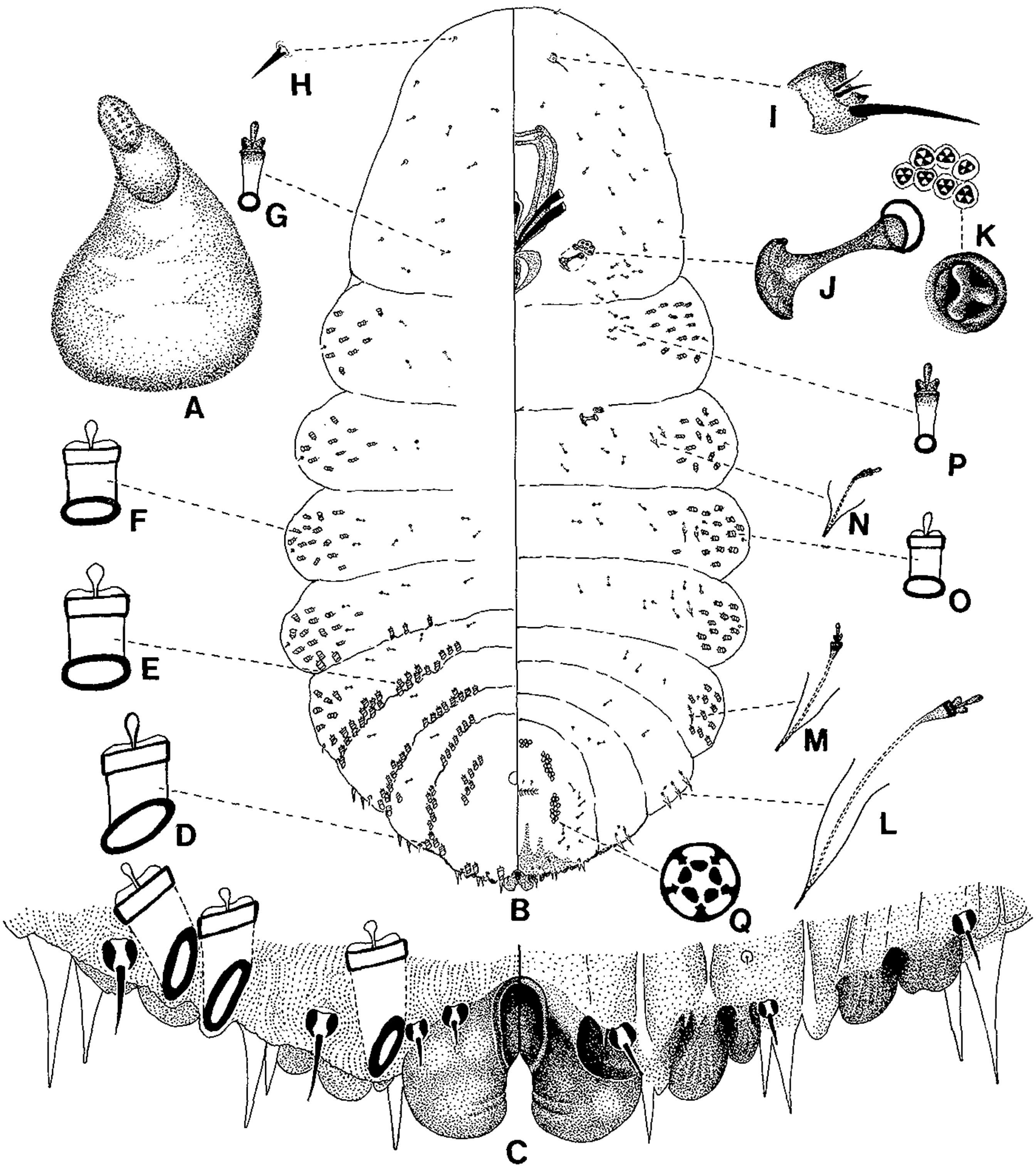

Plate 27. - *Chionaspis sassceri* Cockerell & Robbins

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, hairlike, along margins and on prosoma, length 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 on venter. Distance from anterior margin 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 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 (figs. L&M). 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 sometimes on V, 30.9- 41.7 long; number on III, 1-7; IV, 2-8; V, 1-3 (mostly 2); VI, 1-2 (mostly 2) and VII, 1-2. Frequently the gland spines on abdominal segment III are arranged submarginally.

Gland tubercles (fig. 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 orifice 1.42-2.09 wide, 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, hairlike, scattered on cephalic region, length 6.17-8.62. Very few setae also scattered irregularly on entire ventral surface of body. Marginal setae a 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: median, 8-16; anteriolateral, 14-36; posteriolateral, 7-23; each pore 3.86-5.20 in diameter.

Type material. Lectotype from *Citrus* sp., **CA**, Fallbrook, Apr. 7, 1909, Let. fr. CKL, 1(1) USNM. Paralectotypes, with same data as lectotype, 4(6) USNM; Fallbrook, Apr. 7, 1909, coll. F. Austin, Let. fr. CKL, 2(2) USNM.

Other material studied. *Ceanothus prostratus*, **OR**, 2 mi W Quartz Mt., Lake Co., Aug. 2, 1968, coll. DRM and RFD, 2(4) CDA. *Ceanothus velutinus*, **CA**, Emerald Bay, Lake Tahoe, Sept. 21, 1952, coll. F.L. Blanc, 2(5) CDA. *Ceanothus* sp., **CA**, Pollock Pines, Mar. 22, 1959, coll. RFW, 3(15) CDA; Michigan Bluff, Placer Co., Oct. 25 1967, coll. R.P. Allen, Calif. 20, 6(12) CDA, 4(9) VPI; Idyllwild, Riverside Co., May 14, 1975, coll. RJG and B. Gove, 3(13) CDA; Mt. Wilson, May 1908, coll. R.S. Woglum, 1(3) USNM; 37380 Rohlen Road, Anza, Feb. 27, 1986, coll. Don Domenigoni, C 85 & C 120, 12(30) VPI; **CO**, Mt. Baldy, date unknown, coll. Timberlake, 1(5) USNM. *Citrus* sp., **CA**, Fallbrook, B.M. Reg. no. 1921-345, 1(5) BM. *Fremontia* sp., **CA**, Frazier Park, Kern Co., May 12, 1976, coll. Easley, et al., 4(8) CDA. *Tamarix* sp., **CA**, Coachella Valley, May 1928, coll. GFF, 1(4) UCD; Indio, Nov. 1924, coll. LEM, 2(9) UCD; Indio, 1922, coll. EOE, 1(2) UCD.

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

Affinities and discussion. This species is so similar to *Chionaspis ortholobis* that they are sometimes indistinguishable. Ferris (1937) pointed out that it is doubtful if the two are in reality separate species, but he concluded that the following main morphological characters differentiate *C. sassceri* from *C. ortholobis*: (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 is distinct; (3) the zygosis at the base of median lobes is shorter, while in the latter, the zygosis is elongate and narrow. The two species are occasionally similar to each other even when collected from different localities.

CHIONASPIS STYRACIS LIU AND KOSZTARAB, NEW SPECIES

Plate 28

Suggested common name: Styrax scurfy scale

Test of adult female (fig. A). Elongate, oystershell-shaped, white or dirty white, quite small, about 2.1-3.0 mm long and 0.6-1.0 mm wide; exuviae at pointed end, first instar exuvium light yellow, second light brown, occupying about one fourth of test length. Ventral test white and very thin, developed very well along edge; it stays on surface of bark.

GENERAL DESCRIPTION

Body of adult female (fig. B). Spindle-shaped, distinctly segmented and laterally lobed; broadest at abdominal segment I or metathorax, 1812 (906-1842) long and 815 (453-846) wide; derm membranous except for sclerotized pygidial margin.

Pygidial margin (fig. C). Triangular with median lobes produced and apically sclerotized. Median lobes large and conspicuous, 27.8 (15.2-27.8) long and 16.2 (11.4-18.6) wide; bases of mesal margins close to each other, then well seperated; both mesal and lateral margins with 1-3 regular or irregular notches, apex rounded; zygosis short, well-developed, and strongly sclerotized. Second pair of lobes large, obviously bilobed and oblique mesally; both inner and outer lobules with 1-3 distinct notches on outer margin; inner lobule much longer and wider than outer lobule, which is short and narrow. Third pair of lobes poorly-developed, only inner lobule conspicuous, with several tooth-like serrations on margin; outer lobule reduced to 3-5 distinct saw-tooth-like projections.

Dorsal Surface

Macroducts (figs. D&E). Two-barred, 13.3-17.1 long and 6.7-8.6 wide, arranged in submedian and submarginal groups on posterior margins of segments of abdominal segments III-VI, and in marginal groups on abdominal segments III-VII on each side of body; numbers vary from specimen to specimen, arranged as follows. Submedian: III, 9-11 (2-11); IV, 7-8 (3-9); V, 7-8 (4-8) and VI, 4 (1-5); submarginal: III, 7-10 (6-12); IV, 8 (7-11) and V, 6-8 (3-8); marginal: III, 1 (1); IV, 2 (1-2); V, 2 (2); VI, 2 (2) and VII, 1 (1) only.

Small macroducts (fig. F). Two-barred, 6.7-12.4 long and 3.8-7.6 wide, smaller than normal dorsal macroducts; arranged in marginal-submarginal groups on each side of body as follows: prothorax, 0 (0-2); mesothorax, 2 (0-2); metathorax, 8 (4-8); on abdominal segment I, 9 (3-9); II, 8 (4-10); III, 5 (3-6).

Microducts (fig. G). One-barred, 6.8-11.3 long and 1.03-2.23 wide at orifice, scattered irregularly on submedian, submarginal, and submarginal-marginal region of each side of body; 0-5 on each of abdominal segments I, II and III, and sometime on IV or V, anterior to macroduct groups. In some specimens, their number is much higher than in others; usually 5-16 on cephalic region, 1-6 on each of thoracic segments, 2-7 on abdominal segment I, II and III, sometimes 0-3 on the rest of the segments, and pygidium.

Setae (fig. H). Few, very short, hairlike, on and along margins of cephalic region and margin of each thoracic and abdominal segment; 5.7-16.2 long; usually marginal setae along abdominal segments I-VII longer and stouter, with longest ones on V or VI; those on I, II and III becoming smaller anteriorly.

Anal area. Anal opening circular, 13.9 (11.4-18.6) in diameter, located nearly in same position as vulva on venter. Distance from anterior margin of anus to mid-point of line between abdominal segments V and VI, 97.4 (87.4-109); distance from posterior margin to base of median lobes, 169 (152-190).

Ventral Surface

Antennae (fig. I). Sclerotized, reduced to a small tubercle, 11.6 (9.3-13.3) long and 9.3 (7.6-11.6) wide at base; each antenna with 1 fleshy seta, 18.6 (16.2-23.2) long, and 2 small short and slender sensory setae. Distance between two bases of antennae, 109 (62.6-109).

Clypeolabral shield. Normal in shape for the genus, 165 (146-181) long and 116 (104-1390 wide.

Labium. Cup-shaped, 46.4 (39.4-58.0) long, 51.0 (41.8-58.0) wide.

Spiracles. Anterior (fig. J), 27.5 (26.6-37.1) long and atrium 8.4-9.5 wide, with 30-32 (15-41) associated trilocular pores (fig. K) at each spiracle. Posterior resemble anterior in shape, but somewhat smaller, usually slightly stouter, 27.5 (22.8-30.2) long, with 9 (8-16) associated trilocular pores. Usually very difficult to count exact number of associated trilocular pores because of crowding.

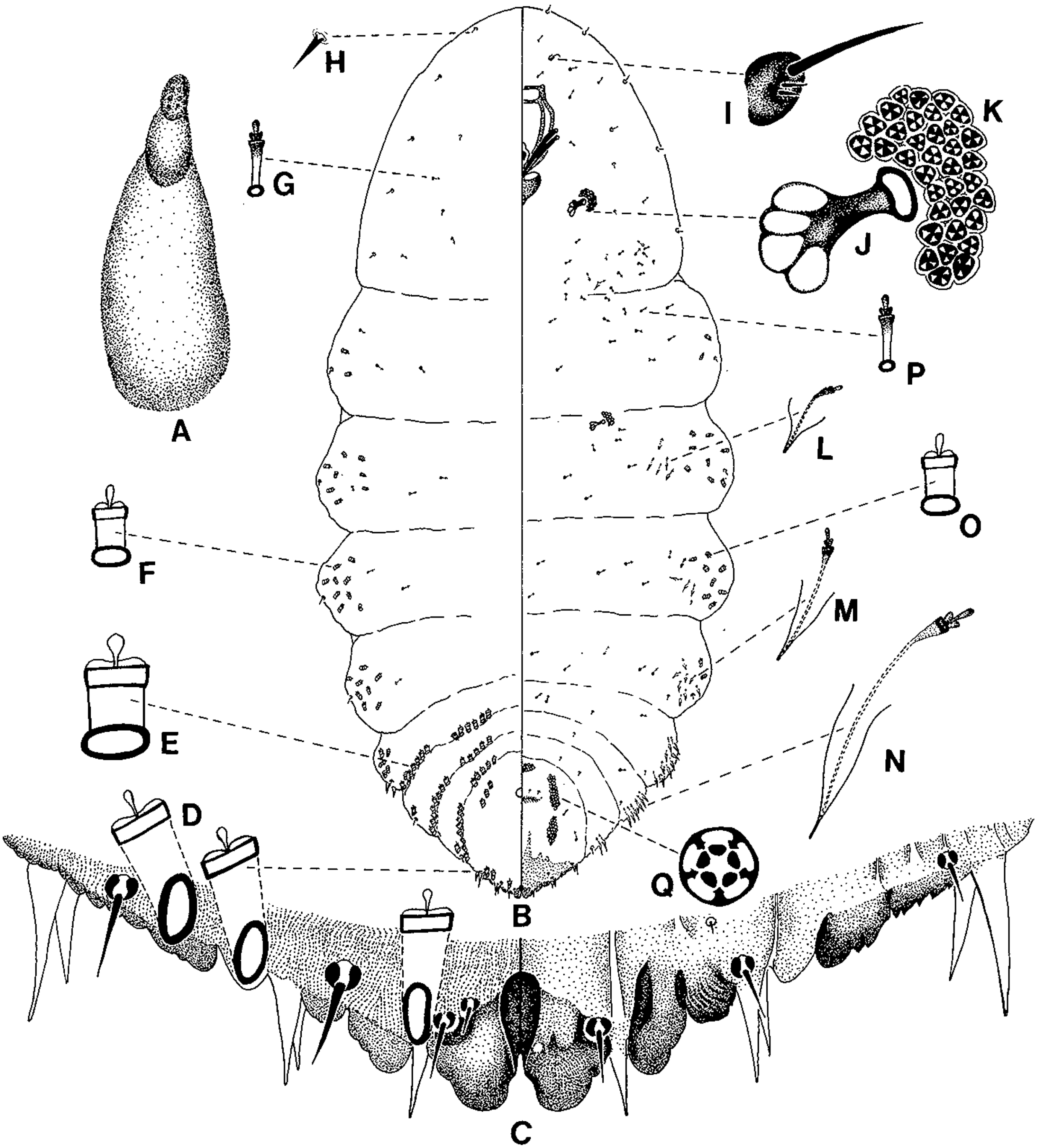

Plate 28. - *Chionaspis styracis* Liu & Kosztarab

Gland spines (figs. L&M). Marginal, 18.6-32.5 long and 3.6-7.0 wide at base, with an associated one-barred microduct on abdominal segments III-VII on each side of body; usually longest ones on IV, or sometime on V; number on III, 9 (6-11); IV, 7-8 (5-8); V, 2 (1-3), most 2; VI, 1-2 (1-2), most 2 and VII, 2 (1-2), and 1 (1-2) laterad of median lobes. Sometimes gland spines on abdominal segment III arranged submarginally.

Gland tubercles (fig. N). Distally spine-like, basally conical, 7.0-16.2 long and 3.5-7.2 wide at base, with an associated one-barred microduct, arranged in submarginal groups on thoracic segments and basal abdominal segments I and II: 1 (0-3) on prothorax; 0 (0-2) on mesothorax; 5-6 (1-8) on metathorax; 4-7 (2-7) on abdominal segment I, 4-8 (4-9) on II.

Small macroducts (fig. O). Same size, shape, and location as those on dorsal surface of body except for being more numerous here.

Microducts (fig. P). Same shape, size, and location as those on dorsal surface except for being much more numerous.

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

Vulvar area. Vulvar opening in middle of pygidium; perivulvar pore (fig. Q) groups: median, 13 (8-23); anteriolateral, 40-41 (23-47); posteriolateral, 27-40 (17-44); each pore 3.8-4.8 in diameter.

Type material studied. Holotype from *Styrax americana*, Auburn, Alabama, collected May 3, 1973, by MLW, 1(1) USNM. Paratypes: same data as holotype, 5(5) AU; **GA**, Taylor Co., Apr. 2, 1980, coll. RB, 11(11) UGAES, 2(2) VPI, 2(2) at USNM; **MS**, Jackson Co., May 2, 1976, coll. B.J. Muse, 2(5) AU. *Styrax grandiflora*, **FL**, Arcadia, May 4, 1961, coll. by G.P. Lamb, 1(1) USNM. *Styrax* sp., **FL**, Wauchula, June 10, 1931, coll. D.H. O'Quinn, 4(5)FSCA. The accompanying illustration is based on the holotype.

Host and distribution. This species has so far been found only on *Styrax* spp. (family Styracaceae) in the southeastern United States.

Affinities and discussion. This species was misidentified as *Chionaspis lintneri* in several collections. It is also more or less similar in morphological characters to the bark form of *C. platani* Cooley and several other species such as *C. longiloba* Cooley and *C. hamoni* Liu and Kosztarab.

The following characters can be used to separate it from other species: (1) no dorsal macroducts on submedian and submarginal area of abdominal segment II; (2) both mesal and lateral margins of median lobes with 1-2 distinct notches, and without fine serrations; (3) the second pair of lobes with irregular notches and without fine serrations; (4) the outer lobule of third pair of lobes reduced into several toothlike projections.

In *C. lintneri* the most important characters to separate it from *styracis* are: (1) several dorsal submedian macroducts on abdominal segment II; (2) both mesal and outer margins of median lobes with fine serrations and without notches; (3) the second pair of lobes with fine serrations; and (4) the outer lobule of third pair of lobes distinct.

The bark form of *C. platani* is similar to this species in general appearance, but it has a more pointed apex of the median lobe; also the outer lobule of the third pair of lobes is distinct, and it has so far only been found on *Platanus*.

In *C. hamoni* and *C. longiloba*, the shape of the median lobes, the marginal serrations of all marginal lobes, and the reduction of the outer lobule of the third lobe are distinctly different from *C. styracis*.

Etymology: This species was named after its only host genus, *Styrax*.

CHIONASPIS TRIFORMIS TIPPINS AND BESHEAR

Plates 29, 30

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: 1022; Beshear et al., 1973: 9; Knipscher et al., 1976: 9.

Test of adult female (Plate 29, 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 recognized. They are described and illustrated below.

Bark Form
Plates 29; 30 (fig. A)

Body of adult female (fig. B). 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 30, 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 zygosis; 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.

Dorsal Surface

Macroducts (Plate 29, 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.

Small macroducts (Plate 29, 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 29, 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 29, fig. H). Very few small and hairlike, 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 (on venter); distance from anterior margin of anus to mid-point of line between abdominal segments V and VI, 51.0-69.5; distance from posterior margin of anus to base of median lobes, 84.9-98.8.

Ventral Surface

Antennae (Plate 29, 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 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 29, 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 the same in shape and size to anterior one, 18.5-19.3 long, most lacking associated trilocular pores, rarely only 1 present.

Gland spines (Plate 29, figs. L&M). 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 29, fig. 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 segments and occasionally on thorax; sometimes 1 on metathorax; 1-4, or rarely absent, on abdominal segment I, 2-5 on II.

Small macroducts (Plate 29, 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 29, 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 29, fig. H). Very few, hairlike, 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 29, fig. Q) groups: median, 4-8; anteriolateral, 11-17; posteriolateral, 8-16; each pore 3.02-4.09 in diameter.

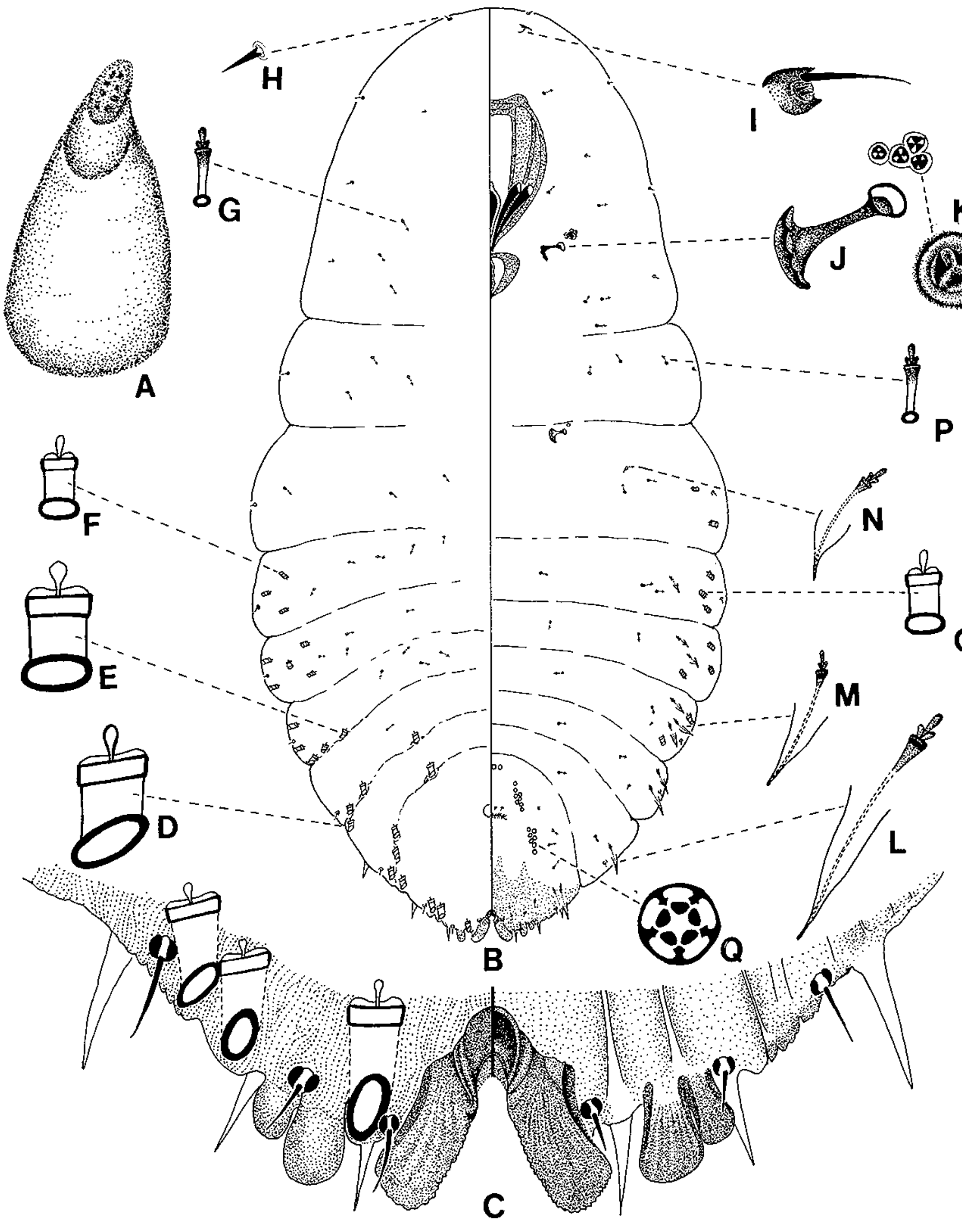

Plate 29. - *Chionaspis triformis* Tippins & Beshear, leaf form

Leaf Form
Plates 29, 30
(Figure references are for Plate 29 unless stated otherwise.)

Body of adult female (fig. B). Spindle-shaped, 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; Plate 30, fig. B). 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 zygosis. 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.

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, hairlike, 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 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 (figs. L&M). 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.

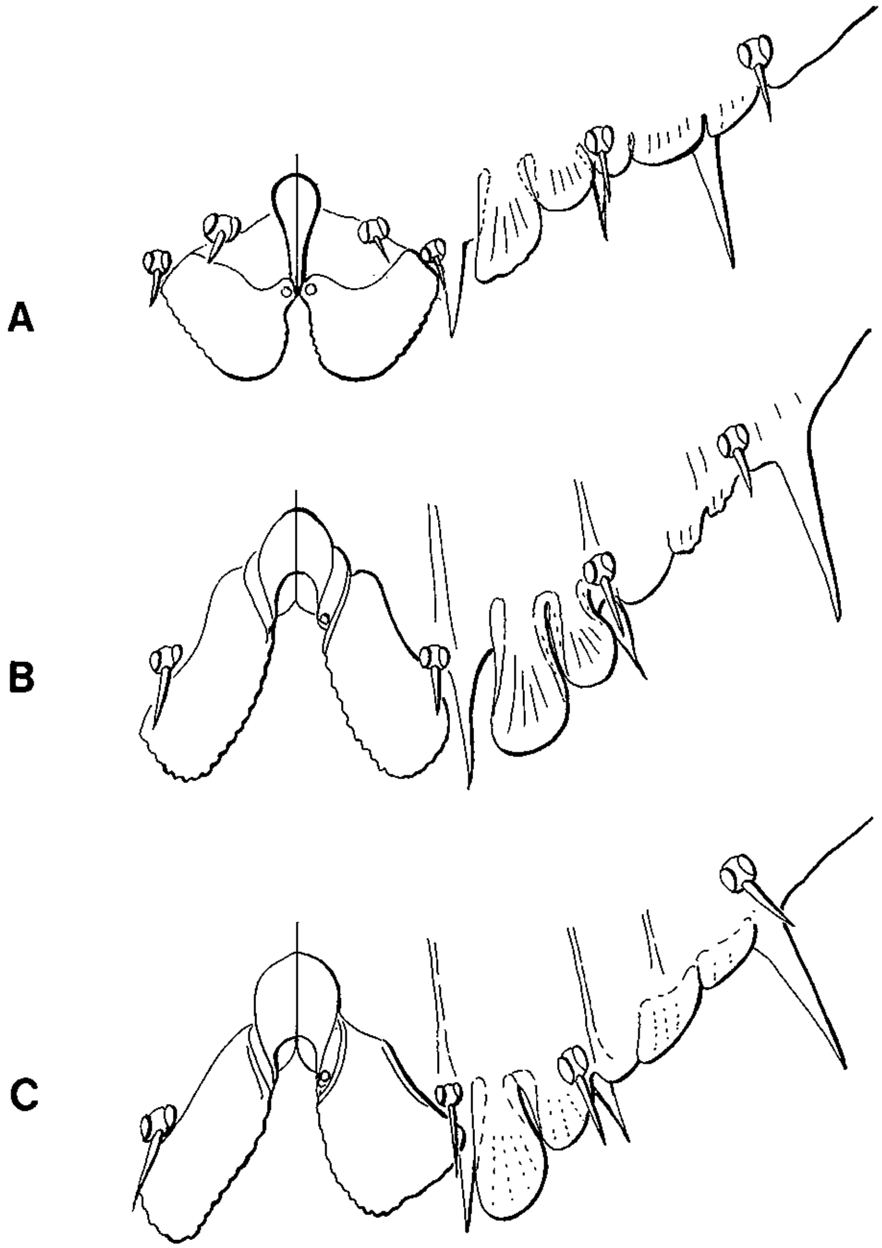

Plate 30. - *Chionaspis triformis* Tippins & Beshear, median lobes of different forms

Gland tubercles (fig. 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, hairlike, 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. Holotype from *Betula* sp., **GA**, Spalding Co., Jan. 3, 1969, coll. RB, 1(1) CDA. Paratypes from *Betula nigra*, **GA**, Spalding Co., Feb. 11, 1968, coll. RB, 1(1) UGAES, 1(1) USNM; Jasper Co., Aug. 28, 1969, coll. HHT, 6(6) UGAES. *Betula* sp., Jasper Co., May 22, 1968, coll. RB, 2(2) UGAES; Spalding Co., Jan. 3, 1969, coll. HHT, 3(3) UGAES.

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

Host and distribution. So far this species has been found only on the bark of *Betula* in Georgia and Florida.

Affinities and discussion. According to the original description by Tippins and Beshear (1970), 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 *C. gleditsiae* are so similar that they are sometimes indistinguishable. The only character which can be used is that *C. gleditsiae* has more than 20 dorsal macroducts.

The only specimen representing an intermediate form in the original description was examined. 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 30, fig.C) so as to show the differences from that of the other forms. We 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 30, fig. A). In addition, the basal sclerotized zygosis 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 31, 32

Suggested common name. Wistaria scurfy scale

Literature and synonymy. *Chionaspis wistariae* Cooley, 1897: 280; 1899: 39; Cockerell, 1899: 398; *Kuwana, 1928: 4; Ferris, 1942: SIV-388-446; Takahashi, 1952: 8, 1953: 48; Ferris, 1956: 74; McKenzie, 1956: 30; Kosztarab, 1963: 78; Willoughby and Kosztarab, 1974: 5; Nakahara, 1975: 202; 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.

Test of adult female (Plate 31, 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 31, 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 31, fig. C and Plate 32, 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 32, figs. A-D). These are described, illustrated, and discussed in order.

Bark Form
Plates 31, 32

Pygidial margin (Plate 31, fig C; Plate 32, 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 to one half 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 31, 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 31, 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 31, fig G). One-barred, very small, 4.94-7.41 long and 1.48-2.35 wide at orifice, only a few scattered irregularly on cephalic region, and on prothorax, mesothorax and metathorax, and on abdominal segments and pygidium of each side of body.

Setae (Plate 31, fig. H). Very few, hairlike, 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 margin of anus to the base of median lobe, 104-120.

Ventral Surface

Antennae (Plate 31, fig. I). Reduced to small scelerotized tubercles, 6.18-8.55 long and 4.94-8.03 wide at base; each with a curved fleshy seta, 13.9-19.2 long; distance between their bases 55.6-72.6.

Spiracles. With sclerotized atrial rim, anterior spiracles (Plate 31, fig. J), about 15.4-23.0 long and atrium 7.6-9.3; each with 10-20 associated trilocular pores (Plate 31, 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 31, figs. L&M). 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 31, fig. 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 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 31, fig. O). Same shape, size, and location and nearly same number as those on each segment of dorsal surface.

Microducts (Plate 31, 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 31, fig. H). Very small, hairlike, 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 31, 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.

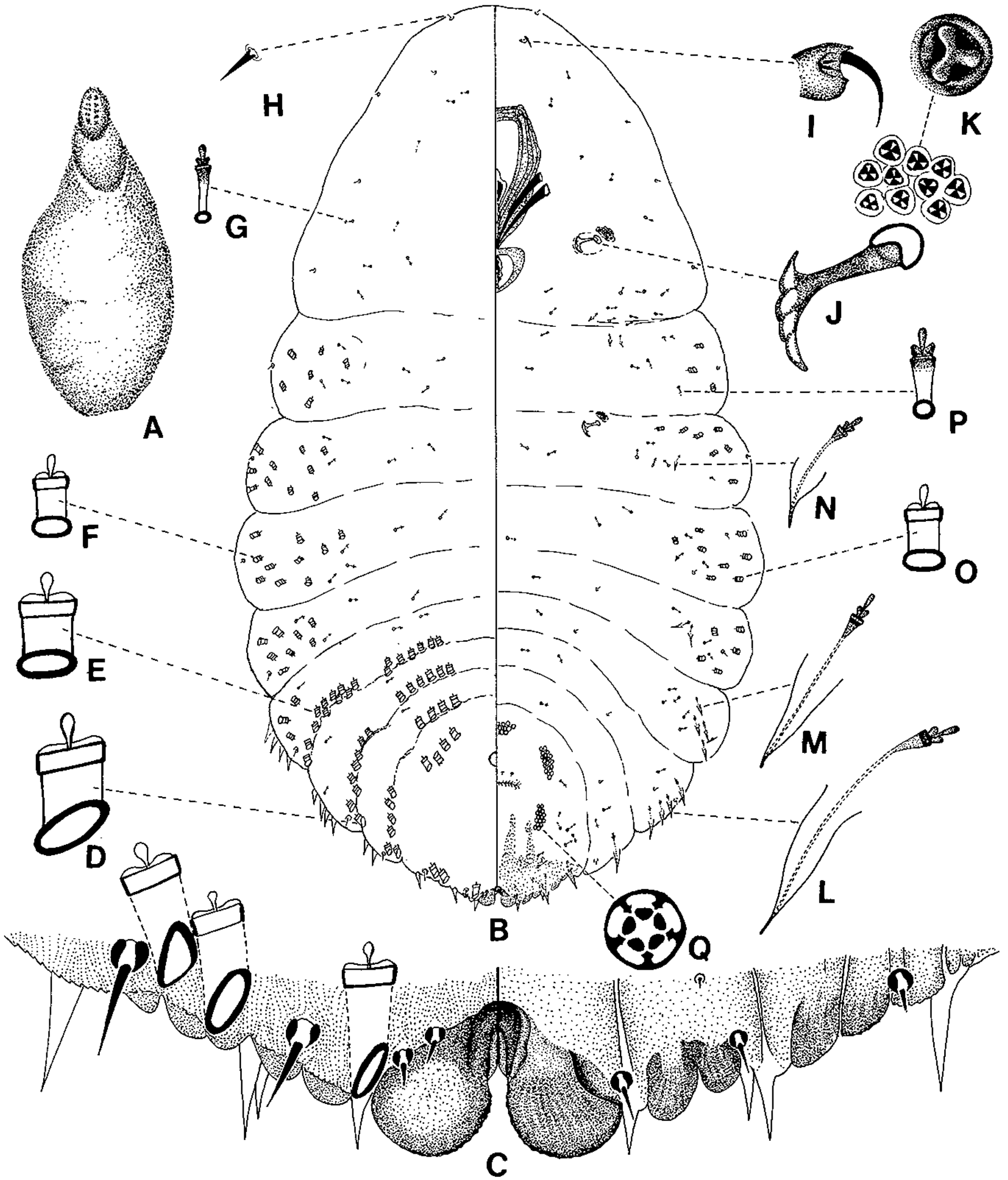

Plate 31. - *Chionaspis wistariae* Cooley, bark form

Leaf Form
Plate 32, 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 zygosis. 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 fleshy seta, 15.3-19.2 long; and each with 2 very short sensory 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 shaped, 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,

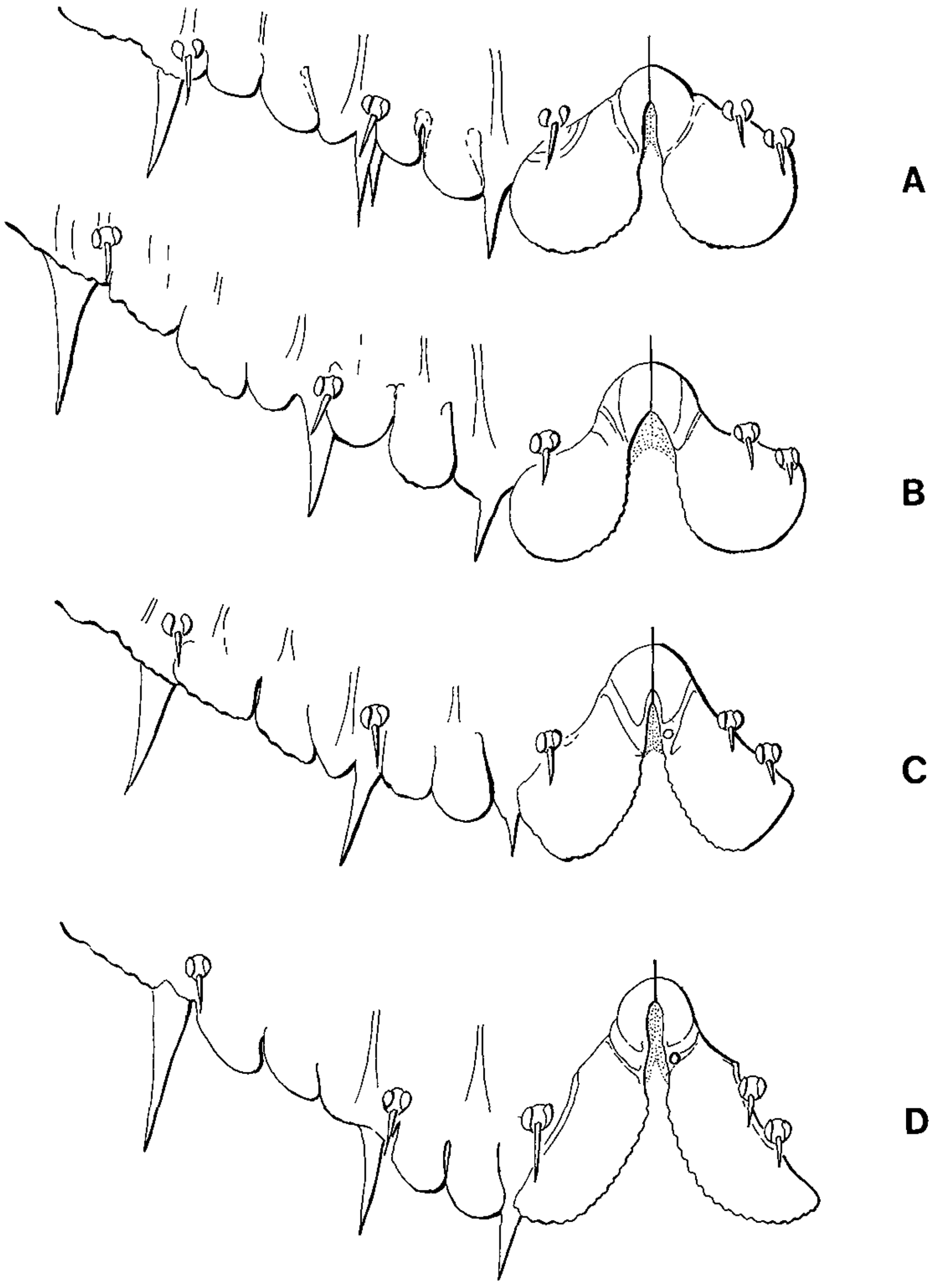

Plate 32. - *Chionaspis wistariae* Cooley, median lobes of different forms

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, and location and about same number on each segment as those 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, hairlike, 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 submarginal 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 32, figs. B & C

Several specimens were considered intermediate forms as shown in Plate 32, figs. B&C. Several specimens originating in Tokyo collected at 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.

Type material studied. Lectotype from *Wistaria* sp., Japan, July 8, 1897, coll. R.A. Cooley, 1(1) MOSU. Paralectotypes, same data as lectotype, 2(2) MOSU.

Material studied. *Wistaria floribunda*, **CA**, Huntington Gardens, July 15, 1979, coll. DRM, 6(10) USNM. *Wistaria multijuga*, **DC**, fr. JAPAN, Jan. 6 1938, coll. W.B. Woods, 2(4) USNM. *Wistaria nankinensis* , **DC**, fr. JAPAN, Jan. 18, 1937, coll. Limber, 1(1) USNM. *Wistaria sinensis*, **CA**, Vista, Sept. 1954, coll. G. Beckett, 1(1) CDA. *Wistaria* sp., **CA**, Vista, San Diego Co., Sept. 30, 1954, coll. Glenn Becket, 8(10) CDA; San Diego, June 29, 1954, coll. S.D. Caly, 1(1) CDA; Inglewood, Aug. 27, 1926, coll. L.E.M., 8(18) UCD; Chula Vista, San Diego Co., Oct. 27, 1950, coll. K.H. Baker, 2(4) CDA, 1(1) UCD; San Marino, Los Angeles Co., June 2, 1980, coll. J. White, 4(21) CDA; Santa Barbara, June 21, 1943, coll. Tower, 1(2) CDA; Montibello, Nov. 2, 1939, coll. Vandenberg Feltrop, 1(2) USNM; San Diego Co., Balboa Park, Feb. 25, 1939, coll. Baumgardner, 3(4) CDA; same only E. Gamman & Bumgardner colls., 2(9) CDA; Santa Barbara, at Hatfields Nursery, May 21, 1943, coll. C.R. Tower, 2(4) UCD; Location unknown (fr. Japan), date and coll. unknown, 2(4) UCD; **DC** (fr. JAPAN), Mar. 26, 1929, coll. Wood and Owrey, 2(4) USNM; (fr. JAPAN), May 25, 1934, coll. W.B. Wood, 2(5) USNM; **HI** (fr. JAPAN), Oct. 1, 1974, coll. S. Ochikubo, 1(1) USNM. **PA**, Narberth, Albrechts Nursery, Sep. 1943, rec'd. from G.B. Sleesman, 2(6) VPI. **WA**, Seattle (fr. Japan), Mar. 15, 1937, coll. M.J. Forsell, 1(1) USNM.

Host and distribution. This species is found only on the leaves and branches of *Wistaria* (= *Wisteria*), family Fabaceae. 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 *Wistaria* at San Fancisco, California (Cooley, 1897). Now it is also known from the District of Columbia, Hawaii, Pennsylvania, and Washington.

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. longiloba*.

Takahashi (1952, 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. Takagi (1961) 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 is 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, was 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 number 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 overlaped 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 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 32, figs. 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

Plates 33, 34

During 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 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 shape of the test. 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 condition 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 occured 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 feeds only on leaves, was remarkably similar, except for the median lobes, to *Chionaspis sylvatica*, which feeds only 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 bark and leaf forms of *Chionaspis nyssae* (synonym: *P. nyssae*). Their observations and conclusions further confirmed the proposal made by Takagi and Kawai. Takagi (1988) also reported such host-site induced polymorphism in the related genus *Aulacaspis*. 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 to 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, the leaf form, and the many variations in the intermediate forms.

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. If the overwintering stage is the egg, with the increase in temperature toward spring 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 exemplified in Plates 33 and 34 which follow.

The morphology of the median lobes of the new generation is thought to be affected by the first instar nymphs or crawlers, their mothers, their grandmothers, and so on, but mainly as below (see Plate 33 for explanation of abbreviations).

1. BO-- > BF, second generation will become the bark form;
2. BO-- > LF, second generation will become the intermediate form;
3. BO-- > PF, second generation will become the intermediate form, more similar to the bark form;
4. LO-- > BF, second generation will become the intermediate form;
5. LO-- > LF, second generation will become the leaf form;
6. LO-- > PF, second generation will become the intermediate form, more similar to the leaf form;
7. PO-- > BF, second generation will become the intermediate form, more similar to the bark form;
8. PO-- > LF, second generation will become the intermediate form, more similar to the leaf form;
9. PO-- > PF, second generation will also become an intermediate form.

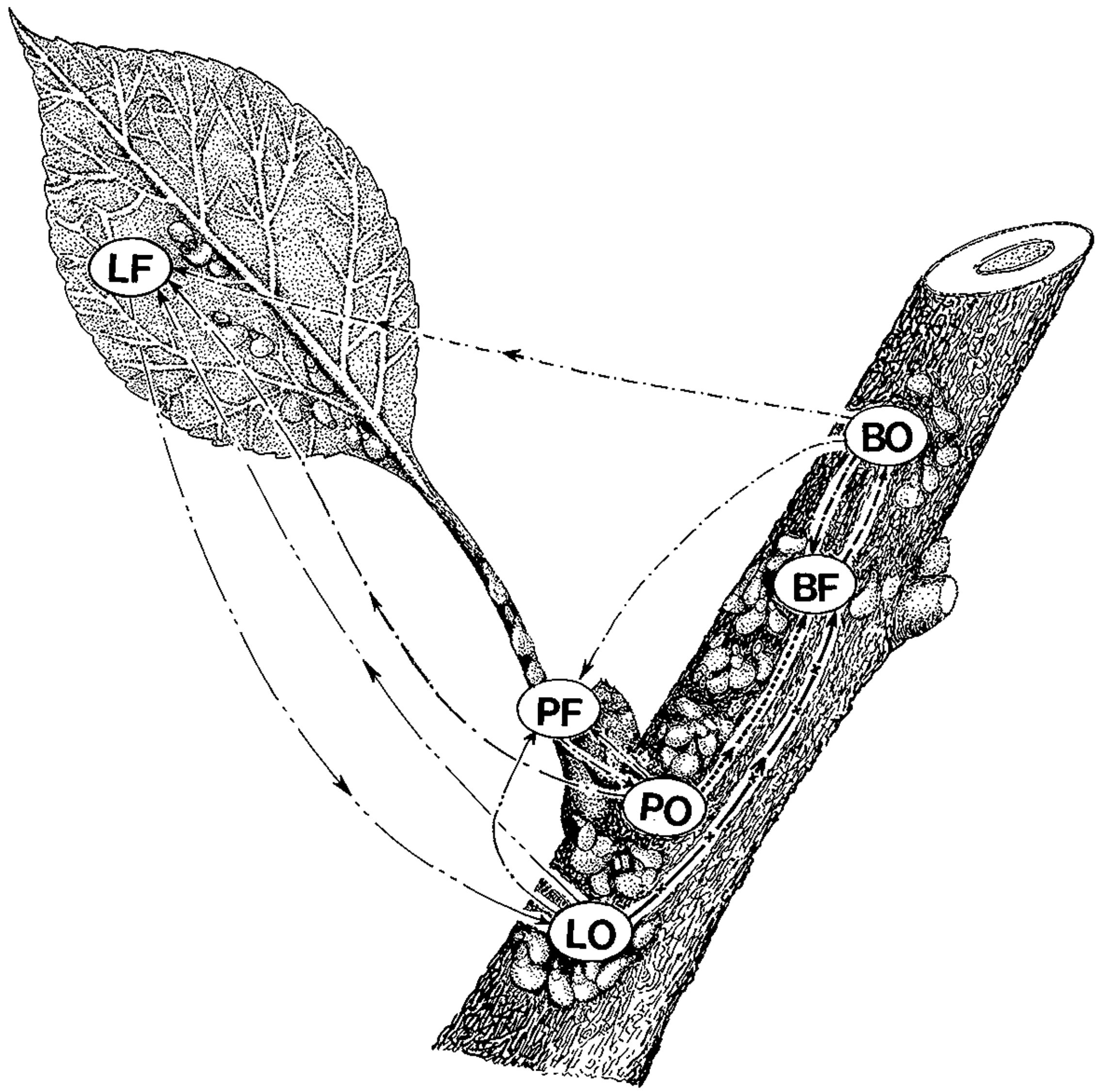

Plate 33. - A hypothetical life cycle producing polymorphism

BF - Bark form, feeding on bark

BO - Bark form - overwintering generation

LF - Leaf form, feeding on leaf

LO - Leaf form - overwintering on bark

PF - Feeding on petiole, bud and other parts of plant

PO - Overwintering on bark, intermediate form

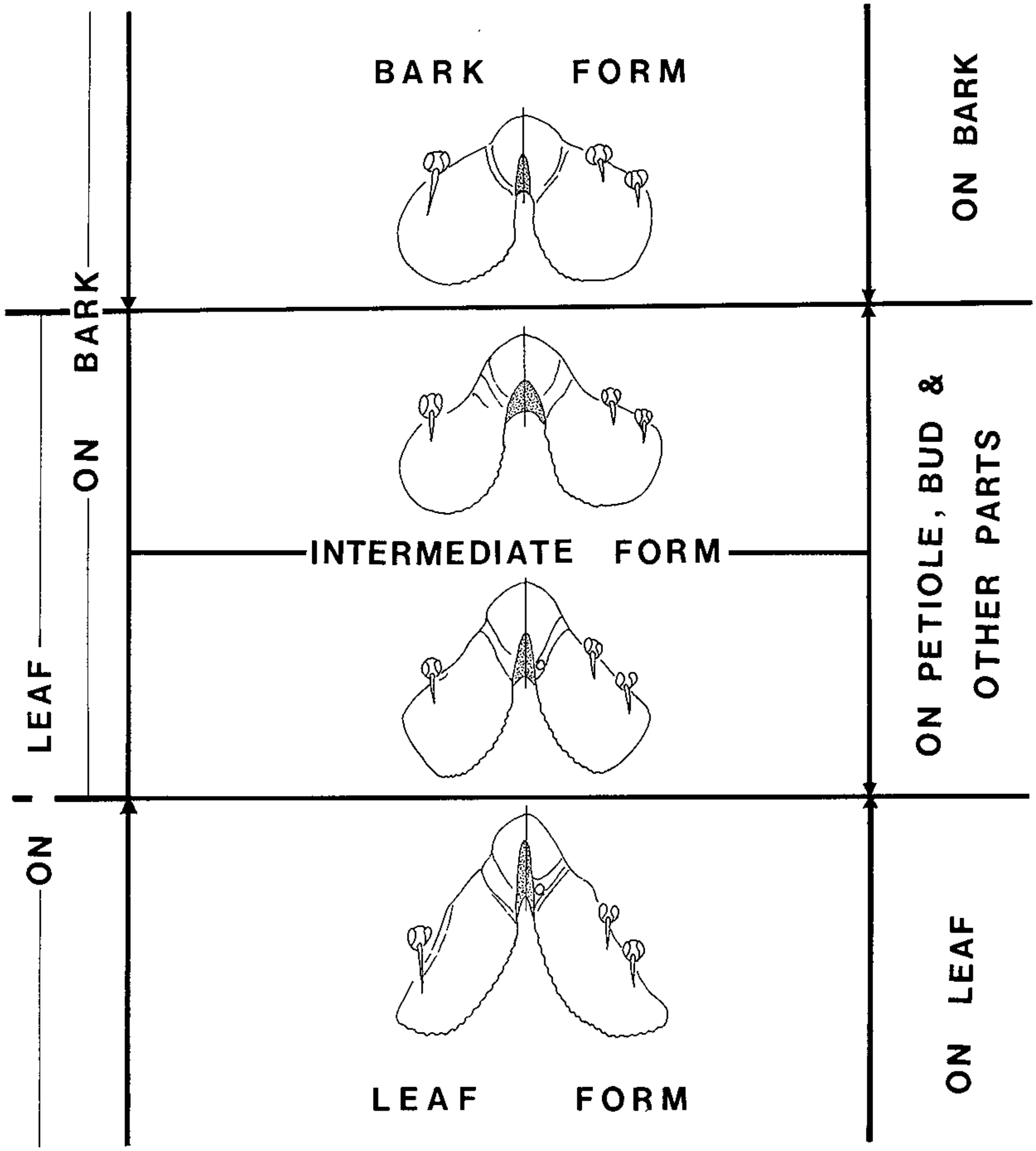

Plate 34. - Diagram of host-site associated polymorphism

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 mothers (the previous generation), but also by the forms of preceding generations; therefore, the forms of adult females collected from the field are very rarely either typical bark forms or typical leaf forms, regardless of whether they are on the bark or the leaves at the time of collection. It is further suggested that there should be an infinite number of variations of median lobes, as continuous variations in intermediate forms between the typical bark and leaf forms.

Some coccidologists have suggested that the change of the median lobes or forms of adult females is 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 we 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 in nutrition 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, we think the polymorphism associated with different feeding sites appears to be affected by the location of the feeding sites more than by the nutrition, or the physical structure of plant tissue at the feeding sites, or possibly genetic factors, also the chemical contents associated with the metabolic processes of the host.

DISCUSSION OF ADULT FEMALE PHYLOGENY BASED ON CLUSTER ANALYSIS

The phylogenetic and evolutionary relationships of all the species of *Chionaspis* in the world have not been completely studied. Takagi (1985) proposed an evolutionary scenario for the genus *Chionaspis* and for the polymorphism caused by feeding sites. He considered the major derived characters (apomorphic) to include: (1) enlarged median lobes, semicircular in shape and connected by a zygosis, and fused; (2) a distribution that expands from subtropical or temperate areas to cooler climates; and (3) host plant range which is increasing. 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: well separated median lobes, with poorly developed basal zygosis or none; median lobes uniform in size and shape; and 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 numerical 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 using Ward's Minimum Variance Cluster Analysis (SAS, 1985). Even though the present conclusions are somewhat general, the goal was to produce a more refined phenogram 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 any of 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 the ratio of length to width), length 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, and 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 of 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 phenogram is shown in Figure 1. This phenogram gives only a general 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 phenogram. Therefore, the phenogram may not show the exact relationship of these species. For example, of all the species with two morphs, only the forms of *C. platani* are greatly separated in the phenogram. When these results are combined with current knowledge of the group and the results from the phenogram of the species, the following phylogeny is discussed and proposed:

1. The shape, marginal structures, degree 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 phenogram. 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 (derived) 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. Characters other than these are considered plesiomorphic.

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*, the shape of median lobes appears apomorphic, while the development of dorsal ducts is considered plesiomorphic. In contrast, in *C. gleditsiae, C. nyssae, and C. triformis*, the dorsal ducts are apomorphically reduced in both bark and leaf forms, whereas the median lobes of leaf forms are plesiomorphic.

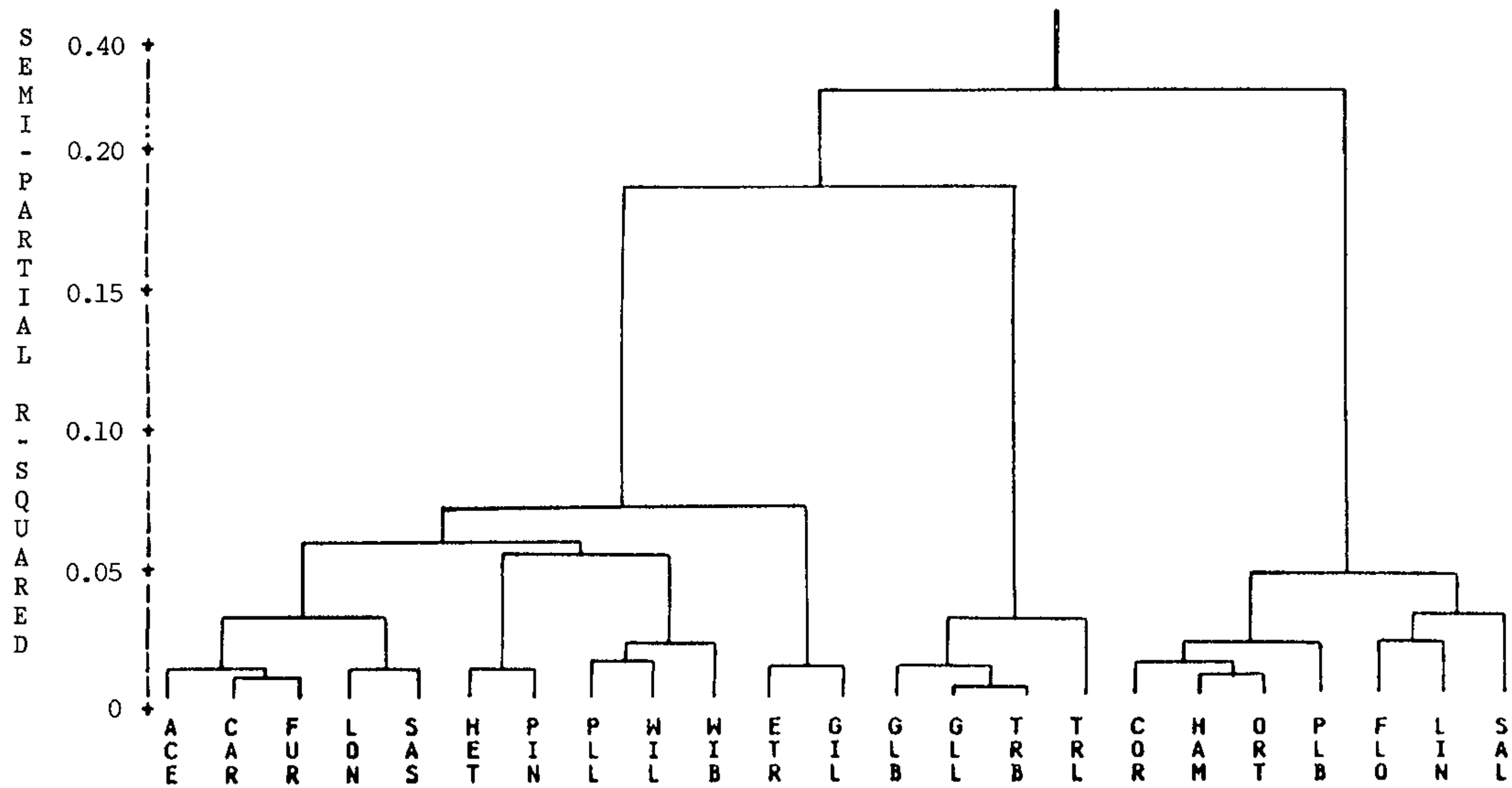

Figure 1. Dendrogram showing relationship of 19 species of *Chionaspis* based on Ward's Minimum Variance Cluster Analysis using 23 numerical characters. Species with only 1 form are abbreviated using the first 3 letters of the species name; those with 2 forms using the first 2 letters plus B for bark form or L for leaf form.

4. Based mainly on the shape and size of median lobes and some other biological characters, which are not included in the phenogram 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 median lobes which are also more or less fused: *C. americana, C. caryae, C. floridensis.*

Group 2, consists of the species with apomorphic 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 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, C. longiloba,* and *C. styracis.*

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, while those of the leaf form are plesiomorphic. 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 median lobes.

In summary, the phylogenetic and evolutionary relationships of all the species are not yet clear. The results of the phenogram and the supplementary 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, based on all the species in the world and on all the morphs and developmental stages of both sexes. The second simultaneous study conducted in our laboratory on the adult males may help to fill in existing gaps in our knowledge on the phylogeny of the genus *Chionaspis*. The reader should also check the "Discussion of Phenetic Similarity of Adult Males Based on Cluster Analysis" at the end of the second study.

BIOLOGY AND ECONOMIC IMPORTANCE OF NORTH AMERICAN *CHIONASPIS* SPECIES

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 and 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 egg under the protection of the scale 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 the 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 the bark to settle on the leaves, petioles, or buds, or may move back to the bark from any of those plant parts. The sexes can be separated in the field when they reach the second instar stage. Usually the female test is pear-shaped, composed of smooth wax, and without carinae, whereas the male test is elongate, has 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, and some begin laying eggs for overwintering, although live females ready to lay eggs may be found every month until spring. Reproduction normally biparental, but both uniparental and biparental reproduction have been reported in *C. pinifoliae* (Luck and Dahlsten, 1974).

For detailed life histories of some North American species, readers can consult Hill (1952) for *C. furfura*; Shour (1986) for *C. heterophyllae*; Willoughby and Kosztarab (1974) for *C. americana* and *C. kosztarabi*; also Knipscher et al. (1976) for *C. nyssae*; and Brown (1958, 1959), Cumming (1953), Luck and Dahlsten (1974), and Shour (1986) for *C. pinifoliae*.

We studied two species of *Chionaspis* which are common near Blacksburg, Virginia, in detail from September 1985 through June 1987 (five generations). Samples of needles were taken weekly at two locations, one the Virginia Polytechnic Institute and State University Horticultural Research Farm-Arboretum (elevation 640 m) about 6 km south of Blacksburg, and the other an abandoned Christmas tree planting on the southfacing slope of Brush Mountain (elevation 807 m), about 5 km northwest of Blacksburg. The two species of pine chosen at the Research Farm were *Pinus nigra* (Austrian pine), which had an infestation of *C. heterophyllae* on it, and *Pinus strobus* (white pine) which had a population of *C. pinifoliae*. The Austrian pine was in a clump with about five other trees, all of that species, in a field and next to an unpaved road. The white pine was also in a clump of similar pines, and across the road from the Austrian pines. Trees of both were about 25-30 years old. On Brush Mountain were many *Pinus sylvestris* (Scotch pine) trees, about 15 years old, which had grown too large for use as Christmas trees. These trees were also in a clump and had grass growing around them. *C. heterophyllae* was quite prominent on these trees. At the edge of the field were a few native *Pinus virginiana* (Virginia pine) trees, about 10 years old, in a stand of mixed hardwoods and conifers. These trees had a light infestation of *C. pinifoliae* on them.

Although none of the populations of *Chionaspis* was large enough to permit heavy sampling, we were able to obtain general life history data from weekly collections of about 20 infested needles. At the Research Farm where both *C. heterophyllae* and *C. pinifoliae* occurred, spring crawler emergence was during mid-May for both species and for both years. Shour (1986) found hatching dates to be similar in Indiana when he observed both species on *Pinus sylvestris*.

Summer crawler emergence for *C. heterophyllae* was in early August. No crawlers were found in the *C. pinifoliae* samples that summer. Overlapping of generations was apparent, because both eggs and females were present throughout the year. Although the two clumps of host trees were very close to each other, each species of *Chionaspis* remained confined to its particular host, despite the fact that *C. heterophyllae* is known from *P. strobus* and *C. pinifoliae* from *P. nigra*.

On Brush Mountain, crawlers of *C. heterophyllae* were active slightly earlier on Virginia pine than on Scotch pine for both years. During 1986 first generation crawlers appeared in late April on Virginia pine and early May on Scotch pine, but during 1987 it was mid-May before they emerged. Initiation of the second generation crawler period was not definite, but appeared to be during late July to early August. Adult females and eggs were present all year on Brush Mountain, as they were at the Research Farm.

Egg production, expressed as average number of eggs per female, for *C. heterophyllae* on *Pinus nigra* showed a marked peak in May, reaching a high of 65 in 1986 and 39 in 1987, after which it dropped off sharply in June. In summer and fall the pattern was alternately up and down, ranging from 0 to 32. Through the winter months counts were more even, remaining close to 20. At the same location the egg production of *C. pinifoliae* on *P. strobus* reached a similar peak in the spring with a high of 32 in April 1986 and 26 in May 1987, but then followed a different pattern, leveling off to around 8 until the end of June. Over the summer egg production was erratic but became fairly steady in the fall and winter, ranging from 10 to 20.

The populations of *C. heterophyllae* at Brush Mountain showed fairly similar patterns of egg production, with one exception. There was a sharp increase in eggs/female on *Pinus sylvestris* in October from essentially 0 to over 30. This high level continued relatively steady until June except for a dip in late April and early May. In the spring of 1986 there was a drought which caused the population to decline, resulting in a drop in egg production before the end of May to almost 0 where it remained until late July.

On *Pinus virginiana* production increased more gradually in the fall and remained lower all winter than that on *P. sylvestris*. Each season there were peaks in the spring, and the drought did not cause the dramatic reduction in egg laying that was evident on *P. sylvestris*, perhaps because the Virginia pines were in the woods rather than in the open. Instead, numbers of eggs decreased gradually until mid-June. Summer egg production was erratic on both hosts.

Shour (1986) concluded that egg production of first generation females (non-overwintering) was less than that of second generation females, and our results agree. Shour also found that drought caused a decrease in the populations of both *C. heterophyllae* and *C. pinifoliae* on *P. sylvestris*. We noticed a similar reduction in the populations we were studying on all four hosts due to dry weather in 1985 and 1986.

Natural enemies. Hymenopterous parasites of *Chionaspis* spp. are common and are often effective natural biological control agents. Willoughby and Kosztarab (1974) reared 8 different parasite species and one hyperparasite 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 mites were important predators of *C. americana* in Virginia (Willoughby and Kosztarab, 1974), *Tydeus* sp., and *Hemisarcoptes malus*. Natural enemies of *C. pinifoliae* were reviewed by Luck and Dahlsten (1974). These included 14 species of predaceous coccinellid beetles. They also found a dramatic effect of predation on the parasite population of *C. pinifoliae*. Shour (1986) has given a detailed account on the parasites and predators of *C. heterophyllae* and *pinifoliae* and their effectiveness.

Economic importance. Some of the *Chionaspis* species are pests of fruit trees in neglected orchards and on ornamental and landscape trees in urban environments. *C. furfura*, the scurfy scale on apple, was recognized as a pest in apple orchards in the northeastern United States (Cooley, 1899) and in Virginia (Hill, 1952). *C. gleditsiae* recently became a pest of honey locust trees in Manhattan, New York, while *C. corni* and *C. salicisnigrae* were considered pests in nurseries by Cooley (1899) and by Kosztarab (unpublished). *C. pinifoliae* has often been reported as a pest of conifers in urban environments (Cooley, 1899) and in shelter belt plantings (Cumming, 1953). Some of the early records on this species may apply to *C. heterophyllae*. *C. heterophyllae* is a pest of mugho pine in College Park, Maryland (D. R. Miller, unpublished).

II. ADULT MALES OF THE GENUS *CHIONASPIS* (HOMOPTERA: COCCOIDEA: DIASPIDIDAE) IN NORTH AMERICA*

by

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CONTENTS

ABSTRACT

This study provides morphological descriptions and illustrations for twelve species of *Chionaspis*, including their seventeen morphs, and a key to separate them. Males of four species were found to be polymorphic, and seven morphs are described and illustrated for the first time here. Methods and materials used and the general morphology of *Chionaspis* adult males are discussed. An evolutionary hypothesis is presented based on Ward's Minimum Variance Cluster Analysis.

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INTRODUCTION

Knowledge of males of *Chionaspis*, in contrast to that of females, has always been extremely limited because the males are both minute and short-lived and, thus, rarely collected. In fact, males have been studied for only four species of *Chionaspis*: *C. americana* and *C. kosztarabi* (Willoughby and Kosztarab, 1974), *C. nyssae* (Knipscher et al., 1976), and *C. salicis* (Ghauri, 1962). Males of all four species were found to be polymorphic. This fact suggests that all species may likewise be polymorphic, and considerably increases the need for a proper description of the morphs of the various species.

In the present study we have described all known morphs for adult males of North American *Chionaspis*. Of the 12 species treated here, seven are described for the first time. Six are represented exclusively by a winged morph, one exclusively by an apterous morph, four species by both a winged and an apterous morph, and one by both a winged and a brachypterous morph. We have presented a key to the 12 species and their 17 morphs. All males examined were collected from bark except those of *C. heterophyllae* and *C. pinifoliae*, which were collected from pine needles.

Winged males of different species of *Chionaspis* differ from one another principally in overall proportions and in meristic characters. The number of antennal segments varies, as well as the number of various setae, namely, the ventromarginal, abdominal, interlocular, midcranial, claviform, leg, genital, and tegular setae. Other morphological variations include presence or absence of wings, their condition if present, presence or absence of bifurcate fleshy setae on the metatarsi, and the relative proportion of the segments of the metathoracic legs. Several species were also distinguished by possessing such unique structures as a pair of recessed setae on the precoxal ridge of the mesothorax (*C. pinifoliae*), and spurlike setae on the protibiae (winged *C. americana*).

MATERIALS AND METHODS

Collection. Scale insects of the genus *Chionaspis* are widely distributed in North America and occur on a broad range of plants. The test or cover of the male (Color figs. 7, 8, 10, 15) is smaller than that of the female, and more narrow and parallel-sided, and is normally found in the same area of the plant as the tests of the females. Most tests of males which are large enough to contain pharate pupae (adults free from pupal integument), when pryed from the substrate, are empty because the insects have already emerged. And even the largest of these tests is so small that, when occupied, it is difficult to determine using a hand lens if the insect inside is an immature or a pharate pupa. The best way to collect a series of adult males of any given species is to collect a number of samples of plants known to be colonized by immatures of both sexes, and keep these samples watered and under glass, or enclosed in cellophane bags, as described Kosztarab (1963). In this way adult males that emerge from the tests can be correlated with females, and, upon emerging they can be collected live with a dampened camel hair brush after being anesthetized with CO_2 or nicotine smoke, or cooled in a refrigerator.

Material examined. We borrowed specimens of 11 species from the United States National Museum (USNM)--9 in pill boxes and 2 mounted on slides. We also borrowed specimens of 1 species from the California Department of Agriculture (CDA) in Sacramento. These specimens were also stored in pill boxes. In addition we collected specimens of 3 species in Virginia. No types were present in the borrowed material. Specimen data for the species has been given at the end of each description. Most specimens were collected between 1895 and 1931. All specimens suitable for mounting on slides were processed, but nevertheless material for some species was scant. We listed the material studied by giving the number of slides from each lot followed by the number of specimens in parentheses. Abbreviations used in the material studied sections are: a = apterous adult male, ap = apterous pupa, b = brachypterous adult, f = adult female, w = winged adult, wp = winged pupa. For other abbreviations the reader is referred to pages 8-10.

Preparation of material. Identification of male scale insects requires examination of slide-mounted specimens with a phase contrast microscope. This microscope should have a magnification of at least 1000x in order to to see the ducts, pores, and smaller setae on the specimen. Good quality slide mounts also allow the observer to see more taxonomic characters for study. A good slide mount is one for which the embedding medium is transparent, and not milky, and for which the specimen itself has been both 'cleared', that is, freed from all unsclerotized matter, and stained, to accentuate the visibility of such discrete but otherwise poorly visible structures as setae. Good slide mounts may be prepared by using the following method:

1. Search the dry-preserved material for tests of males by using a magnifiying glass.
2. Pry tests from substrate with a sharp pin. Moisten tip of pin to actually remove insect. To avoid breaking specimens, steam infested twigs for a few minutes prior to touching them with the pin. Steam softens the specimens.
3. Clear and remove wax from specimens by placing them into 10% KOH, at room temperature, for 10-24 hours.
4. Transfer into 70% ethyl alcohol for 10 minutes. Flatten, but not as much as one would if specimen were a female. Adult males have little body contents and, in contrast to females, are not dorsoventrally flattened while alive. For these reasons excessive flattening accomplishes little, and distorts the specimen needlessly in the process.
5. Transfer into Essig's Aphid Fluid, add 2 drops of Wilkey's Double Stain, and leave for at least 2 hours. If sufficiently stained, transfer to 100% ethyl alcohol; if not, return to staining solution. In the event the specimen has been overstained, remove to 70% ethyl alcohol until the desired shade of staining has been achieved.
6. Transfer into 100% ethyl alcohol, and leave for 10 minutes.
7. Transfer into clove oil, and leave for 24 hours or longer.

8. Place drop of Canada balsam in the center of a clean slide. Transfer specimen into balsam, keeping alternately the dorsal or ventral side up; then arrange legs, antennae, and wings so that they will be visible once the slide is completed. If balsam hardens, add a drop of xylene before placing a circular cover slip on slide. Mark an identification number on slide, to insure correlation with correct collecting data, before placing in drying oven. Leave in oven, at 40° C, for 2 weeks or longer. After slide has dried completely around margin of cover slip, affix 2 labels, 1 at each end, to allow sufficient space for data. Label permanently with India ink pen.

Note. A more delicate method of slide mounting for males is given by Afifi and Kosztarab (1969).

Measurements. Measurements were taken from slide-mounted specimens at magnifications of 400-1000x with a Zeiss phase contrast microscope. We measured up to 5 specimens, if available, for each species. In the descriptions, for each structure measured or counted, the average has been given first, followed by the range in parenthesis. All measurements are given in microns.

Illustrations. On the plate for each species or morph we have provided a drawing of the entire insect (A), without the wings (except for their bases). During the slide-making process, the wings themselves had inflated (i.e., the dorsal and ventral surfaces had separated, and the intervening space had filled with fluid), and subsequently had collapsed, making the correct interpretation of their original size and boundaries difficult, and often impossible. Hence the wings could afford no reliable taxonomic characters, and thus were not illustrated. The drawing of the body itself has been divided by a vertical line into two halves, the left half representing a dorsal view of the insect, and the right half a ventral view. These two drawings have been made from slide-mounted specimens, and as none of these specimens was flattened so as to be perfectly symmetrical, we have stylized the drawings to make them so.

When possible, we have drawn each plate from a single individual. For many of the species, however, no single specimen was entire. For these species, if two specimens were available that in combination represented the entire insect, and if both were from the same lot, we have combined the needed parts so as to produce a single drawing. If the needed specimens were of different sizes, we have scaled the initial drawings so that the hind femora of each specimen is of the same length. The length of the leg segments is one of the least variable (i.e., least subject to distortion by slide mounting) of all morphological characters involving direct measurement, and thus a most reliable indicator of actual size. In cases where two individuals from different lots were required to represent the entire insect, the parts from each individual have been drawn separately (as A1, A2, A3, etc.).

On each plate (except on Plate 11) we have provided an enlargement of the 3 terminal antennal segments (B), a posterior view of the right foreleg (C), and an anterior view of the left hindleg (D). As a rule the body setae have been depicted at the same scale as the body outline. Some of the setae, however, were so small that, in order to show them on the plate, they have been drawn proportionally larger than the rest of the insect.

All drawings and enlargements, except enlargements of the pro- and metathoracic legs, are not in proportion to one another, and have always been drawn as large as possible to fully utilize available space. Leg enlargements on the same plate have been drawn to the same scale. All drawings were made initially with a camera lucida attached to a Zeiss phase contrast microscope. This microscope had a high magnification of 1000x (oil immersion).

GENERAL MORPHOLOGY OF ADULT MALES

Plate 1, Fig. A

Following is an abbreviated general description of the male of the genus, based on both the winged and apterous morphs of the 12 species we studied.

Body (fig. A). Left side = dorsal view; right side = ventral view. Length varies both within and among species, usually between 564-941; winged males larger and more sclerotized than apterous counterparts of same species, also winged males widest at mesothorax, apterous males of 2 species conspicuously widest at middle of abdomen.

Head

Head Capsule. Roughly conical, with a pair of dorsal and ventral simple eyes; invariably with 4 pairs of dorsal head setae (1 pair posterior to dorsal simple eyes, 3 pairs anterior to these eyes); head ventrally with 1 or 2 pairs of setae along midcranial ridge (here and in species descriptions called midcranial setae) and with 2 to 5 pairs of interocular setae between ventral simple eyes; postoccipital ridge always present; cranial apophysis and median crest prominent; 1 or 2 pairs of genal setae present; ventral simple eyes in some species larger or smaller in diameter than dorsal simple eyes.

Antennae (fig. B). Apparently 10-segmented in all specimens of winged males examined during this study, but 9- or 10-segmented in apterous and brachypterous males; pedicel with placoid sensillum; flagellar segments (marked F1-F8 in the species descriptions) setose; terminal segment in addition to regular setae with 1-3 claviform setae, 1 of which always situated apically; terminal flagellar segment probably with basiconic sensillar pore in all species. The ratio of length of first and last flagellar segment was given with each description. It ranged from 0.59 to 1.14.

Thorax

Well developed, with discrete sclerites and well-developed legs; legs of apterous males larger than legs of winged males in proportion to rest of body.

Prothorax. Narrower than mesothorax, with 1-3 pairs of dorsomarginal setae; median longitudinal ridge of prosternum well sclerotized.

Mesothorax. Differs in winged and apterous males. In winged males broad, with subquadrate prescutum; prescutal ridge usually visible; scutum and prealare distinguishable; scutellum strongly sclerotized; scutellar foramen and 1 pair of setae invariably present; postnotal apophysis of mesothorax well developed; postnotal sclerite of mesothorax present but not obvious; pleural apophysis strongly sclerotized; mesoepisternum distinguishable; subepisternal ridge well developed; tegula rounded, usually bearing 1 to 2 setae, but in 1 species these setae apparently lacking altogether; mesosternum wide, weakly sclerotized; median ridge of mesothorax and marginal ridge of mesosternum visible but poorly sclerotized; mesothoracic spiracle present. Wings membranous, with alar lobe, radial vein, and median vein present. In apterous males prescutum and prealare absent; margins of scutellum usually not distinguishable; scutellar foramen lacking but scutellar setae invariably present; postnotal sclerite and postnotal apophysis weakly developed or lacking; remaining structures same as in winged males.

Metathorax. Weakly sclerotized; suspensorial sclerite present; metapleural apophysis developed; metapostnotal sclerite slightly sclerotized if present; metathoracic spiracle present, similar to mesothoracic spiracle. Winged males with pair of halteres or reduced wings, each with long hooked seta or hamulus at apical end; these compound structures, called hamulohalteres, present or absent in brachypterous morphs, but invariably absent in morphs lacking mesothoracic wings.

Legs (figs. C&D.). Winged, apterous, and brachypterous males all with well-developed legs, but legs of apterous males, in proportion to rest of the body, larger than those of males with either long or short wings. Each leg with well developed coxa, trochanter, femur, tibia, tarsus, and claw. Trochanter and femur immovably fused to each other, and on all trochanters 6 sensillar pores form ring or band around segment; tarsi bear pair of campaniform sensillum basally. Coxa, trochanter and femur each bear only few setae, but tibia and tarsus bear more. Fleshy bifurcate setae present on tarsi of some species. In all species, both anterior and posterior ungual digitules developed and longer than claws.

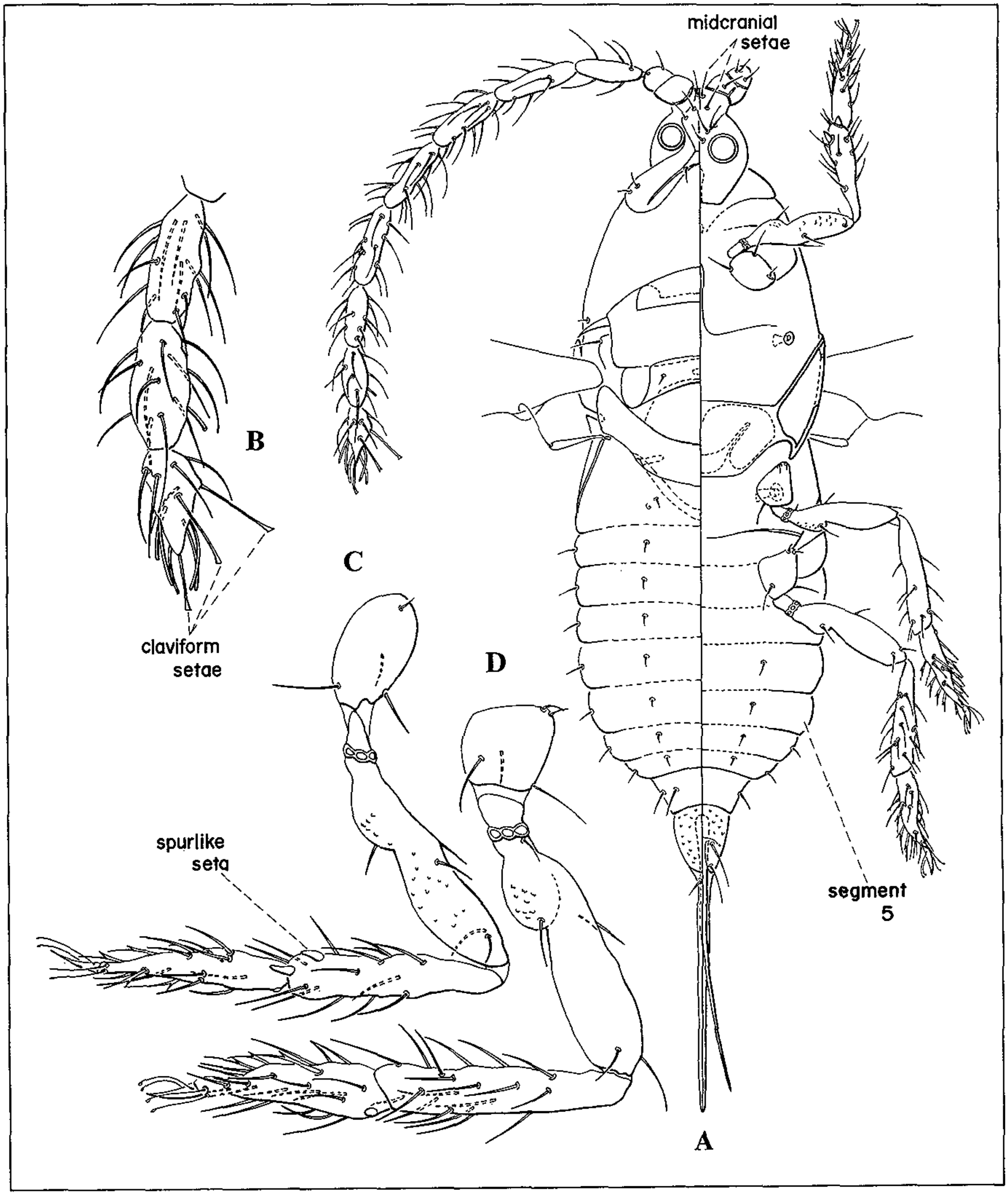

Plate 1. - *Chionaspis americana* Johnson, Winged Morph

Abdomen

Abdominal segments 1-8. Membranous, with 8 segments visible dorsally, 7 ventrally. All segments with 1 pair of setae dorsomarginally, forming complete row on each side, as well as pair of setae ventromarginally, on segments 5 or 6 through 8. All segments additionally with pair of setae submarginally on dorsal surface, forming complete row on each side. Segments 4-7 with 1 pair of submarginal setae on ventral surface as well. Eighth segment much narrower than preceding segments, and longitudinally striate.

Genitalia. Aedeagus of apterous males, in relation to rest of body, larger than that of winged males. With 3 pairs of setae on penial sheath (1 pair on dorsal surface, 2 pairs on ventral surface); occasionally anterior pair on ventral surface augmented by additional 1 or 2 pairs; length of genitalia varies, being longer than 1/3 of body length in some species.

KEY TO 17 ADULT MALE MORPHS OF 12 SPECIES OF NORTH AMERICAN *CHIONASPIS*

1. Mesothoracic wings brachypterous (Plate 2); hamulohalteres present (Plate 4) or absent . . . . *americana*, brachypterous morph, p. 138

-- Wings and hamulohalteres either fully developed or entirely lacking 2

2(1). Protibiae distally with 2 spurlike setae (Plate 1); abdominal segment 5 lacking ventromarginal setae (Plate 1); head anterioventrally with 2 pairs of midcranial setae; terminal antennal segment bearing 3 claviform setae (Plate 1) . . . . . *americana*, winged morph, p. 136

-- Protibiae lacking spurlike setae; abdominal segment 5 with ventromarginal setae (Plate 3); head anterioventrally with 1 pair of midcranial setae; terminal antennal segment never bearing but 1 claviform seta 3

3. Precoxal ridge of mesothorax bearing a pair of recessed setae (Plate 17); metafemora, when leg held outstretched at side of body, with 8 or more setae visible on anterior face; genital segment occasionally bearing as many as 3 setae anterioventrally on each side (Plate 17) . . . . *pinifoliae*, winged morph, p. 176

-- Precoxal ridge of mesothorax lacking recessed setae; metafemora, when leg is held outstretched at side of body, with 7 or fewer setae visible on anterior face; genital segment never with more than 1 seta anterioventrally on each side (Plate 4) 4

4. Apterous (Plate 7). 5

-- Winged (Plate 4). 9

5. Metatarsi bearing bifurcate fleshy seta (Plate 5). 6

-- Metatarsi lacking bifurcate fleshy seta 7

6. Combined length of metatibia and tarsus longer than coxa and femur; 5 interocular setae fringing anterior margin of each ventral simple eye (Plate 14) . . . . *nyssae*, apterous morph, p. 167

-- Combined length of metatibia and tarsus about as long as coxa and femur; 2 interocular setae fringing anterior margin of each ventral simple eye (Plate 11) . . . . *lintneri*, apterous morph, p. 160

7(5). Pronotum dorsally with a pair of median setae (Plate 10). . . . . *kosztarabi*, apterous morph, p. 158

-- Pronotum dorsally lacking median setae 8

8. Antennae 9-segmented, with penultimate segment lacking fleshy setae; each gena with 2 setae (Plate 7); 3 interocular setae fringing anterior margin of each ventral simple eye . . . . *gleditsiae*, apterous morph, p. 150

-- Antennae 10 segmented, with penultimate segment bearing at least 1 fleshy seta (Plate 16); each gena with 1 seta; 2 interocular setae fringing anterior margin of each ventral simple eye . . . . *ortholobis*, apterous morph, p. 172

9(4). Metatarsi lacking bifurcate fleshy setae 10

-- Metatarsi with bifurcate fleshy setae (Plate 5) 11

10. Each tegula bearing 2 setae (Plate 12); pronotum with 2 pairs of marginal setae (Plate 12); each antennal pedicel with 5 setae (Plate 12) . . . . *longiloba*, winged morph, p. 164

-- Each tegula bearing 1 seta; pronotum with 3 pairs of marginal setae (Plate 9); each antennal pedicel with 4 setae . . . . *kosztarabi*, winged morph, p. 155

11(9). Most setae of antennal flagellum as long as corresponding segment (Plate 5) 12

-- Most setae of antennal flagellum noticeably shorter than corresponding segment (Plate 4). 14

12. Each gena dorsally with 2 setae; each antennal pedicel bearing only 3 setae (Plate 6); genitalia length 159 in single measurable specimen . . . . *gleditsiae*, winged morph, p. 148

-- Each gena dorsally with 1 seta; each antennal pedicel bearing 4 or more setae; genitalia length 224-300 13

13. 4 interocular setae fringing anterior margin of each ventral simple eye; each antennal pedicel with 5 setae; total antennal length 362-385 (Plate 5). . . . . *furfura*, winged morph, p. 145

-- 5 interlocular setae fringing anterior margin of each ventral simple eye; each antennal pedicel with 4 setae; total antennal length 456-475 (Plate 13) . . . . *nyssae*, winged morph, p. 165

14(11). Each antennal pedicel with 5 setae (Plate 3) . . . . *corni*, winged morph, p. 140

-- Each antennal pedicel with 3 setae 15

15. 5 interocular setae fringing anterior margin of each ventral simple eye; width of metatrochanter-femora about 1/3 its length; ratio of length of terminal flagellar segment to that of 1st flagellar segment 1.00 or greater (Plate 15) . . . . *ortholobis*, winged morph, p. 170

-- 4 or fewer interocular setae fringing anterior margin of each ventral simple eye; width of metatrochanter-femora about 1/4 to 1/5 its length; ratio of length of terminal flagellar segment to that of 1st flagellar segment 0.63 or less 16

16. Each gena dorsally with 2 setae; 2 interocular setae fringing anterior margin of each ventral simple eye; each tegula bearing 2 setae (Plate 4) . . . . *etrusca*, winged morph, p. 143

-- Each gena dorsally with 1 seta; 4 interocular setae fringing anterior margin of each ventral simple eye; each tegula bearing 1 seta (Plate 8) . . . . *heterophyllae*, winged morph, p. 153

CHIONASPIS AMERICANA JOHNSON

Plates 1, 2

Known from both long and short winged morphs, here called winged and brachypterous morphs, respectively. Apterous forms apparently lacking. Developmental stages of the male described by Willoughby and Kosztarab (1974).

Illustration. One slide (1 adult) from twigs collected by P. A. Willoughby, on *Ulmus americana*, Blacksburg, VA, on June 18, 1972 (PAW 037a), VPI.

DESCRIPTION OF WINGED MORPH

Plate 1

Body (fig. A). 561 long, including genitalia; widest, 104, at mesothorax.

Head

Head capsule. Width at genae 82; distance from apex to postoccipital ridge 38; 2 pairs of midcranial setae, 4 pairs of interocular setae, and 2 pairs of genal setae; dorsal eyes smaller than ventral eyes, former 23 in diameter and 27 apart, latter 16 in diameter and 12 apart.

Antennae (fig. B). Ten-segmented; pedicel with 4 setae; each flagellar segment with 6-14 setae, most of which are noticeably shorter than segment bearing them; penultimate flagellar segment with 1 fleshy seta, and terminal segment with 3 claviform setae; length of antennal segments from single specimen as follows:

Scape	Pedicel	F1	F2	F3	F4	F5	F6	F7	F8	Total	F8/F1
13	12	37	43	41	40	42	34	31	27	320	0.73

Thorax

Distance from postoccipital ridge to postnotal sclerite of mesothorax 195.

Prothorax. With 1 pair of dorsomarginal setae; lacking dorsomedian setae; longitudinal median ridge of prosternum 46 long.

Mesothorax. Prescutum 12 long, 71 wide; scutellum 17 long, 57 wide; each tegula with 1 seta; mesosternum 38 long, 117 wide; precoxal ridge lacking setae; wings present and fully developed.

Metathorax. No dorsomarginal setae; hamulohalteres present; length of haltere 30, of hamulus 27.

Legs (figs. C, D). Protibiae bearing 2 short, stout spurlike setae on posteriomesal surface; 4 fleshy bifurcate setae on protarsus, 10 on mesotarsus, and 3 on metatarsus; anterior face of metafemur with 3 setae visible; greatest width of metatrochanter-femora nearly 1/5 its length; length of legs, and of segments from single specimen, as follows:

Segment	Coxa	Troch.	Femur	Tibia	Tarsus	Claw	Total
Pro-	27	37	52	57	46	15	234
Meso-	28	37	57	67	52	12	253
Meta-	21	37	63	61	48	13	243

Abdomen

Abdominal segments 1-8. Greatest width 136; length from postnotal sclerite of mesothorax to basal ridge of penial sheath 163; ventromarginal setae absent on segment 5.

Genitalia. 173 long from basal ridge of penial sheath to apex of aedeagus, and 32 wide at basal ridge of penial sheath; genital capsule with 2 pairs of setae on ventral side, 1 anterior to other.

Material studied. From *Ulmus americana*, VA, Blacksburg, Sept. 5, 1972, coll. P. A. Willoughby, (PAW 85a), 1(1w, 7b) VPI; same data as previous, 1(2w, 2b), (PAWe [prob. PAW 85e]), VPI.

One additional specimen with fully developed wings. Specimen more strongly resembles brachypterous morph in thoracic structure than winged one just described. On *Ulmus americana*, VA, Blacksburg, Sept. 5, 1972, coll. P. A. Willoughby, VPI.

Affinities and discussion. Winged males of *C. americana* distinguished from all other *Chionaspis* by any one of the following characters present in *C. americana*: 1) protibiae bearing 2 short, stout, spurlike setae on posteriomesal surface; 2) 5th segment of abdomen lacking ventromarginal setae; 3) terminal segment of antennae bearing 3 claviform setae; or 4) head bearing 2 pairs of midcranial setae.

DESCRIPTION OF BRACHYPTEROUS MORPH

Plate 2

Illustration. Records listed under "Other material studied" at the end of this description.

Body (fig. A). 349 (299-387) long, including genitalia; widest, 110 (102-115), at middle of abdomen.

Head

Head capsule. Width at genae 67 (64-70); distance from apex to postoccipital ridge 18 (11-26); 1 pair of midcranial setae, 4 pairs of interocular setae, and 1 pair of genal setae; dorsal eyes 10 (10-12) in diameter and 25 (15-41) apart, ventral eyes 10 (10-11) in diameter and 13 (10-15) apart.

Antennae (fig. B). Nine-segmented; pedicel with 4 setae; each flagellar segment with 4-7 setae, most of which are about same length or little shorter than segment bearing them; penultimate flagellar segment lacking fleshy setae, and terminal segment with 1 claviform seta; length of antennal segments from 1 specimen as follows:

Scape	Pedicel	F1	F2	F3	F4	F5	F6	F7	Total	F7/F1
12	9	26	27	24	27	21	26	25	197	0.96

Thorax

Distance from postoccipital ridge to postnotal sclerite of mesothorax 104.

Prothorax. With 3 pairs of dorsomarginal setae; lacking dorsomedian setae; longitudinal median ridge of prosternum 22 (20-24) long.

Mesothorax. Prescutum apparently absent; scutellum 9 (7-11) long, 36 (34-37) wide; tegula with indistinct margins, sclerotized anteriorly, and lacking setae; mesosternum with indistinct margins, 79 (76-85) wide; precoxal ridge lacking setae; wings present but developed only as short, laterally projecting balloonlike stubs.

Metathorax. With 1 pair of dorsomarginal setae; hamulohalteres usually absent, haltere present in 1 specimen (fig. A2), 11 long.

Legs (figs. C&D). Protibiae lacking spurlike setae; 3 fleshy bifurcate setae on protarsus, 4 on mesotarsus, and 6 on metatarsus; anterior face of metafemur with 5 setae visible; greatest width of metatrochanter-femora nearly 1/4 its length; length of legs, and of segments comprising them, from 3 specimens as follows:

Segment	Coxa	Troch.	Femur	Tibia	Tarsus	Claw	Total
Pro-	26 (23-31)	26 (24-30)	37 (36-37)	35 (31-38)	24 (21-27)	10 (9-12)	158 (144-175)
Meso-	27 (23-29)	28 (27-29)	43 (39-49)	48 (46-49)	32 (27-35)	10 (10-12)	188 (172-203)
Meta-	26 (21-27)	28 (26-29)	43 (43-44)	46 (46-47)	36 (34-40)	9 (6-10)	188 (176-197)

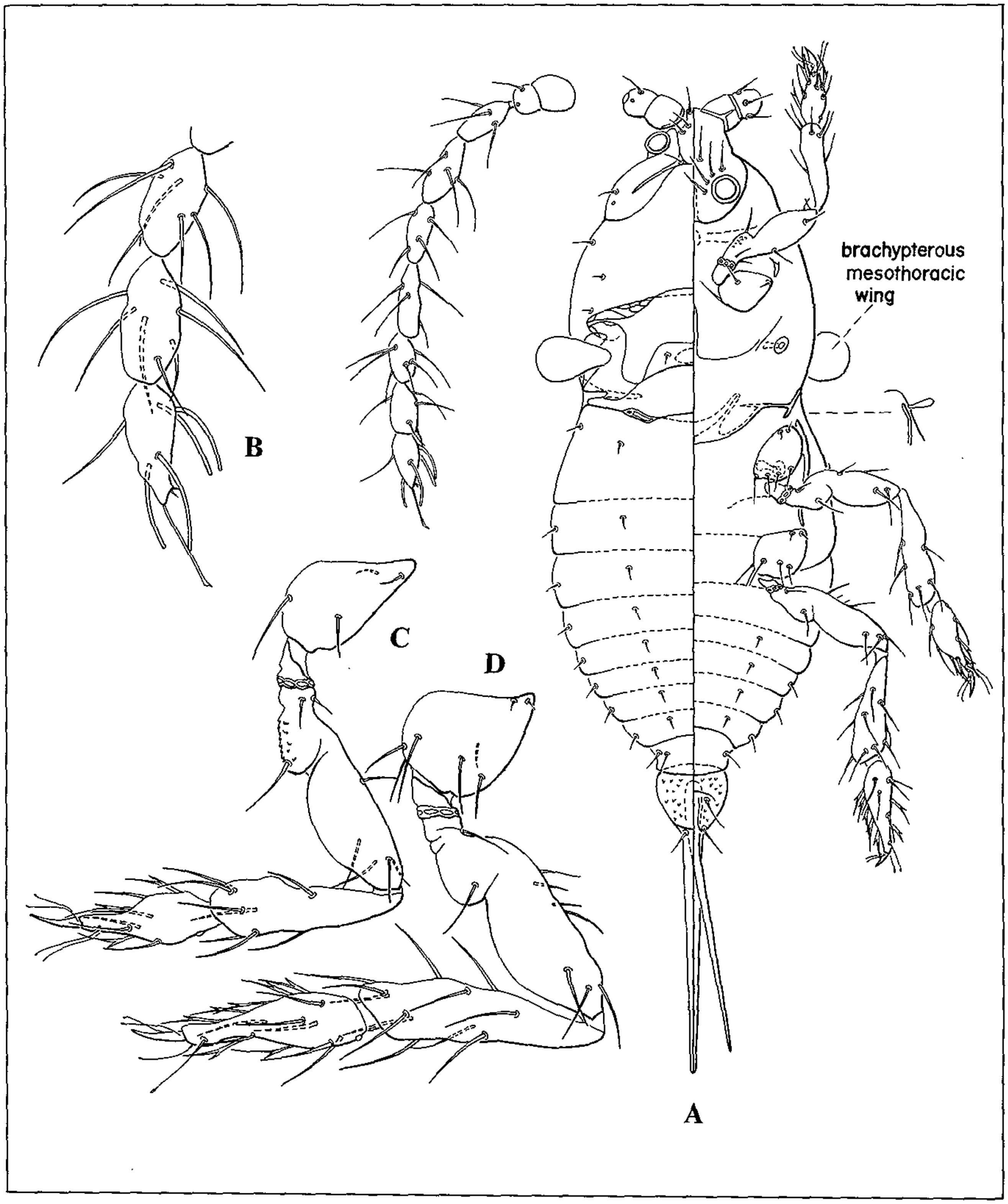

Plate 2. - ***Chionaspis americana*** **Johnson, Brachypterous Morph**

Abdomen

Abdominal segments 1-8. Greatest width 110 (102-115); length from postnotal sclerite of mesothorax to basal ridge of penial sheath 128 (101-148); ventromarginal setae present on segment 5.

Genitalia. 136 (125-143) long from basal ridge of penial sheath to apex of aedeagus, and 25 (24-26) wide at basal ridge of penial sheath; genital capsule with 2 pairs of setae, 1 anterior to other.

Other material studied. Slides with both brachypterous and winged adults listed in description for winged morph. Twenty-four slides with entirely brachypterous forms, 16 of which contain specimens collected on *Ulmus americana*, **VA**, Blacksburg, by P. A. Willoughby. Slides with additional specific information as follows: twigs coll. June 13, 1972, specimens emerged June 19, 1972 (PAW 037 b, c, d, e, and g), 5(35b), VPI; Price Hall, June 13, 1972 (PAW 048a), 1(3 2nd instars, 6p, 2b), VPI; June 20, 1972, 1(1p, 4b), VPI; June 26, 1972 (PAW 038b), 1(4b), VPI; July 3, 1972 (PAW 039a), 2(7b), VPI; Aug. 28, 1972, (PAW 83a), 1(2b), VPI; 2 (7 adults), Sept. 5, 1972, (PAW 85b and d), 2(7b), VPI; Sept. 5, 1972, (PAW 077b and c), 2(2 2nd instars, 9b), VPI; at police station on leaves Sept. 19, 1972 (H37a), 1(5p, 5b), VPI.

Illustrations from two different lots for brachypterous morph, both from *Ulmus americana*. **VA**, Blacksburg, June 13, 1972, males emerged June 18, coll. P. A. Willoughby (PAW 037f) 1(1) VPI; June 26, 1972, coll. P. A. Willoughby (PAW 038a) 1(2) VPI. Body of first named specimen in good condition; however, it lacks antennae and halteres, and shows no indication it ever possessed latter. Body drawn from this specimen, and antennae and haltere (separately) from 1 specimen in the second lot.

Remaining 7 slides with the following data: *Ulmus americana*, Aug. 31, 1895, (21481), 1(14b), USNM; *Ulmus* sp., **KS**, Lawrence, Feb. 10, 1928, (PAW 072a), 1(9 2nd and 3rd instar f, 1b), VPI; **MI**, Ypsilanti, H. C. Swift, let. June 24, 1916, 2 (19b), VPI, USNM; Aug. 19, 1895, Exp. Sta # 624, W. G. Johnson (21481), 3(16b), USNM;

Affinities and discussion. Brachypterous males of *C. americana* are distinguished from all other *Chionaspis* by their stubby, balloon-like wings.

CHIONASPIS CORNI COOLEY

Plate 3

Known only from winged morph; described for the first time below.

Illustration. Specimens from Arrow wood [*Viburnum acerifolium* or *dentatum*], **MA**, Sauque, March 19, 1906, coll. E. S. G. Titus (8906), 3(5w, 1wp), USNM [mounted from dry material]. Body of one specimen in acceptable condition, except that antennae, genital styli, and aedeagus are missing; body of remaining specimens in poor condition, except one with intact aedeagus and genital styli, and with 1 antenna present; this antenna, however, appears slightly deformed. Main body drawn from first mentioned specimen, and antenna, genital styli, and aedeagus from latter.

DESCRIPTION OF WINGED MORPH

Body (fig. A). 690 (647-789) long, including genitalia; widest, 189 (177-216), at mesothorax.

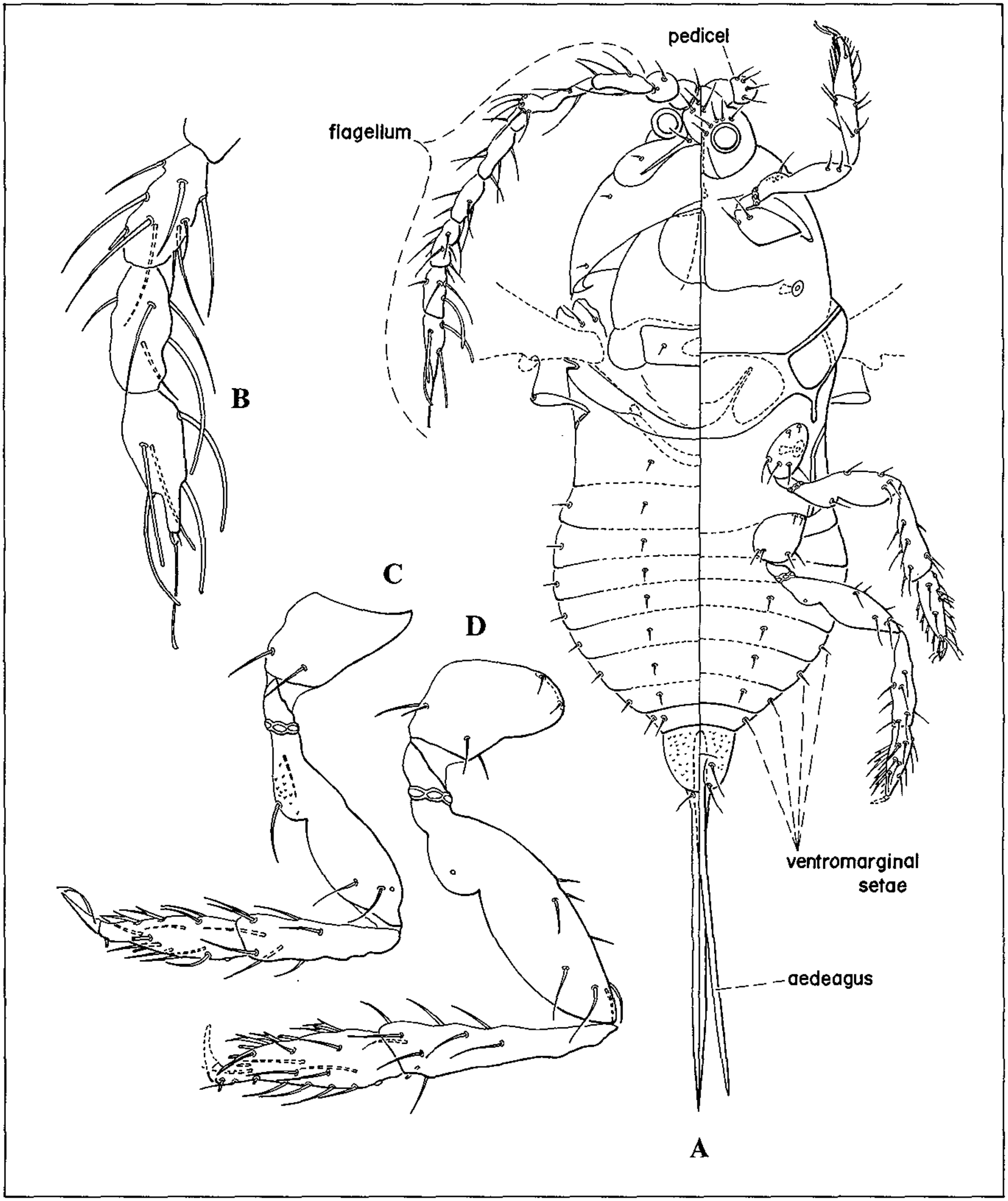

Plate 3. - *Chionaspis corni* Cooley, Winged Morph

Head

Head capsule. Width at genae 76 (72-86); distance from apex to postoccipital ridge 41 (37-44); 1 pair of midcranial setae, 4-5 pairs of interocular setae, and 1 pair of genal setae; dorsal eyes larger than ventral eyes, former 21 in diameter and 25 (23-30) apart, latter 19 in diameter and 13 (12-14) apart.

Antennae (fig. B). Ten-segmented; pedicel with 5 setae; each flagellar segment with 3-6 setae, most noticeably shorter than segment bearing them; 2nd flagellar segment deformed in specimen examined; penultimate flagellar segment with 1 fleshy seta, and terminal segment with 1 claviform seta; length of antennal segments from single specimen as follows:

Scape	Pedicel	F1	F2	F3	F4	F5	F6	F7	F8	Total	F8/F1
14	30	48	36	44	46	39	39	39	32	367	0.67

Thorax

Distance from postoccipital ridge to postnotal sclerite of mesothorax 237 (228-259).

Prothorax. With 2 pairs of dorsomarginal setae; lacking dorsomedian setae; longitudinal median ridge of prosternum 31 (30-32) long.

Mesothorax. Prescutum 46 long, 54 (51-58) wide; scutellum 26 (22-28) long, 81 (69-93) wide; each tegula with 1 pair of setae; mesosternum 73 (70-76) long, 108 (104-116) wide; precoxal ridge lacking setae; wings present and fully developed.

Metathorax. No dorsomarginal setae; hamulohalteres present; length of haltere 29, of hamulus 18.

Legs (figs. C&D). Protibiae without spurlike setae; 2 fleshy bifurcate setae on protarsus, 6 on mesotarsus, and at least 4 on metatarsus; anterior face of metafemur with 7 setae visible; greatest width of metatrochanter-femora about 1/4 its length; length of legs, and of segments comprising them, based on 2 specimens, as follows:

Segment	Coxa	Troch.	Femur	Tibia	Tarsus	Claw	Total
Pro-	35 (34-36)	46 (45-48)	67 (65-69)	55 (53-56)	46 (44-48)	12 (11-12)	261 (252-269)
Meso-	42 (41-44)	47 (46-48)	70 (69-72)	64 (63-64)	46 (45-46)	7 (7-7)	276 (271-281)
Meta-	36 (35-38)	50 (48-51)	84 (83-86)	80 (80-81)	46 (46-46)	7 (7-7)	303 (299-309)

Abdomen

Abdominal segments 1-8. Greatest width 165 (132-200); length from postnotal sclerite of mesothorax to basal ridge of penial sheath 108 (58-198); ventromarginal setae present on segment 5.

Genitalia. 307 (303-316) long from basal ridge of penial sheath to apex of aedeagus, and 56 (53-59) wide at basal ridge of penial sheath; genital capsule with 2 pairs of setae on ventral side, 1 anterior to other.

Material studied. From *Cornus amomum*, **OH**, Cedar Pt., Erie Co., June 30, 1903, coll. J. G. Sanders (8906), 1(1w), USNM [mounted from dry material].

Affinities and discussion. Winged males of *C. corni* distinguished from other winged *Chionaspis* by following combination of characters present in *C. corni*: 1) genitalia 303 or longer, and 2) each antennal pedicel bears 5 setae. *Chionaspis ortholobis* occasionally with genitalia 303 or longer, but, in contrast to *C. corni*, with antennal pedicels each bearing only 3 setae.

CHIONASPIS ETRUSCA LEONARDI

Plate 4

Known only from winged morph; described for the first time here.

Illustration. Two slides (2 winged adults) used for drawing: From citrus red scale trap, **CA**, Winterhaven, Imperial Co., Oct. 5, 1983, coll. R. A. Flock, det. by R. J. Gill (No. 83J7-25), CDFA. Both specimens in excellent condition.

DESCRIPTION OF WINGED MORPH

Body (fig. A). Length 784 (764-830), including genitalia; widest, 215 (209-253), at mesothorax.

Head

Head capsule. Width at genae 84 (79-90); distance from apex to postoccipital ridge 48 (41-57); 1 pair of midcranial setae, 2 pairs of interocular setae, and 2 pairs of genal setae; dorsal eyes smaller than ventral eyes, former 19 (18-21) in diameter and 39 (37-44) apart, latter 23 in diameter and 20 (19-21) apart.

Antennae (fig. B). Ten-segmented; pedicel with 3 setae; each flagellar segment with 4-8 setae, most noticeably shorter than segment bearing them; penultimate flagellar segment lacking fleshy setae, and terminal segment with 1 claviform seta; length of antennal segments from 4 specimens as follows:

Scape	Pedicel	F1	F2	F3	F4	F5	F6	F7	F8	Total	F8/F1
26 (22-28)	17 (16-19)	58 (58-59)	45 (40-46)	47 (44-49)	47 (46-49)	48 (44-49)	37 (36-38)	37 (36-38)	37 (36-37)	399 (382-409)	0.64 (0.62-0.63)

Thorax

Distance from postoccipital ridge to postnotal sclerite of mesothorax 276 (247-295).

Prothorax. With 2 pairs of dorsomarginal setae; no dorsomedian setae; longitudinal median ridge of prosternum 60 long.

Mesothorax. Prescutum 46 long, 60 (58-67) wide; scutellum 20 (19-21) long, 100 (88-116) wide; each tegula with 1 pair of setae; mesosternum 92 (88-94) long, 139 (134-143) wide; precoxal ridge without setae; wings present and fully developed.

Metathorax. No dorsomarginal setae; hamulohalteres present; length of haltere 37 long, of hamulus 26.

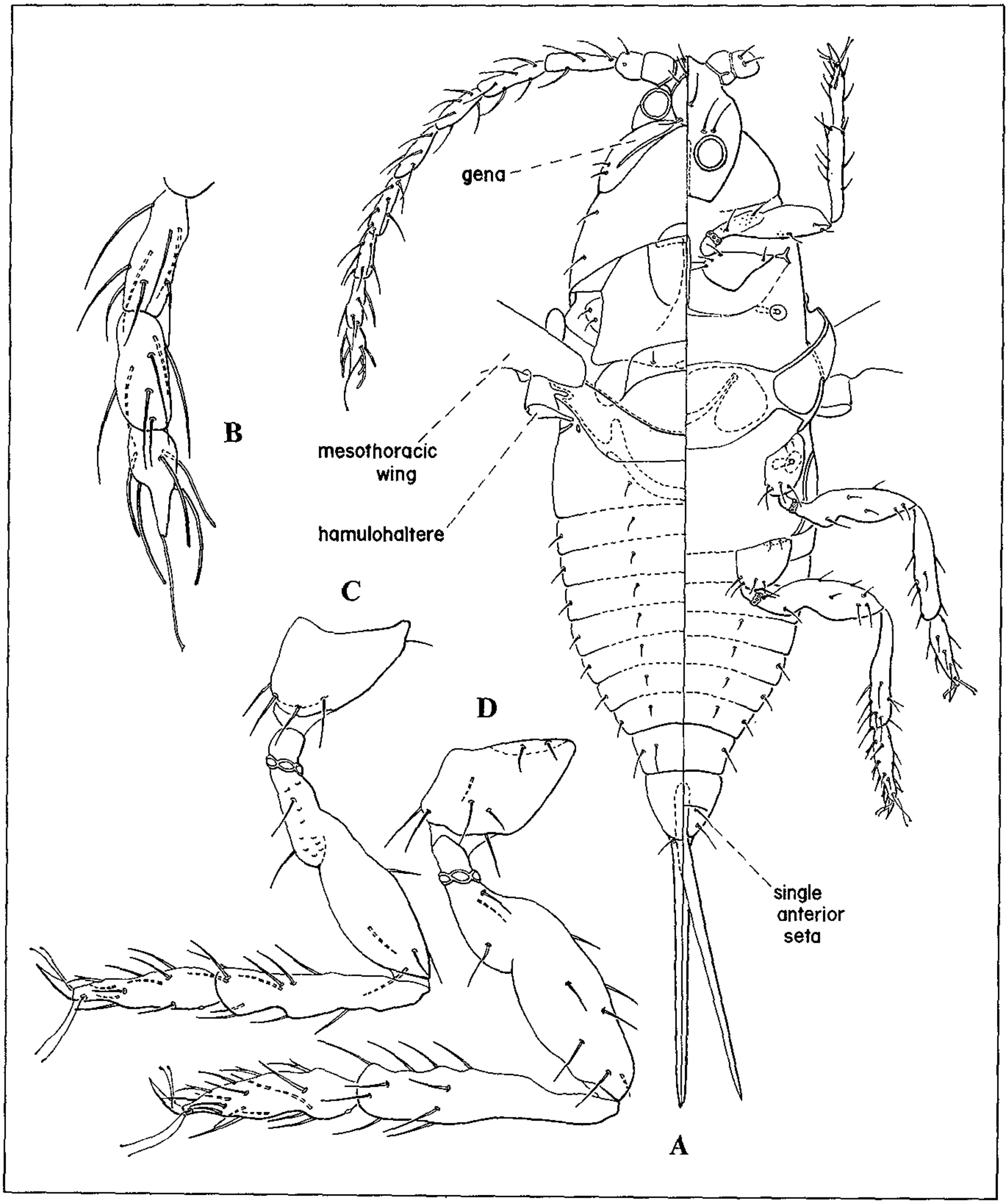

Plate 4. - *Chionaspis etrusca* Leonardi, Winged Morph

Legs (figs. C&D). Protibiae without spurlike setae; 1 fleshy bifurcate setae on protarsus, none on mesotarsus, and 3 on metatarsus; anterior surface of metafemur with 7 setae visible; greatest width of metatrochanter-femora subequal to 1/4 its length; length of legs from 4 specimens as follows:

Segment	Coxa	Troch.	Femur	Tibia	Tarsus	Claw	Total
Pro-	34 (33-36)	39 (38-40)	72 (70-75)	71 (70-72)	50 (48-51)	11 (10-11)	276 (270-289)
Meso-	32 (30-34)	47 (46-48)	72 (70-74)	86 (84-88)	51 (49-53)	11 (11-12)	297 (290-307)
Meta-	46 (44-46)	51 (50-53)	92 (90-94)	92 (91-94)	84 (82-86)	11 (10-11)	374 (359-384)

Abdomen

Abdominal segments 1-8. Greatest width 185 (162-216); length from postnotal sclerite of mesothorax to basal ridge of penial sheath 231 (212-253); ventromarginal setae present on segment 5.

Genitalia. 234 (206-253) long from basal ridge of penial sheath to apex of aedeagus, and 54 (46-71) wide at basal ridge of penial sheath; genital capsule with 2 pairs of setae on ventral side, 1 anterior to other.

Material studied. From *Tamarix gallica*, **AZ**, Safford, Sept. 13, 1943, coll. L. P. Wehrle, 2(4w), UCD; **CA**, Coachella Valley, coll. Stickney, rec'd 1937, 1(1w, 4wp), USNM. *Tamarix* sp., **AZ**, Salt River Valley, Aug. 30, 1923, coll. Perry A. Glick, 15(13w, 2wp), USNM [mounted from dry material]; **CA**, Winterhaven, Imperial Co., Oct. 26, 1967, coll. R. A. Waegner (67K9-33), 1(2f, 1w), CDA; **NM**, Albuquerque, Bernallillo Co., Nov. 20, 1979, coll. D. C. Heninger (79-11444), 1(1w), USNM.

Affinities and discussion. Winged males of *C. etrusca* distinguished from other winged *Chionaspis* by its following combination of characters: 1) genal lobes each bearing 2 setae; and 2) antennae 382 or longer. In two other species of *Chionaspis*, namely, *C. americana* and *C. gleditsiae*, genal lobes each bearing 2 setae, but, in contrast to *C. etrusca*, in both species antennae 320 or less in length.

CHIONASPIS FURFURA (FITCH)

Plate 5

Known only from winged morph. Apterous morph exists, however, for one pharate pupa at hand, in excellent condition, clearly lacks pads for wings. Hill (1952) provided a general description of the adult male and its developmental stages. He noted only winged morphs that were reddish when live.

DESCRIPTION OF WINGED MORPH

Illustration. Pupa removed from underneath test: from *Malus pumila*, **MA**, Springfield, 1900, coll. G. Dimmock (Dim. No. 1352, 271580), USNM. Two additional pharate pupae removed from twigs in same pill box; these pupae, however, bear well-developed wing pads. Four winged males also found, which had either already emerged or died crawling out of pupal exuviae, in box. Each specimen on a separate slide.

Body (fig. A). Length about 624 (583-662) including genitalia; widest at mesothorax 177 (172-185).

Head

Head capsule. Width at genae 84 (79-90); distance from apex to postoccipital ridge 43 (41-53); 1 pair of midcranial setae, 4 pairs of interocular setae, and 1 pair of genal setae; dorsal eyes smaller than ventral eyes, former 19 in diameter and 25 (23-30) apart, latter 21 in diameter and 13 (11-14) apart.

Antennae (fig. B). Ten-segmented; pedicel with 5 setae; each flagellar segment with 6-11 setae, most about same length as segment bearing them; penultimate flagellar segment lacking fleshy setae, and terminal segment in all probability with 1 claviform seta as in most other species (in only specimen with intact antennae, only broken stubs were visible of what we presumed to be this seta); length of antennal segments from 2 specimens as follows:

Scape	Pedicel	F1	F2	F3	F4	F5	F6	F7	F8	Total	F8/F1
16 (16-16)	16 (16-16)	50 (49-51)	50 (49-51)	48 (46-51)	46 (46-46)	44 (42-46)	35 (33-40)	34 (33-36)	31 (30-32)	368 (362-385)	0.62 (0.61-0.63)

Thorax

Distance from postoccipital ridge to postnotal sclerite of mesothorax 225 (212-237).

Prothorax. With 2 pairs of dorsomarginal setae; lacking dorsomedian setae; longitudinal median ridge of prosternum 78 (75-81) long.

Mesothorax. Prescutum 44 long, 46 wide; scutellum 22 (21-23) long, 87 (81-93) wide; each tegula with 1 pair of setae; mesosternum 59 (58-60) long, 119 (110-128) wide; precoxal ridge without setae; wings present and fully developed.

Metathorax. No dorsomarginal setae; hamulohalteres present; length of haltere 32, of hamulus 23.

Legs (figs. C&D). Protibiae without spurlike setae; 3 fleshy bifurcate setae on protarsus, 8 on mesotarsus, and 7 on metatarsus; anterior surface of metafemur with 6 setae visible; greatest width of metatrochanter-femora about 1/4 its length; length of legs from 2 specimens as follows:

Segment	Coxa	Troch.	Femur	Tibia	Tarsus	Claw	Total
Pro-	29 (28-30)	40 (37-46)	67 (58-76)	58 (53-62)	38 (35-42)	19 (18-20)	251 (229-276)
Meso-	28 (28-28)	46 (46-46)	76 (65-86)	73 (70-76)	38 (36-39)	21 (20-22)	282 (265-297)
Meta-	28 (28-28)	51 (50-51)	76 (74-77)	73 (72-74)	38 (35-41)	12 (12-12)	278 (271-283)

Abdomen

Abdominal segments 1-8. Greatest width 193 (189-195), length from postnotal sclerite of metathorax to basal ridge of penial sheath 112 (106-116). Ventromarginal setae present on segment 5.

Genitalia. 240 (224-256) long from basal ridge of penial sheath to apex of aedeagus, and 54 (53-56) wide at basal ridge of penial sheath; genital capsule with 2 pairs of setae on ventral side, 1 anterior to the other.

Material studied. From *Malus pumila*, Aug. 12, 1895, coll. W. G. Johnson (B-5, No. 25, 21454), 1♂(1w), USNM.

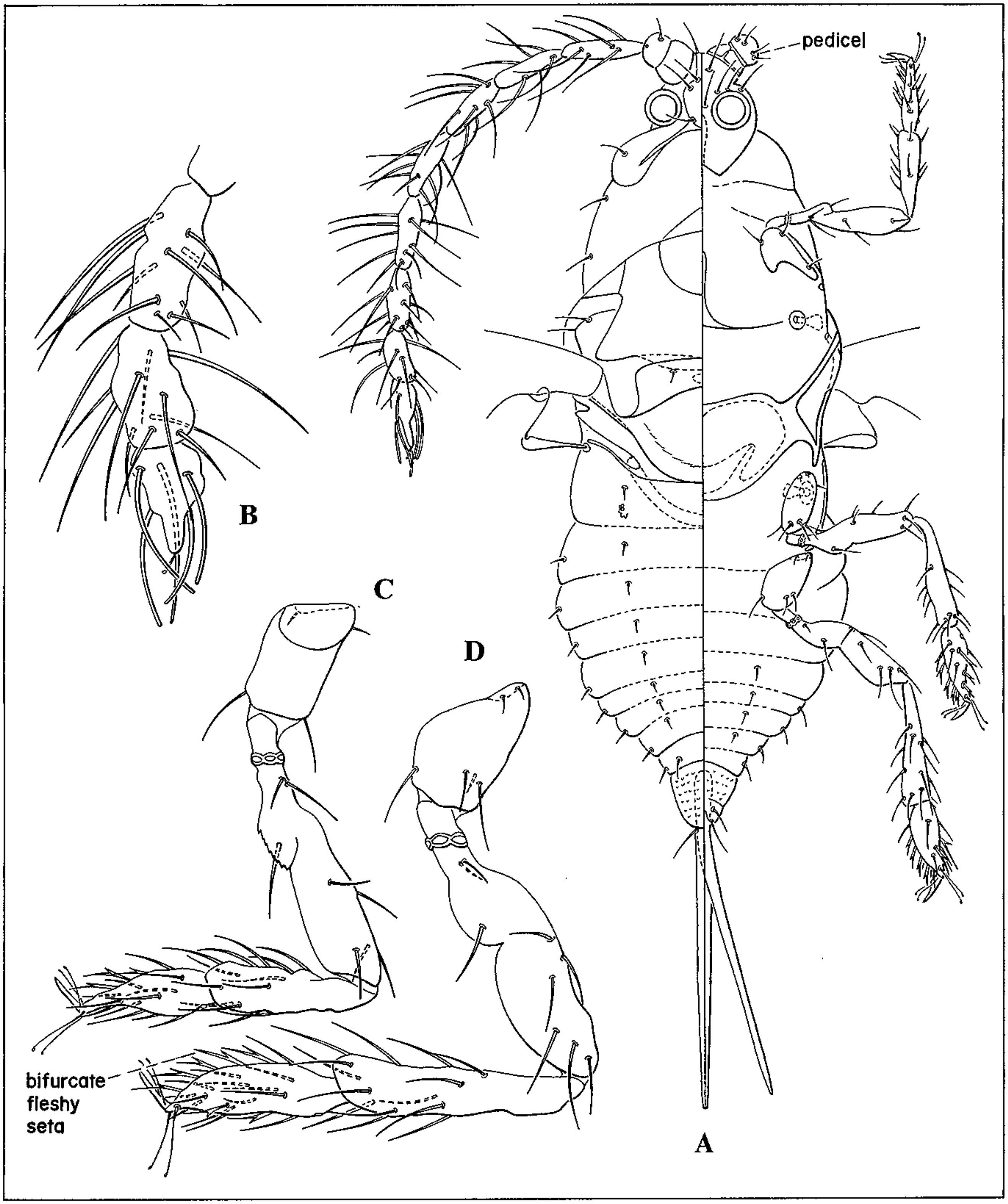

Plate 5. - *Chionaspis furfura* (Fitch), Winged Morph

Affinities and discussion. Winged males of *C. furfura* distinguished from other winged *Chionaspis* by its following combination of characters: 1) Each antennal pedicel bears 5 setae; 2) antennae with setae on flagellum about same length as segment bearing them; and 3) metatrochanter-femora with width/length ratio of 1/4. In 3 other species of *Chionaspis*, namely *C. longiloba*, *C. pinifoliae*, and *C. corni*, antennal pedicels each bearing 5 setae, but, in contrast to *C. furfura*, in both *C. pinifoliae* and *C. corni* most flagellar setae noticeably shorter than segment bearing them. *Chionaspis longiloba* differs from *C. furfura* in that metatrochanter-femora width/length ratio is nearly 1/3 instead of 1/4.

CHIONASPIS GLEDITSIAE SANDERS

Plates 6, 7

Known from both winged and apterous morphs; described for the first time here.

DESCRIPTION OF WINGED MORPH

Plate 6

Illustration. One slide (1 adult female, 1 adult male) in lot for drawing of winged morph: on "golden" locust, IN, Bluffton, Wells Co., June 29, 1979, coll. R. F. Wilkey, USNM. Specimen in good condition, except for abdomen, which folded upon itself in manner that precludes counting setae or drawing natural shape with confidence. For this reason we deleted the abdomen from the plate.

Body (fig. A). 284 long, including genitalia; widest, 122, at mesothorax.

Head

Head capsule. Width at genae 85; distance from apex to postoccipital ridge 32; 1 pair of midcranial setae, 5 pairs of interocular setae, and 2 pairs of genal setae; dorsal eyes smaller than ventral eyes, former 13 in diameter and 13 apart, latter 14 in diameter and 12 apart.

Antennae (fig. B). Ten-segmented; pedicel with 3 setae; each flagellar segment with 6-8 setae, many about same length or little longer than segment bearing them; penultimate antennal segment lacking fleshy setae, and terminal segment with 1 claviform seta; length of antennal segments from single specimen as follows:

Scape	Pedicel	F1	F2	F3	F4	F5	F6	F7	F8	Total	F8/F1
15	11	32	38	34	31	29	27	27	32	276	1.00

Thorax

Distance from postoccipital ridge to postnotal sclerite of mesothorax 160.

Prothorax. With 2 pairs of dorsomarginal setae; no dorsomedian setae; longitudinal median ridge of prosternum 40 long.

Mesothorax. Prescutum 34 long, 38 wide; scutellum 22 long, 61 wide; each tegula with 1 seta; mesosternum 22 long, 85 wide; precoxal ridge without setae; wings present and fully developed.

Metathorax. No dorsomarginal setae; hamulohalteres present; length of halteres 23, of hamulus 15.

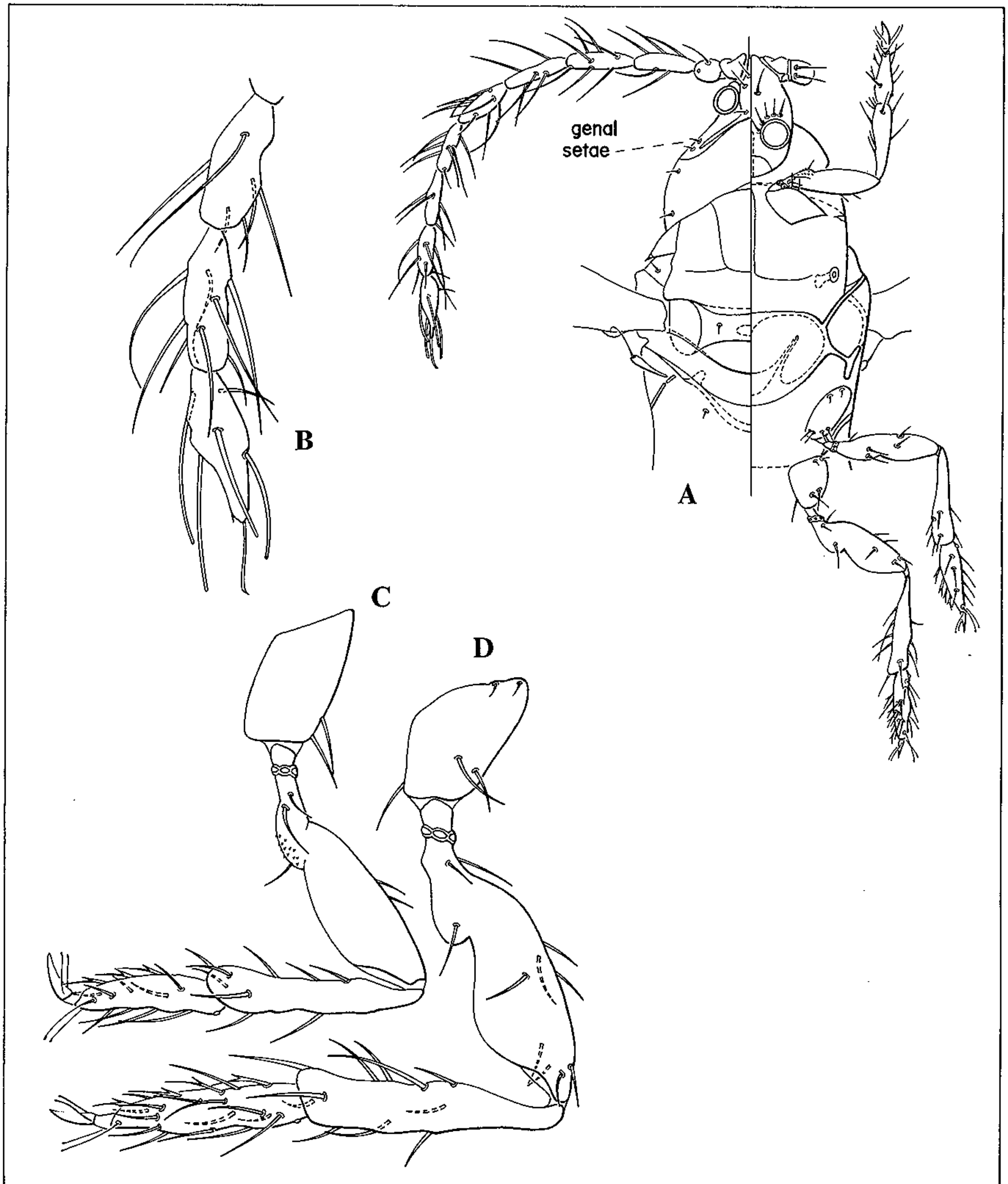

Plate 6. - *Chionaspis gleditsiae* Sanders, Winged Morph

Legs (figs. C&D). Protibiae without spurlike setae; 3 fleshy bifurcate setae on protarsus, 4 on mesotarsus, and 4 on metatarsus; anterior face of metafemora with 5 setae visible; greatest width of metafemora-femora nearly 1/4 its length; length of legs, and of segments comprising them, from single specimen as follows:

Segment	Coxa	Troch.	Femur	Tibia	Tarsus	Claw	Total
Pro-	46	34	58	49	39	16	242
Meso-	49	39	67	67	39	14	275
Meta-	51	39	72	63	56	7	288

Abdomen

Abdominal segments 1-8. See note in introductory section.

Genitalia. 159 long from basal ridge of penial sheath to apex of aedeagus, and 27 wide at basal ridge of penial sheath; genital capsule with 2 pairs of setae on ventral side, 1 anterior to other.

Material studied. One slide (1wp, 1a): from *Ostrya virginiana*, **MD**, College Park, let. April 12, 1927, coll. M. S. McConnell, USNM (mounted from dry material). Pupa in excellent condition; apterous adult in poor condition.

Affinities and discussion. Winged males of *C. gleditsiae* distinguished from other winged *Chionaspis* by its following combination of characters: 1) each genal lobe bearing 2 setae; and 2) most setae of antennal flagellum about same length or little longer than segment bearing them. In winged males of 2 other species, *C. etrusca* and *C. kosztarabi*, each genal lobe also with 2 setae, but in both cases most of setae of antennal flagellum conspicuously shorter than segment bearing them.

DESCRIPTION OF APTEROUS MORPH

Plate 7

Illustration Two slides (2 apterous adult males) in lot for drawing of apterous morph: from *Gleditsia triacanthos*, **OH**, Columbus, Oct. 28, 1919, coll. P. R. Lowry, USNM. When received, specimens were on same slide; entire drawing made from 1 remounted specimen.

Body (fig. A). 380 (376-384) long, including genitalia; widest, 88 (78-98), at mesothorax.

Head

Head capsule. Width at genae 53 (51-55); distance from apex to postoccipital ridge 27 (24-29); 1 pair of midcranial setae, 3 pairs of interocular setae, and 2 pairs of genal setae; dorsal eyes about same size as ventral eyes, former 10 in diameter and 17 (16-17) apart, latter 10 (9-11) in diameter and 10 apart.

Antennae (fig. B). Nine-segmented; pedicel with 3 setae; each flagellar segment with 5-7 setae, many as long or longer than segment bearing them; penultimate flagellar segment lacking fleshy setae, and terminal segment with 1 claviform seta; length of antennal segments from 1 adult as follows:

Scape	Pedicel	F1	F2	F3	F4	F5	F6	F7	Total	F7/F1
12	9	27	24	24	19	24	28	23	190	0.85

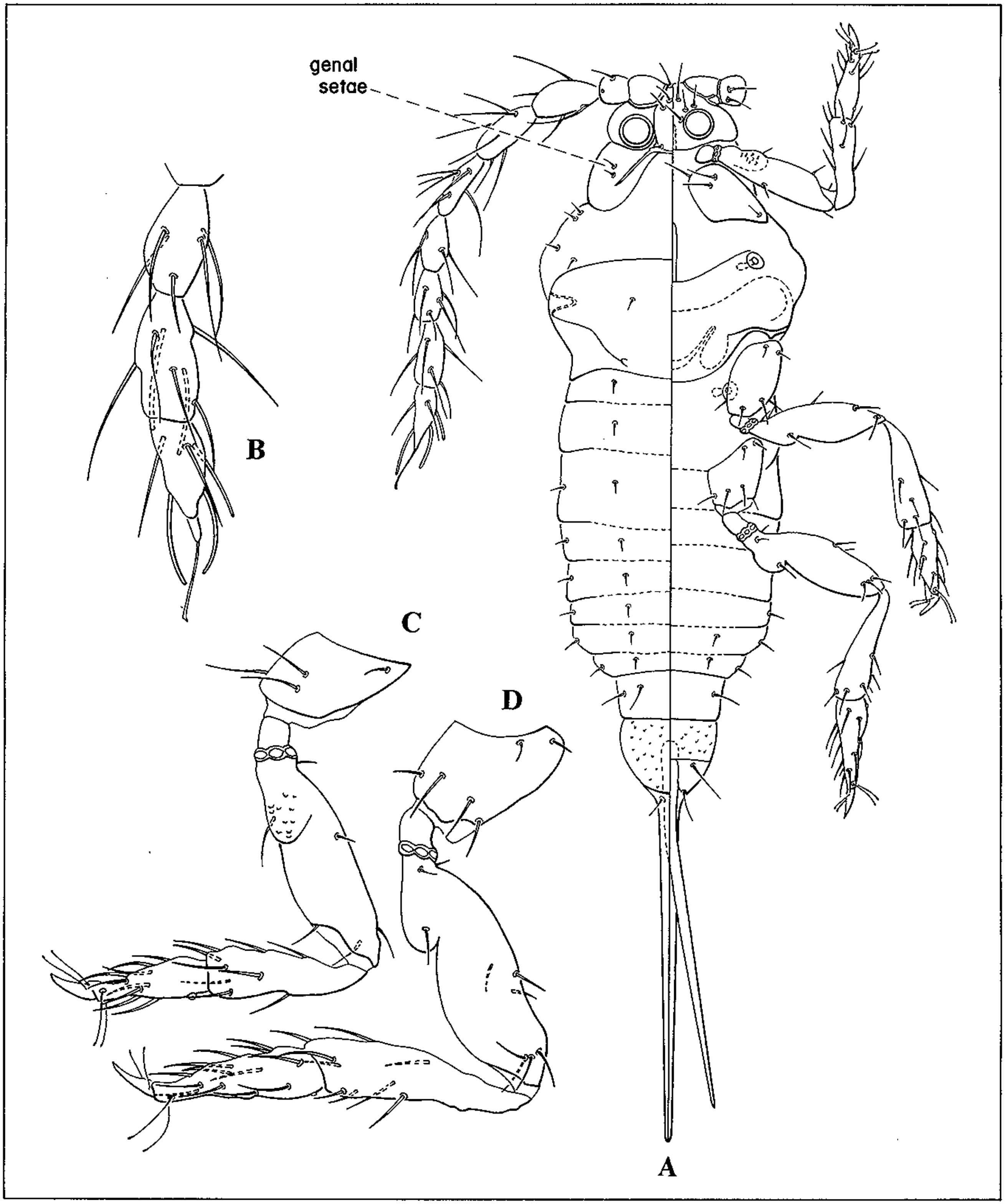

Plate 7. - *Chionaspis gleditsiae* Sanders, Apterous Morph

Thorax

Distance from postoccipital ridge to postnotal sclerite of mesothorax 90 (88-92).

Prothorax. With 4 pairs of dorsomarginal setae; lacking dorsomedian setae; longitudinal median ridge of prosternum 31 (27-35) long.

Mesothorax. Prescutum with margins obliterated, apparently absent; scutellar and tegular margins indistinct; tegulae lacking setae; mesosternum with indistinct margins, 76 (59-93) wide; precoxal ridge lacking setae; wings absent.

Metathorax. No dorsomarginal setae; hamulohalteres absent.

Legs (figs. C&D). Protibiae lacking spurlike setae; tarsi lacking fleshy bifurcate setae; anterior face of metafemur with 4 setae visible; greatest width of metatrochanter-femora nearly 1/4 its length; length of legs, and of segments comprising them, based on 2 specimens, as follows:

Segment	Coxa	Troch.	Femur	Tibia	Tarsus	Claw	Total
Pro-	33 (31-34)	28 ----	41 ----	34 ----	24 ----	10 ----	170 (168-171)
Meso-	28 (24-31)	28 (27-28)	42 (38-45)	49 (48-50)	30 (29-31)	11	188 (177-196)
Meta-	33 (31-34)	32 (31-32)	50 (49-51)	51 (50-51)	36 (34-37)	12	214 (207-217)

Abdomen

Abdominal segments 1-8. Greatest width 85 (61-108); length from postnotal sclerite of mesothorax to basal ridge of penial sheath 85 (61-108); ventromarginal setae present on segment 5.

Genitalia. 156 (153-158) long from basal ridge of penial sheath to apex of aedeagus, and 32 (23-40) wide at basal ridge of penial sheath; genital capsule with 2 pairs of setae on ventral side; 1 anterior to other.

Other material studied. See section for winged morph.

Affinities and discussion. Apterous males of *C. gleditsiae* distinguished from other apterous *Chionaspis* by following combination of characters present in *C. gleditsiae*: 1) each genal lobe bearing 2 setae; and 2) dorsal and ventral simple eyes approximately equal in diameter. Only other apterous males in which each genal lobe has 2 setae are found in *C. kosztarabi*, but here, in contrast to the condition in *C. gleditsiae*, dorsal eyes smaller than ventral eyes. Another easily discernible difference between the two is length of 9-segmented antennae. In *C. gleditsiae* length is 190; in *C. kosztarabi* 148.

CHIONASPIS HETEROPHYLLAE COOLEY

Color figs. 7, 8. Plate 8

Known only from the winged morph; also described recently by Shour (1986).

DESCRIPTION OF WINGED MORPH

Illustration. Four slides (9 adult males) in lot for drawing: from *Pinus sylvestris*, VA, Rankin Farm, Brush Mtn., Montgomery Co., June 8, 1985, coll. M. Rhoades and J. Lasota, VPI. Collected live.

Specimens not in good condition. To complete drawing, one specimen used for antennal structures, another for the rest of the body.

Body (fig. A). 867 (772-929) long including genitalia; widest, 200 (189-214), at mesothorax; but in 1 specimen with thorax but little compressed, abdomen much wider than thorax.

Head

Head capsule. Width at genae 92 (83-106); distance from apex to postoccipital ridge 50 (47-53); 1 pair of midcranial setae, 4 pairs of interocular setae, and 1 pair of genal setae; dorsal eyes smaller than ventral eyes, former 18 in diameter and 19 apart, latter 23 in diameter and 9 apart.

Antennae (fig. B). Ten-segmented; pedicel with 3 setae; each flagellar segment with 4-11 setae, most noticeably shorter than segment bearing them; penultimate flagellar segment with 1 fleshy seta, and terminal segment with 1 claviform seta; length of antennal segments from 4 specimens as follows:

Scape	Pedicel	F1	F2	F3	F4	F5	F6	F7	F8	Total	F8/F1
23 (23-24)	21 (17-23)	61 (58-65)	60 (55-65)	51 (49-52)	51 (46-53)	47 (46-51)	42 (37-46)	42 (35-51)	36 (30-42)	440 (398-462)	0.59 (0.52-0.65)

Thorax

Distance from postoccipital ridge to postnotal sclerite of mesothorax 365 (330-401).

Prothorax. With 2 pairs of dorsomarginal setae; no dorsomedian setae; longitudinal median ridge of prosternum 78 (76-81) long.

Mesothorax. Prescutum 46 (41-48), wide; each tegula with 1 seta; mesosternum 101 (97-106) long, 140 (139-141) wide; precoxal ridge without setae; wings present and fully developed.

Metathorax. No dorsomarginal setae; hamulohalteres present; length of haltere 28 (23-32) long, of hamulus 32 (25-39).

Legs (figs. C&D). Protibiae lacking spurlike setae; 2 fleshy bifurcate setae on protarsus, 3 on mesotarsus, and 4 on metatarsus; anterior face of metafemur with 4 setae visible; greatest width of metatrochanter-femora between 1/4 and 1/5 its length; length of legs, and of segments comprising them, based on 3 specimens, as follows:

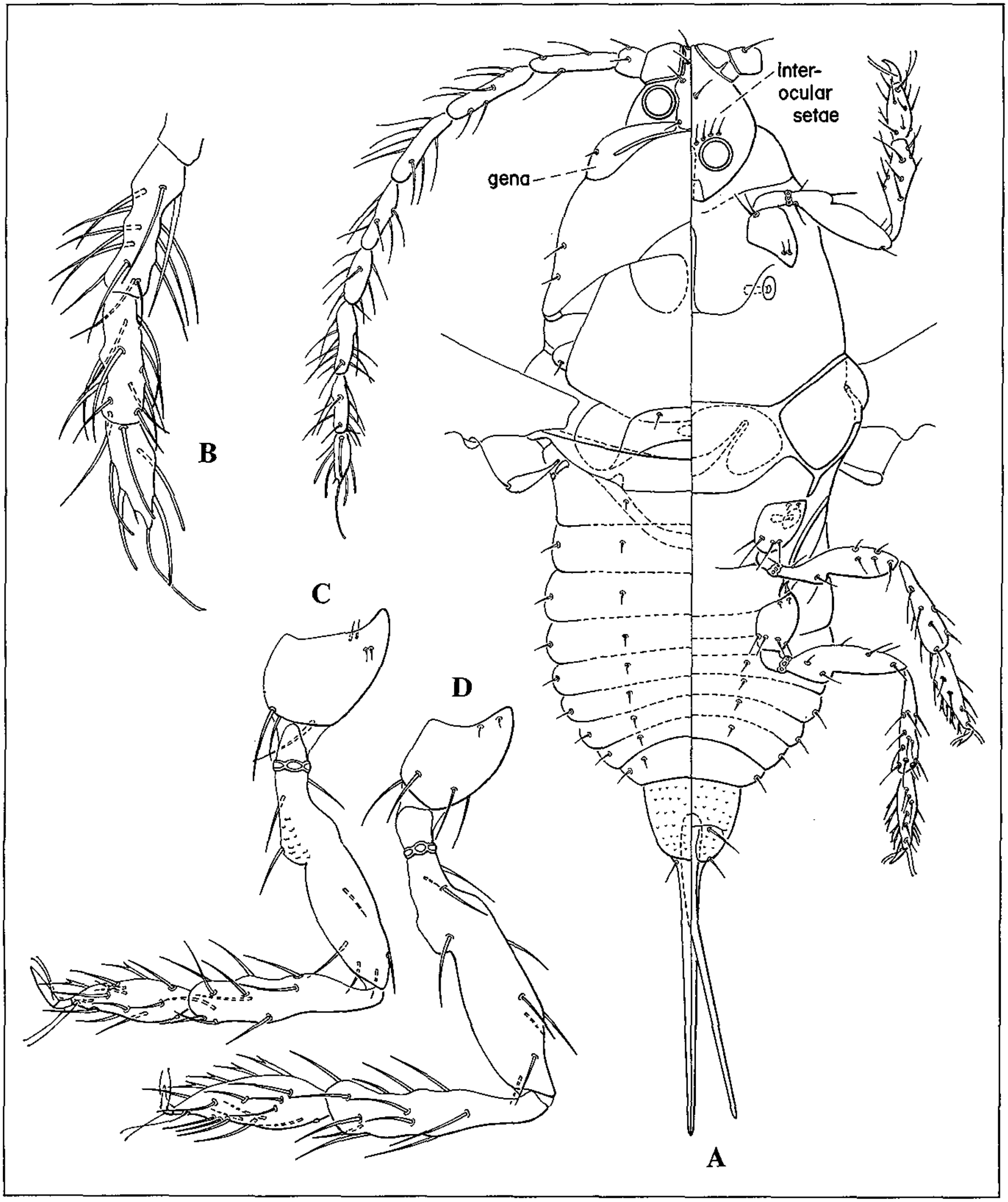

Plate 8. - *Chionaspis heterophyllae* Cooley, Winged Morph

Segment	Coxa	Troch.	Femur	Tibia	Tarsus	Claw	Total
Pro-	32 (26-35)	46 (46-46)	63 (56-71)	65 (58-71)	39 (37-41)	23 (23-23)	267 (255-285)
Meso-	34 (33-35)	49 (46-53)	66 (63-70)	78 (69-84)	48 (46-53)	23 (23-23)	301 (283-318)
Meta-	35 (35-35)	48 (46-53)	75 (69-78)	81 (74-88)	48 (46-51)	23 (23-23)	311 (293-326)

Abdomen

Abdominal segments 1-8. Greatest width 200 (189-214); length from postnotal sclerite of mesothorax to basal ridge of penial sheath 206 (165-228). Ventromarginal setae present on segment 5.

Genitalia. 224 (212-236) long from basal ridge of penial sheath to apex of aedeagus, and 57 wide at basal ridge of penial sheath; genital capsule with 2 pairs of setae on ventral side, 1 anterior to other.

Material studied. From *Pinus strobus*, NC, Swimming area, Bent Creek Campgrd., Exp. Forest (near Asheville), June 18, 1986, coll. M. Rhoades, 3(2wp, 1w), VPI.

Affinities and discussion. Winged males of *C. heterophyllae* distinguished from other winged *Chionaspis* by its following combination of characters: 1) antennal pedicels each bearing 3 setae; 2) tegulae each bearing 1 seta; and 3) genal lobes each bearing 1 seta. In 3 other species of *Chionaspis*, namely, *C. etrusca*, *C. ortholobis*, and *C. gleditsiae*, antennal pedicels each bearing 3 setae, but in contrast to *C. heterophyllae*, in both *C. etrusca* and *C. ortholobis* tegulae each bearing 2 setae. *Chionaspis gleditsiae* differs from *C. heterophyllae* in that genal lobes each bear 2 setae instead of 1. Our description of *C. heterophyllae* does not differ significantly from that of Shour (1986).

CHIONASPIS KOSZTARABI TAKAGI AND KAWAI

Plates 9, 10

Known from both winged and apterous morphs. Developmental stages of the male described by Willoughby and Kosztarab (1974).

DESCRIPTION OF WINGED MORPH

Plate 9

Illustration. Two specimens, on separate slides, in lot for drawing of winged morph: from *Fraxinus* sp., **FL**, R.F.D. 3, Lake City, coll. A. E. Graham, FDA. Enlargement of nine-segmented antennae drawn from following lot: 1 slide (1 winged adult, 3 apterous adults), on *Fraxinus americana*, **VA**, Blacksburg, coll. July 15, 1972, by P. A. Willoughby (PAW 058a), VPI.

Body (fig. A). 377 long, including genitalia; widest at prothorax, 124.

Head

Head capsule. Width at genae 79; distance from apex to postoccipital ridge 20; 1 pair of midcranial setae, 5 pairs of interocular setae, and 1 pair of genal setae; dorsal eyes about same size as ventral eyes, former 10 in diameter and 21 apart, latter 9 in diameter and 10 apart.

Antennae (fig. B). Ten-segmented; pedicel with 4 setae; each flagellar segment with 7-10 setae, most slightly shorter than segment bearing them; penultimate flagellar segment without fleshy setae, and terminal segment with 1 claviform seta; length of antennal segments from single specimen as follows:

Scape	Pedicel	F1	F2	F3	F4	F5	F6	F7	F8	Total	F8/F1
14	9	29	31	31	27	23	23	23	26	236	0.90

Thorax

Distance from postoccipital ridge to postnotal sclerite of mesothorax 168.

Prothorax. With 3 pairs of dorsomarginal setae; no dorsomedian setae; longitudinal median ridge of prosternum 34 long.

Mesothorax. Prescutum 38 long, 42 wide; scutellum 17 long, 52 wide; each tegula with 1 seta; mesosternum 23 long, 108 wide; precoxal ridge lacking setae; wings present and fully developed.

Metathorax. No dorsomarginal setae; hamulohalteres present; length of haltere 25, of hamulus 21.

Legs (figs. C&D). Protibiae without spurlike setae; no bifurcate setae on tarsi; anterior face of metafemur with 6 setae visible; greatest width of metatrochanter-femur about 1/4 its length; hind claws broken; length of legs, and of segments comprising them, from single specimen, as follows:

Segments	Coxa	Troch.	Femur	Tibia	Tarsus	Claw	Total
Pro-	27	29	41	37	25	10	169
Meso-	30	29	40	46	32	10	187
Meta-	26	32	49	48	35	4+	194+

Abdomen

Abdominal segments 1-8. Greatest width 109; length from postnotal sclerite of mesothorax to basal ridge of penial sheath 126; ventromarginal setae present on segment 5.

Genitalia. 119 long from basal ridge of penial sheath to apex of aedeagus, and 23 wide at basal ridge of penial sheath; genital capsule with 2 pairs of setae on ventral side, 1 anterior to other.

Material studied. All specimens from twig of *Fraxinus americana*, **VA**, Blacksburg, by P. A. Willoughby, VPI. Slides with the following additional individual data: 1(1w, 2a), (PAW 056a), specimens emerged July 19, 1972; 1(1w, 3a, 1wp), (PAW 052b), July 14, 1972; 1(3w, 5a), (PAW 054a), July 20, 1972.

Affinities and discussion. Winged males of *C. kosztarabi* distinguished from other winged *Chionaspis* by its following combination of characters: 1) tarsi lacking fleshy bifurcate setae; and 2) tegulae each bearing single seta. Winged males of 1 other species, *C. longiloba*, lack fleshy bifurcate setae on tarsi, but, in contrast to males of *C. kosztarabi*, they have tegulae each bearing 2 setae. Winged males of *C. kosztarabi* and *C. longiloba* further distinguished from each other by the number of setae on each antennal pedicel: *C. kosztarabi* has 4; *C. longiloba* has 5.

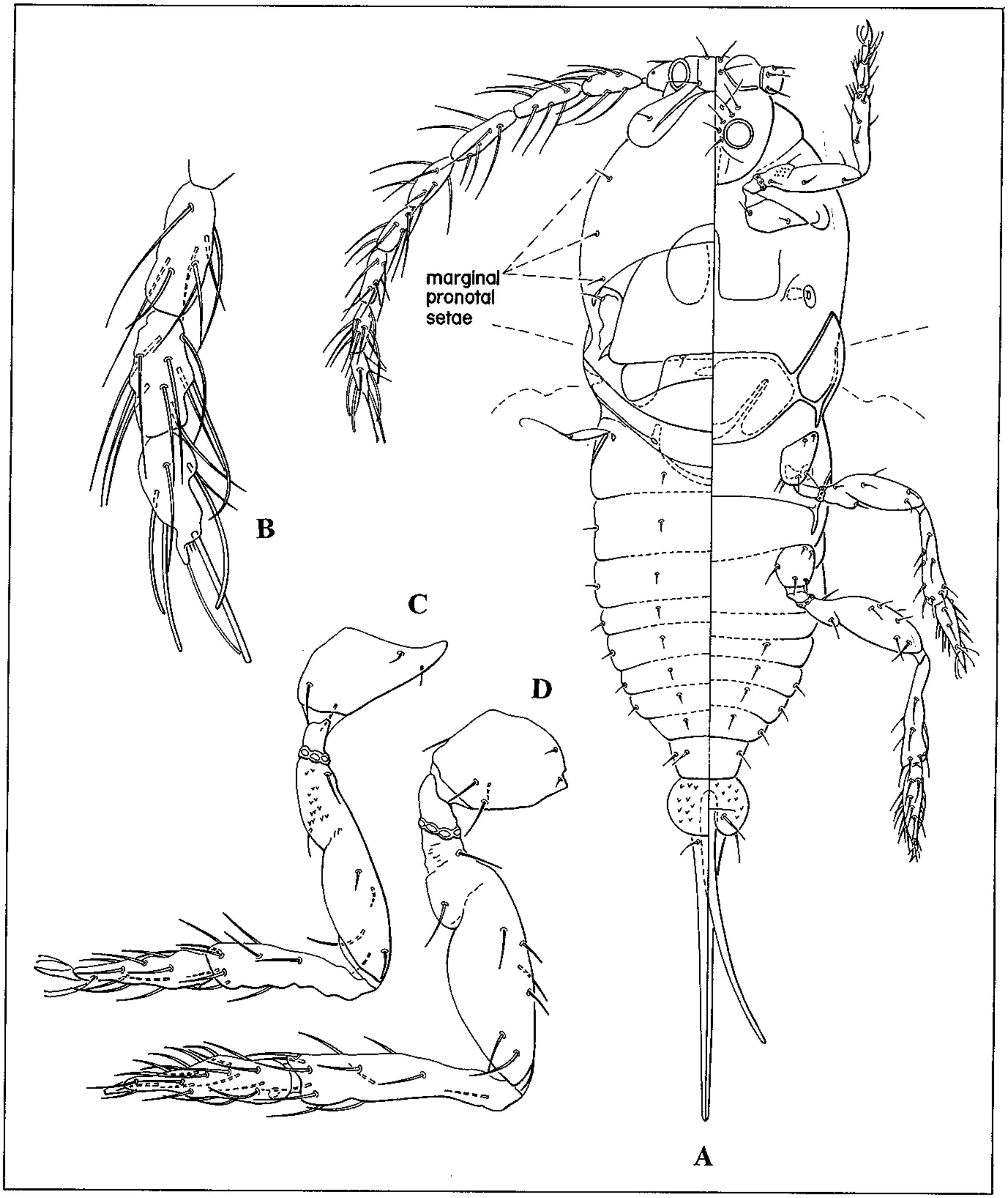

Plate 9. - *Chionaspis kosztarabi* Takagi and Kawai, Winged Morph

DESCRIPTION OF APTEROUS MORPH

Plate 10

Illustration. One slide (2 apterous adult males) in lot for drawing of apterous morph: from *Fraxinus americana*, VA, Blacksburg, Oct. 12, 1972, emerged Oct. 22, 1972, coll. P. A. Willoughby (PAW 061a), VPI. One poor specimen not measured; drawing, except enlargement of antenna, from other specimen.

Body (fig. A). 344 (328-352) long, including genitalia; widest, 77 (61-84), at mesothorax.

Head

Head capsule. Width at genae 63 (49-79); distance from apex to postoccipital ridge 21 (17-24); 1 pair of midcranial setae, 3 pairs of interocular setae, and 1 pair of genal setae; dorsal eyes smaller than ventral eyes, former 8 (7-9) in diameter and 13 (11-17) apart, latter 9 in diameter and 11 (10-13) apart.

Antennae (fig. B). Nine- or 10-segmented; pedicel with 4 setae; each flagellar segment in 9-segmented form with 4-7 setae, in 10-segmented form with 5-8 setae, in both instances with some shorter and with some longer than segment bearing them; penultimate flagellar segment lacking fleshy setae, and terminal segment with 1 claviform seta; length of antennal segments from 9-segmented specimen as follows:

Scape	Pedicel	F1	F2	F3	F4	F5	F6	F7	Total	F7/F1
9	10	18	20	20	17	17	17	20	148	1.11

Length of antennal segments from 10-segmented specimen as follows:

Scape	Pedicel	F1	F2	F3	F4	F5	F6	F7	F8	Total	F8/F1
5	11	21	22	24	21	18	20	17	24	183	1.14

Thorax

Distance from postoccipital ridge to postnotal sclerite of mesothorax 86 (82-93).

Prothorax. With 3 pairs of dorsomarginal setae; with 1 pair of dorsomedian setae; longitudinal median ridge of prosternum 20 (16-23) long.

Mesothorax. Prescutum apparently absent; scutellar margins obliterated; each tegula with 1 seta; mesosternum with indistinct margins, 72 (61-78) wide; precoxal ridge lacking setae; wings absent.

Metathorax. With 1 pair of dorsomarginal setae; hamulohalteres absent.

Legs (figs. C&D). Protibiae without spurlike setae; tarsi without fleshy bifurcate setae; anterior face of metafemur with 4 setae visible; greatest width of metatrochanter-femora about 1/3 its length; length of legs, and of segments comprising them, based on 5 specimens, as follows:

Segment	Coxa	Troch.	Femur	Tibia	Tarsus	Claw	Total
Pro-	29 (26-30)	25 (24-27)	37 (31-44)	36 (32-40)	24 (22-26)	12 (9-15)	163 (144-182)
Meso-	28 (24-30)	27 (24-29)	42 (38-47)	47 (43-53)	29 (26-33)	10 (9-12)	183 (164-204)
Meta-	28 (24-30)	27 (24-31)	48 (45-53)	51 (44-55)	34 (29-40)	10 (9-12)	198 (180-221)

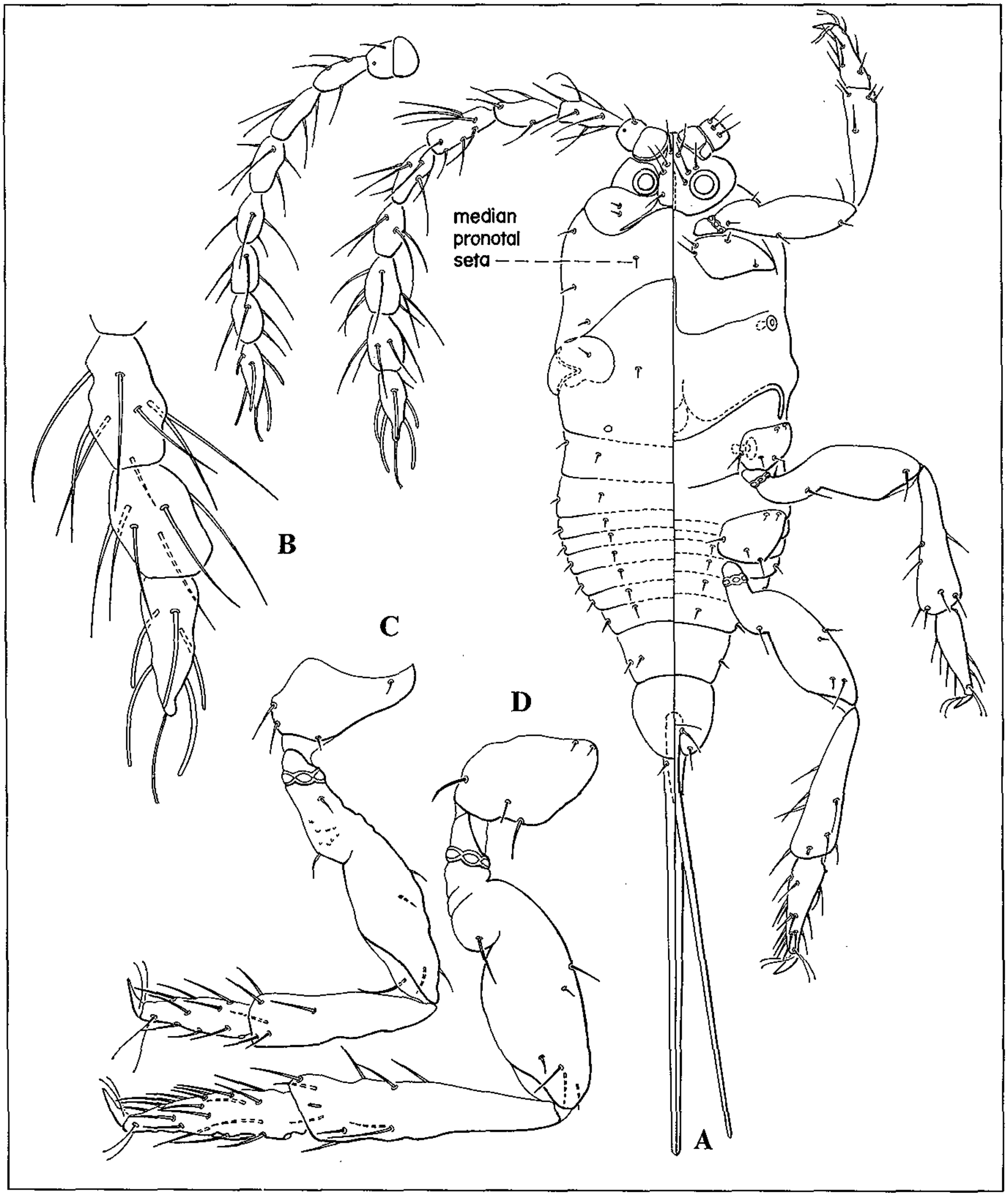

Plate 10. - *Chionaspis kosztarabi* Takagi and Kawai, Apterous Morph

Abdomen

Abdominal segments 1-8. Greatest width 75 (61-85); length from postnotal sclerite of mesothorax to basal ridge of penial sheath 84 (64-104); ventromarginal setae present on segment 5.

Genitalia. 161 (154-169) long from basal ridge of penial sheath to apex of aedeagus, and 28 (24-41) wide at basal ridge of penial sheath; genital capsule with 2 pairs of setae on ventral side, 1 anterior to other.

Other material studied. For additional specimens see list for winged morph. List includes slides with both winged and apterous specimens. All slides with apterous specimens collected from *Fraxinus americana*, VA, Blacksburg, by P. A. Willoughby, VPI. Slides with the following additional individual data: 1 (2a), (PAW 056b), from twig specimen emerged July 19, 1972; 1(1a), (PAW 063), pupa collected Oct. 19, 1972, adult emerged Oct. 30, 1972; 1(1a), (PAW 060a), pupa coll. Oct 5, 1972, adult emerged Oct. 9, 1972; 1(2a), (PAW 057a), from twig coll. July 15, 1972, adults emerged July 24, 1972; 1(2a, 1 pharate ap), (PAW 81b), collected on leaves, Sept. 28, 1972; 1 (1a, 1 pharate ap), (PAW 95b), Sept. 21, 1972.

Affinities and discussion. Apterous males of *C. kosztarabi* distinguished from all other apterous *Chionaspis* by their 1 pair of dorsomedian setae on prothorax. If one believes specimen is *C. kosztarabi*, but cannot locate these setae (because setae are inconspicuous), then note that only in *C. kosztarabi* and *C. gleditsiae* are genal lobes of apterous morph each with 2 setae. Apterous *C. kosztarabi* and *C. gleditsiae* are easily distinguished from each other by relative size of dorsal to ventral simple eyes. In *C. kosztarabi* dorsal eyes are smaller in diameter than ventral eyes; in *C. gleditsiae* these are about equal in diameter.

CHIONASPIS LINTNERI COMSTOCK

Plate 11

Known from both winged and apterous morph, neither described previously. Adult in good enough condition to describe. Winged morph not available.

DESCRIPTION OF APTEROUS MORPH

Illustration. Four slides (1 apterous pupa, 1 apterous adult crawling out of pupal exuviae, 1 free apterous adult, 1 winged adult): from *Cornus* sp., NY, N. Y. State Coll. of Forestry, Ref. Slip 31-478, Feb. 24, 1931, coll. A. H. MacAndrews, USNM, [mounted from dry material]. Winged specimen in extremely poor condition, and unsuitable material for either drawing or description. Drawing made from free apterous adults, but neither had antennal flagellum.

Body (fig. A). 564 (523-624) long, including genitalia; widest, 160 (153-167), at mesothorax.

Head

Head capsule. Width at genae 73 (72-74); distance from apex to postoccipital ridge 28 (26-30); 1 pair of midcranial setae, 2 pairs of interocular setae, and 1 pair of genal setae; dorsal eyes smaller than ventral eyes, former 15 (14-16) in diameter and 34 apart, latter 21 in diameter and 12 apart.

Antennae. With flagellum broken off at base in only specimen examined; pedicel with 4 setae; length of scape and pedicel from 2 examined specimens 9 (8-10) and 10 (10-11), respectively.

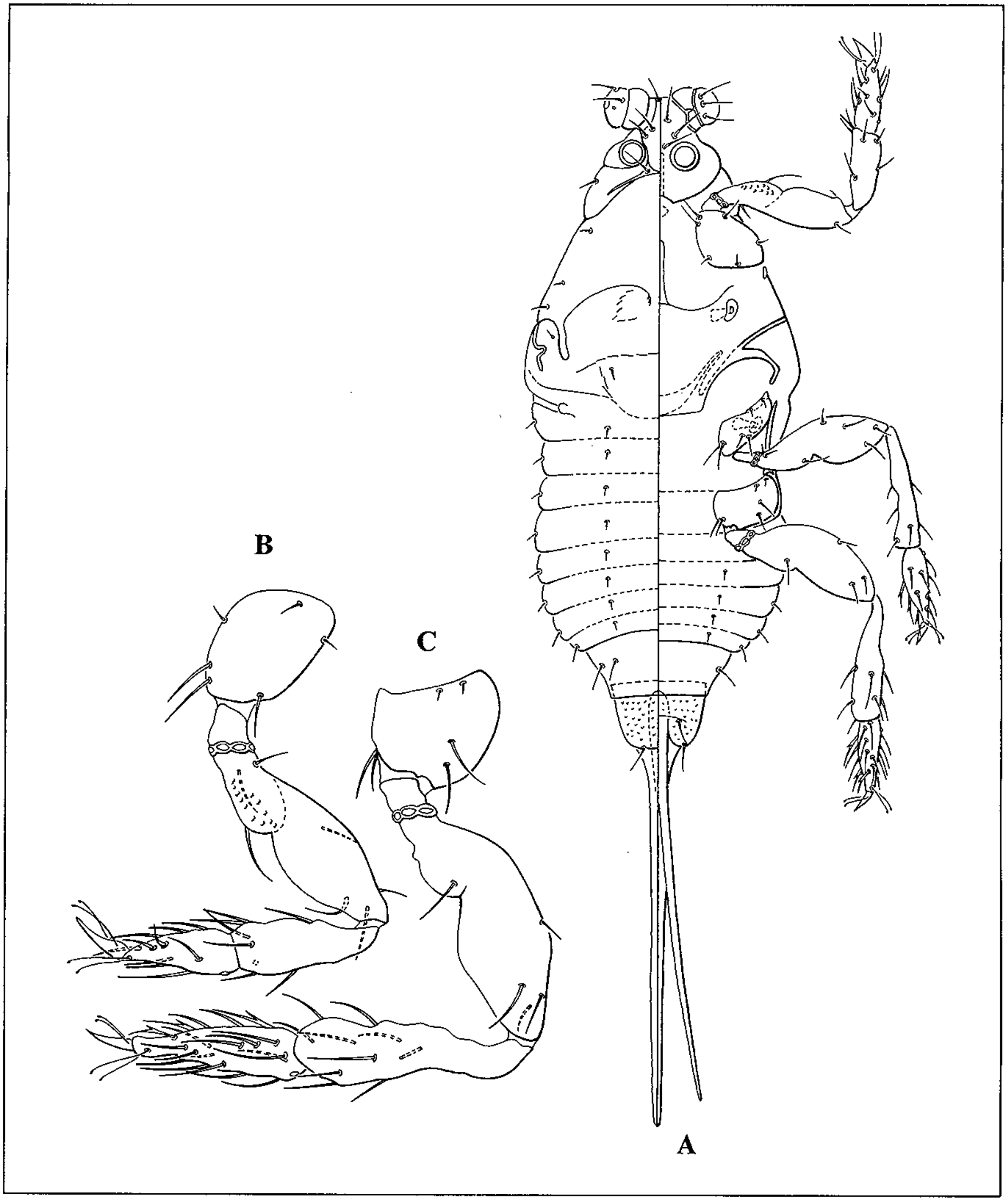

Plate 11. - *Chionaspis lintneri* Comstock, Apterous Morph

Thorax

Distance from postoccipital ridge to postnotal sclerite of mesothorax 146 (136-166).

Prothorax. With 3 pairs of dorsomarginal setae; no dorsomedian setae; longitudinal median ridge of prosternum 43 (39-46) long.

Mesothorax. Prescutal, scutellar, and tegular margins indistinct; tegula with 1 seta; mesosternum 47 (42-51) long, 84 (82-85) wide; precoxal ridge without setae; wings absent.

Metathorax. With 1 pair of dorsomarginal setae; hamulohalteres absent.

Legs (figs. B&C). Protibiae without spurlike setae; no fleshy bifurcate setae on protarsus, 3 on mesotarsus, and 3 on metatarsus; anterior face of femur with 3 setae visible; greatest width of metatrochanter-femora little less than 1/3 its length; length of legs, and of segments comprising them, from 2 specimens, as follows:

Segment	Coxa	Troch.	Femur	Tibia	Tarsus	Claw	Total
Pro-	34 (33-35)	33 (30-35)	63 (56-67)	46 (46-46)	42 (42-42)	16 (16-16)	234 (228-236)
Meso-	31 (30-32)	46 (46-47)	66 (62-69)	67 (62-70)	50 (49-51)	16 (16-16)	276 (265-285)
Meta-	31 (31-31)	44 (44-44)	75 (74-79)	66 (63-72)	50 (46-53)	16 (16-16)	282 (274-295)

Abdomen

Abdominal segments 1-8. Greatest width 153 (149-157); length from postnotal sclerite of mesothorax to basal ridge of penial sheath 136 (109-163); ventromarginal setae present on segment 5.

Genitalia. 253 (232-273) long from basal ridge of penial sheath to apex of aedeagus, and 62 (60-64) wide at basal ridge of penial sheath; genital capsule with 2 pairs of setae on ventral side, 1 anterior to other.

Affinities and discussion. Apterous males of *C. lintneri* bear only about 3 fleshy bifurcate setae on each metatarsus. In apterous *C. nyssae* fleshy bifurcate setae are likewise developed on metatarsi, but, in contrast to *C. lintneri*, here there are 6 bifurcate setae in a well-defined row. To determine specimens to species in which bifurcate fleshy setae definitely occur, but for which number not ascertainable, note width/length ratio of metatrochanter-femora. In *C. lintneri* width/length ratio slightly less than 1/3; in *C. nyssae*, about 1/4.

CHIONASPIS LONGILOBA COOLEY

Plate 12

Known only from winged morph; described for the first time here. Apterous morph exists, however, because lot used for drawing included two pharate pupae, which clearly lack pads for wings, along with one winged adult and one pupa (with wing pads). Winged adult in poor condition, lacking wings, antennal flagella, and mesothoracic legs; antennae on plate drawn from pupa with wing pads, as it displays many characters found in adults of other species.

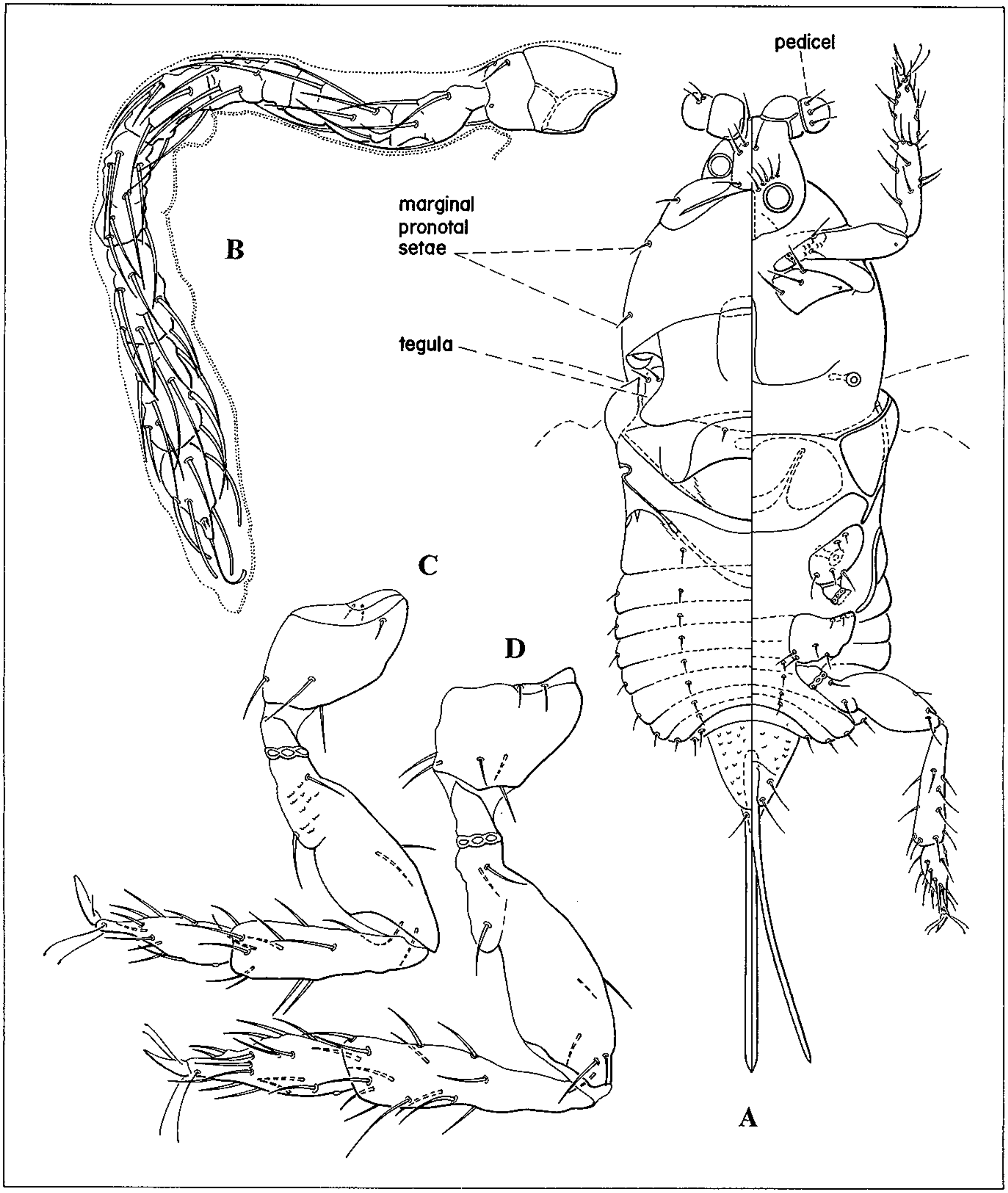

Plate 12. - *Chionaspis longiloba* Cooley, Winged Morph

DESCRIPTION OF WINGED MORPH

Illustration. Four slides: from *Salix* sp., **TX**, Mission, Dec. 11, 1926, coll. F. F. Bibby, USNM [mounted from dry material].

Body (fig. A). 451 long, including genitalia; widest at mesothorax, 162.

Head

Head capsule. Width at genae 95; distance from apex to postoccipital ridge 38; 1 pair of midcranial setae, 5 pairs of interocular setae, and 1 pair of genal setae; dorsal eyes smaller than ventral eyes, former 12 in diameter and 18 apart, latter 16 in diameter and 7 apart.

Antenna (from one pharate pupa) (fig. B). Ten-segmented; pedicel with 5 setae; each flagellar segment with 5-10 setae; penultimate flagellar segment lacking fleshy setae, and terminal segment with 1 claviform seta; length of antennal segments as follows:

Scape	Pedicel	F1	F2	F3	F4	F5	F6	F7	F8	Total	F8/F1
17	12	22	23	20	20	23	23	24	20	204	0.90

Thorax

Distance from postoccipital ridge to postnotal sclerite of mesothorax 186.

Prothorax. With 2 pairs of dorsomarginal setae; no dorsomedian setae; longitudinal median ridge of prosternum 46 long.

Mesothorax. Prescutum 43 long, 38 wide; scutellum 18 long, 60 wide; each tegula with 1 seta; mesosternum 29 long, 125 wide; precoxal ridge without setae; wings present, probably fully developed.

Metathorax. No dorsomarginal setae; hamulohalteres apparently absent in single specimen, probably broken off.

Legs (figs. C&D). Protibiae without spurlike setae; tarsi lacking fleshy bifurcate setae; anterior face of metafemur with 3 setae visible; greatest width of metatrochanter-femora nearly 1/3 its length; length of pro- and metathoracic legs, and of segments comprising them, from single specimen as follows:

Segment	Coxa	Troch.	Femur	Tibia	Tarsus	Claw	Total
Pro-	34	34	44	45	31	13	201
Meso-	34	--	--	--	--	--	---
Meta-	35	37	52	58	37	12	231

Abdomen

Abdominal segments 1-8. Greatest width 131; length from postnotal sclerite of mesothorax to basal ridge of penial sheath 58; ventromarginal setae present on segment 5.

Genitalia. 171 long from basal ridge of penial sheath to apex of aedeagus, and 46 wide at basal ridge of penial sheath; genital capsule with 2 pairs of setae on ventral side, 1 anterior to other.

Affinities and discussion. Winged males of *C. longiloba* distinguished from other *Chionaspis* by their following combination of characters: 1) tarsi lacking fleshy bifurcate setae and 2) tegulae each bearing 2 setae. Winged males of 1 other species, *C. kosztarabi*, lack fleshy bifurcate setae on tarsi, but, in contrast to males of *C. longiloba* as well as to those of most other species of *Chionaspis*, here each tegula bears only a single seta. Winged males of *C. longiloba* and *C. kosztarabi* are further distinguished from each other by the number of setae on each antennal pedicel: *C. longiloba* has 5; *C. kosztarabi* has 4.

CHIONASPIS NYSSAE COMSTOCK

Color fig. 10. Plates 13, 14

Known from both winged and apterous morphs; described in detail by Knipscher et al. (1976). Their description is more than adequate for recognition of species. However, we present here a new description and drawings for *C. nyssae* for comparison among congeners.

DESCRIPTION OF WINGED MORPH

Plate 13

Illustration. Three slides (3 winged adults) in lot for drawing of winged morph: from *Nyssa sylvatica*, AL, Auburn, Lee Co., May 15, 1976, coll. I. Daniels, (AL 746 76 b, c, and d) AU. We made the entire drawing from specimen "c."

Body (fig. A). 834 (817-851) long, including genitalia; widest, 178 (153-202), at mesothorax.

Head

Head capsule. Width at genae 97 (94-104); distance from apex to postoccipital ridge 55 (51-58); 1 pair of midcranial setae, 5 pairs of interocular setae, and 1 pair of genal setae; dorsal eyes smaller than ventral eyes, former 22 (21-23) in diameter and 22 apart, latter 25 (23-27) in diameter and 12 apart.

Antennae (fig. B). Ten-segmented, pedicel with 4 setae; each flagellar segment with 6-13 setae, most about same length as segment bearing them; penultimate flagellar segment lacking fleshy setae, and terminal segment with 1 claviform seta; length of antennal segments from 3 specimens as follows:

Scape	Pedicel	F1	F2	F3	F4	F5	F6	F7	F8	Total	F8/F1
19 (16-23)	17 (16-19)	61 (60-62)	59 (57-60)	60 (58-62)	57 (56-60)	54 (53-56)	46 (44-48)	48 (42-58)	39 (38-39)	461 (456-475)	0.64 (0.63-0.65)

Thorax

Distance from postoccipital ridge to postnotal sclerite of mesothorax 289 (277-302).

Prothorax. With 2 pairs of dorsomarginal setae but without dorsomedian setae; longitudinal median ridge of prosternum 69 long.

Mesothorax. Prescutum 19 long, 58 wide; scutellum 23 long, 93 wide; tegula with 1 pair of setae; mesosternum 65 long, 146 wide; precoxal ridge without setae; wings present and fully developed.

Metathorax. No dorsomarginal setae; hamulohalteres present; length of haltere 30, of hamulus 23.

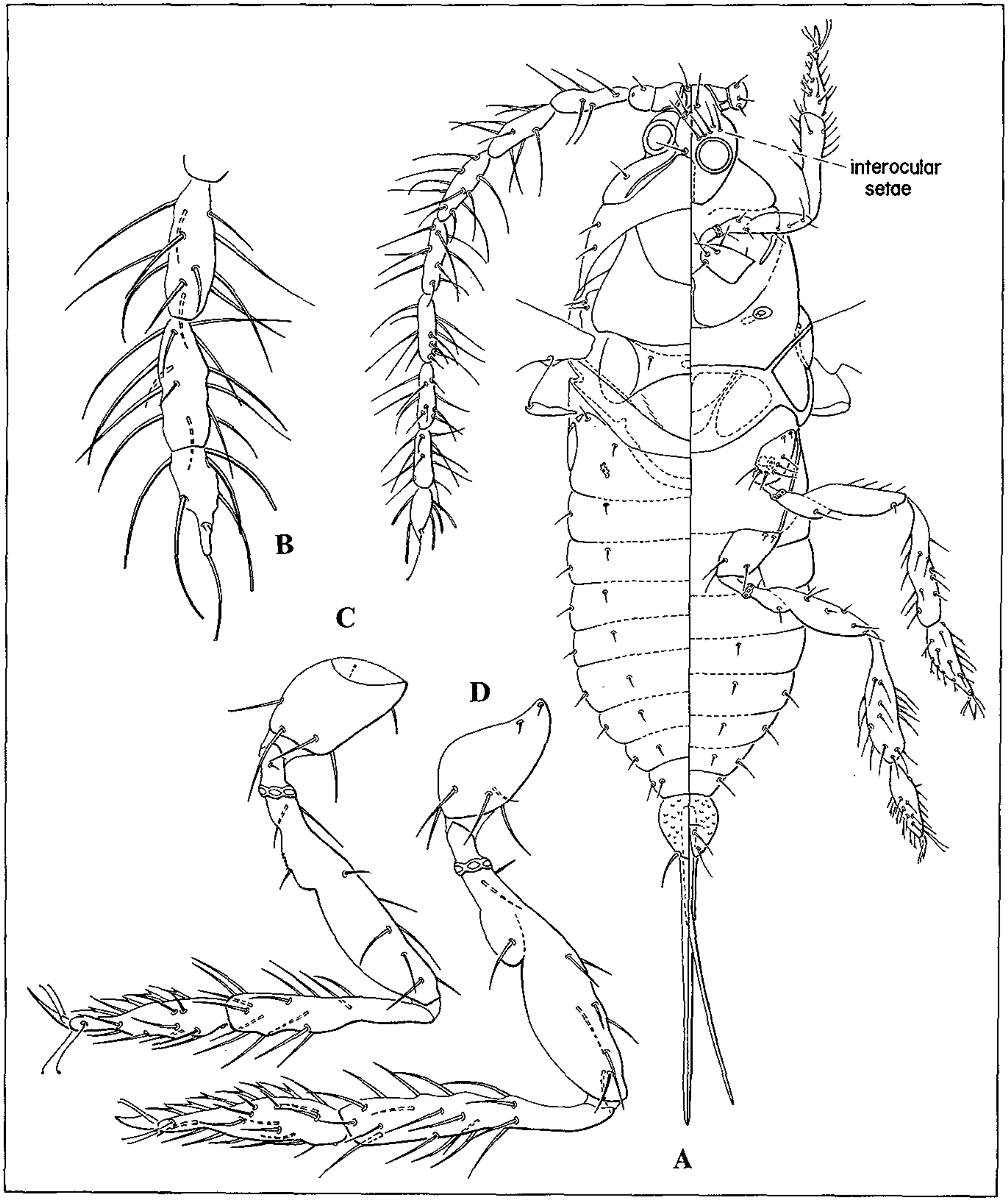

Plate 13. - *Chionaspis nyssae* Comstock, Winged Morph

Legs (figs. C&D). Protibiae lacking spurlike setae; 4 fleshy bifurcate setae on protarsus, 7 on mesotarsus, and 6 on metatarsus; anterior face of metafemur with 6 setae visible; greatest width of metatrochanter-femora a little under 1/4 their length; length of legs, and of segments comprising them, based on 3 specimens, as follows:

Segment	Coxa	Troch.	Femur	Tibia	Tarsus	Claw	Total
Pro-	23 (23-23)	33 (30-34)	70 (67-74)	73 (70-76)	55 (53-56)	23 (18-25)	277 (201-306)
Meso-	32 (30-34)	34 (30-42)	84 (81-90)	98 (92-106)	64 (58-72)	22 (20-25)	334 (316-364)
Meta-	37 (34-39)	36 (30-46)	90 (86-97)	102 (95-111)	67 (60-78)	25 (23-28)	357 (338-394)

Abdomen

Abdominal segments 1-8. Greatest width 165 (151-178); length from postnotal sclerite of mesothorax to basal ridge of penial sheath 214 (191-236); ventromarginal setae present on segment 5.

Genitalia. 277 (253-300) long from basal ridge of penial sheath to apex of aedeagus, and 56 (53-59) wide at basal ridge of penial sheath; genital capsule with 2 pairs of setae on ventral side, 1 anterior to other.

Material studied. 1 slide (2 w) from *Nyssa sylvatica*, **AL**, Covington Co., May 17, 1980, coll. C. H. Ray, Jr., (AL 053 80f), AU; two slides (2 w) **MD**, College Park, Prince Georges Co., 1975, coll. J. A. Davidson, UM; 1 slide (1 w) from *Nyssa* sp., **GA**, Echols Co., May 17, 1976, coll. B. J. Muse, (AL 766 76a), AU.

Affinities and discussion. Winged males of *C. nyssae* are distinguished from other winged *Chionaspis* by the following combination of characters: 1) antennae 456 or more long; 2) mesothorax with precoxal ridge lacking setae; and 3) antennal pedicels each bearing 4 setae. In three other species of *Chionaspis*, namely *C. pinifoliae*, *C. ortholobis*, and *C. heterophyllae*, antennae regularly 456 or more long, but, in contrast to *C. nyssae*, in *C. pinifoliae* precoxal ridge bears 2 setae, and in the other two, antennal pedicels each bear 3 instead of 4 setae.

DESCRIPTION OF APTEROUS MORPH

Plate 14

Illustration. Two slides (6 apterous adults) in lot for drawing of apterous morph: unknown host, VA, White Oak Canyon, Shenandoah Nat'l. Park, Sept. 13, 1970, coll. D. R. Miller. Entire plate, except the antennae, drawn from 1 specimen; 2 additional specimens used to draw 9- and 10-segmented antennae. All specimens for plate on same slide. Only specimens on this slide used for measurements.

Body (fig. A). 498 (485-523) long, including genitalia; widest, 114 (105-129), at middle of abdomen.

Head

Head capsule. Width at genae 73 (67-85); distance from apex to postoccipital ridge 33 (27-38); 1 pair of midcranial setae, 4 pairs of interocular setae, and 1 pair of genal setae; dorsal eyes smaller than ventral eyes, former 12 (10-12) in diameter and 15 (13-17) apart, latter 13 (12-15) in diameter and 9 (6-13) apart.

Antennae (fig. B). Nine- or 10-segmented; pedicel with 4 setae; each flagellar segment with 5-9 setae in 9-segmented form and 4-9 setae in 10-segmented form; in both forms most of flagellar setae from slightly shorter to slightly longer than segment bearing them; penultimate flagellar segment with 1 fleshy seta in 9-segmented form, none in 10-segmented form; terminal segment in both forms with 1 claviform seta; length of antennal segments from 5, 9-segmented specimens as follows:

Scape	Pedicel	F1	F2	F3	F4	F5	F6	F7	Total	F7/F1
13 (11-17)	9 (8-11)	30 (28-32)	31 (30-32)	30 (26-32)	30 (28-32)	26 (25-27)	26 (23-30)	24 (23-25)	219 (202-238)	0.80 (0.78-0.82)

Length of antennal segments from one 10-segmented specimen as follows:

Scape	Pedicel	F1	F2	F3	F4	F5	F6	F7	F8	Total	F8/F1
12	9	35	38	34	31	31	30	31	24	275	0.69

Thorax

Distance from postoccipital ridge to postnotal sclerite of mesothorax 130 (110-156).

Prothorax. With 3 pairs of dorsomarginal setae but lacking dorsomedian setae; longitudinal median ridge of prosternum 25 (21-29) long.

Mesothorax. Prescutum apparently absent; scutellum 9 (6-12) long, 50 (38-58) wide; tegula with indistinct margins and 1 seta; mesosternum with indistinct margins, 97 (81-107) wide; precoxal ridge lacking setae; wings absent.

Metathorax. With 1 pair of dorsomarginal setae; hamulohalteres absent.

Legs (figs. C&D). Protibiae lacking spurlike setae; 3 fleshy bifurcate setae on protarsus, 4 on mesotarsus, and 6 on metatarsus; anterior face of metafemur with 6 setae visible; greatest width of metatrochanter-femora about 1/4 its length; length of legs, and of segments comprising them, based on 6 specimens, as follows:

Segment	Coxa	Troch.	Femur	Tibia	Tarsus	Claw	Total
Pro-	33 (21-43)	32 (27-34)	44 (38-51)	46 (43-50)	31 (29-34)	15 (13-16)	201 (171-228)
Meso-	36 (29-49)	34 (32-37)	49 (44-52)	59 (55-62)	37 (34-41)	15 (12-23)	230 (206-264)
Meta-	36 (32-41)	35 (31-37)	55 (45-60)	62 (56-67)	43 (40-49)	13 (11-15)	244 (215-269)

Abdomen

Abdominal segments 1-8. Greatest width 114 (105-125); length from postnotal sclerite of mesothorax to basal ridge of penial sheath 176 (159-189); ventromarginal setae present on segment 5.

Genitalia. 182 (174-192) long from basal ridge of penial sheath to apex of aedeagus, and 30 (26-34) wide at basal ridge of penial sheath; genital capsule with 2 pairs of setae on ventral side, 1 anterior to the other.

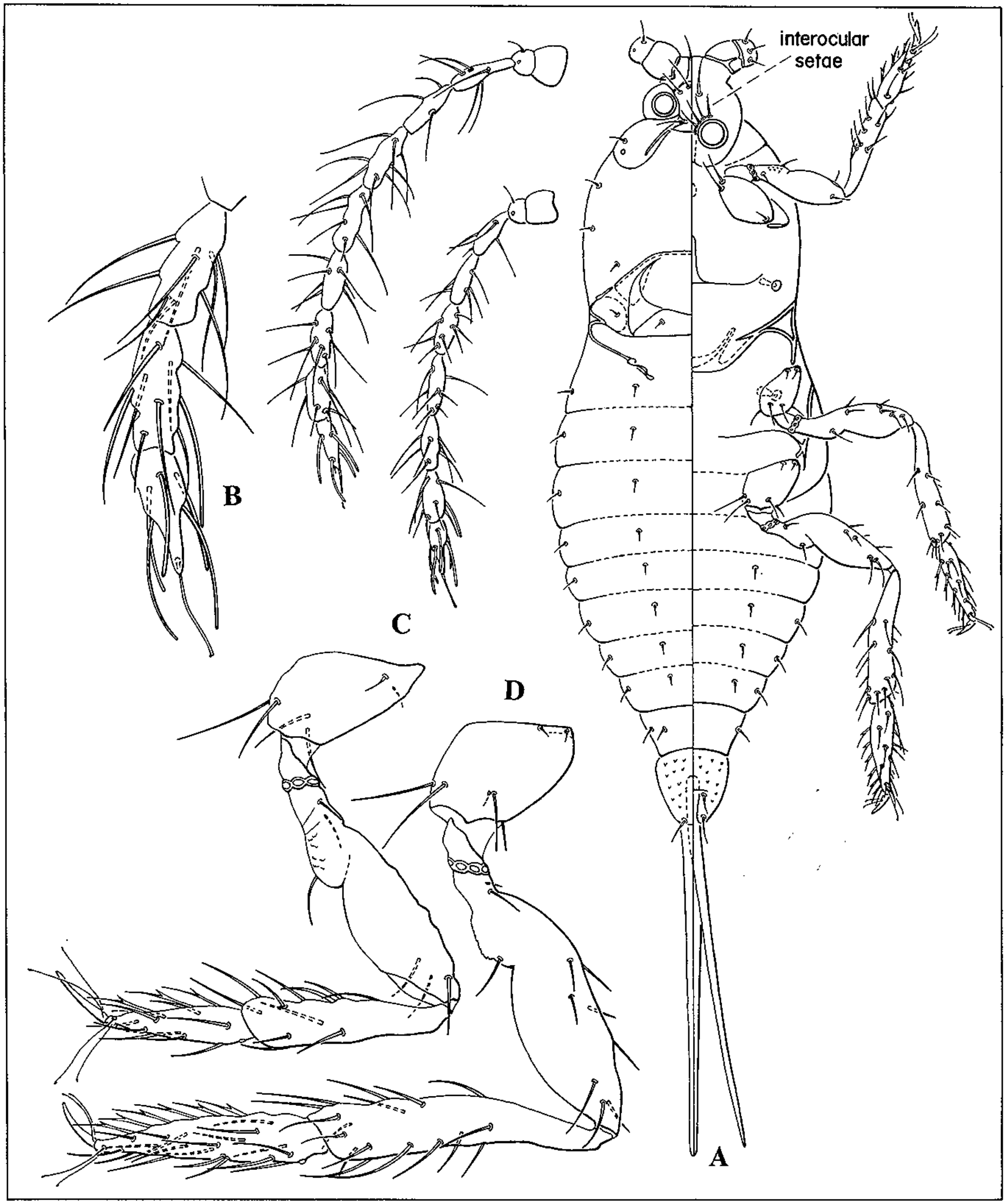

Plate 14. - *Chionaspis nyssae* Comstock, Apterous Morph

Other material studied. Two slides (3wp, 2a) from *Nyssa sylvatica*, **MD**, College Park, Prince Georges Co., 1975, coll. J. A. Davidson, UM; 1 slide (1 a) from *Fraxinus* sp., **NC**, Chapel Hill, Oct. 10-17, 1928, coll. J. N. Couch, (# 8362), USNM.

Affinities and discussion. Apterous males of *C. nyssae* can be distinguished from other apterous *Chionaspis* by their metatarsi, each bearing a well-developed row of about 6 fleshy bifurcate setae. In apterous *C. lintneri* fleshy bifurcate setae likewise developed on metatarsi, but, in contrast to *C. nyssae*, with only 3 to each; if after examining specimen with fleshy bifurcate setae on metatarsi, doubt still exists as to whether it is *C. nyssae* or *C. lintneri*, then ascertain width/length ratio of metatrochanter-femora; in *C. nyssae* length/width ratio about 1/4; in *C. lintneri*, a little less than 1/3.

CHIONASPIS ORTHOLOBIS COMSTOCK

Plates 15, 16

Known from both winged and apterous morphs; described for the first time below.

DESCRIPTION OF WINGED MORPH

Plate 15

Illustration. Twenty-five slides (2 winged pupae, 23 winged adults) from *Populus tremuloides*, **IN**, 3 mi. SW Crumstown, Aug. 27, 1920, coll. C. C. Deam (Deam No. 32,422), USNM [mounted from dry material]. Many specimens in good condition, but no one specimen by itself suitable for complete drawing. Body drawn from one specimen, aedeagus from another, antennae and abdominal setae from yet another.

Body (fig. A). 941 (921-981) long, including genitalia; widest, 239 (218-259), at mesothorax.

Head

Head capsule. Width at genae 95 (93-97); distance from apex to postoccipital ridge 59 (53-65); 1 pair of midcranial setae, 5 pairs of interocular setae, and 1 pair of genal setae; dorsal eyes larger than ventral eyes, former 22 (20-23) in diameter and 31 (28-35) apart, latter 20 (19-21) in diameter and 22 (19-25) apart.

Antennae (fig. B). Ten-segmented; pedicel with 3 setae; each flagellar segment with 3-8 setae, most noticeably shorter than segment bearing them; penultimate flagellar segment lacking fleshy setae, and terminal segment with 1 claviform seta; length of antennal segments from 5 specimens as follows:

Scape	Pedicel	F1	F2	F3	F4	F5	F6	F7	F8	Total	F8/F1
21 (14-21)	22 (20-24)	50 (46-53)	52 (47-53)	52 (49-58)	48 (45-51)	52 (47-56)	47 (47-51)	48 (45-54)	51 (49-53)	443 (409-519)	1.02 (1.00-1.06)

Thorax

Distance from postoccipital ridge to postnotal sclerite of mesothorax 281 (262-312).

Prothorax. With 2 pairs of marginal setae; lacking dorsomedian setae; longitudinal median ridge of prosternum 100 (85-106) long.

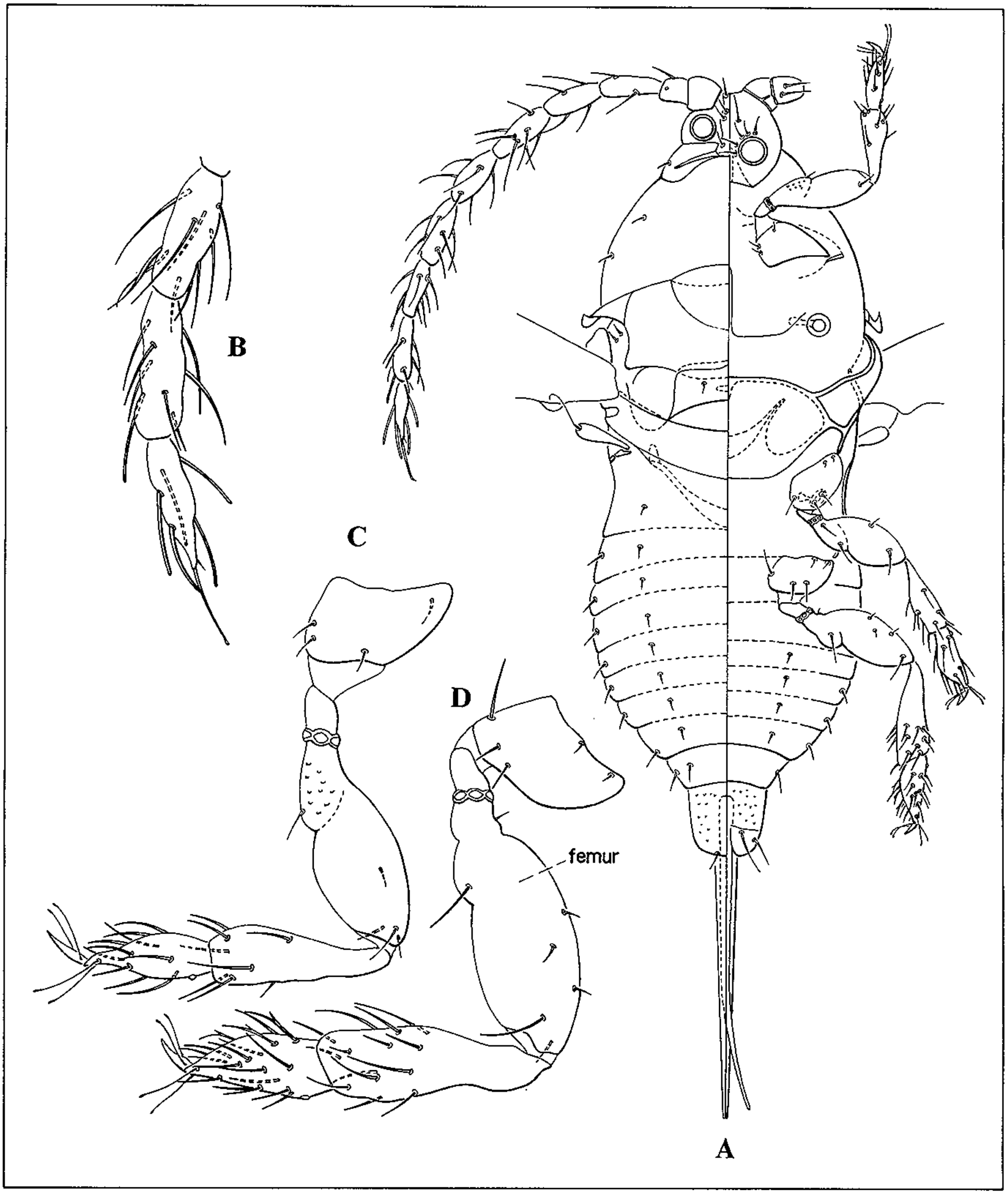

Plate 15. - *Chionaspis ortholobis* Comstock, Winged Morph

Mesothorax. Prescutum 58 (53-62) long, 60 (44-74) wide; scutellum 25 (21-28) long, 99 (97-104) wide; each tegula with 1 pair of setae; mesosternum 124 (120-127) long, 161 (154-168) wide; precoxal ridge lacking setae; wings present and fully developed.

Metathorax. No dorsomarginal setae; hamulohalteres present; length of haltere 32, of hamulus 32.

Legs (figs. C&D). Protibiae lacking spurlike setae; pro- and meso-tibiae lacking bifurcate fleshy setae, metatibiae each with 3; anterior face of metafemur with 4 setae visible; greatest width of metatrochanter-femora about 1/3 its length; length of legs, and of segments comprising them, from 5 specimens, as follows:

Segment	Coxa	Troch.	Femur	Tibia	Tarsus	Claw	Total
Pro-	44 (42-49)	46 (44-49)	67 (65-70)	57 (51-65)	44 (41-46)	17 (14-18)	275 (251-297)
Meso-	54 (49-58)	50 (46-56)	71 (70-76)	82 (81-84)	51 (46-53)	18 (16-19)	326 (308-346)
Meta-	40 (39-44)	52 (48-58)	86 (79-92)	82 (79-83)	50 (44-53)	17 (16-18)	327 (303-348)

Abdomen

Abdominal segments 1-8. Greatest width 207 (198-252); length from postnotal sclerite of mesothorax to basal ridge of penial sheath 345 (320-361); ventromarginal setae present on segment 5.

Genitalia. 306 (289-318) long from basal ridge of penial sheath to apex of aedeagus, and 74 (70-76) wide at basal ridge of penial sheath; genital capsule with 2 pairs of setae on ventral side, 1 anterior to other.

Affinities and discussion. Winged males of *C. ortholobis* are distinguished from other winged *Chionaspis* by their following combination of characters: 1) ratio of length of 1st flagellar segment to that of last flagellar segment 1.00-1.06; and 2) total antennal length 409-519. In *C. gleditsiae* the given antennal ratio is also as high as 1 (next highest 0.90, for *C. kosztarabi* and *C. longiloba*); but, in contrast to *C. ortholobis*, in *C. gleditsiae* antennae are short, with length of only 276.

DESCRIPTION OF APTEROUS MORPH

Plate 16

Illustration. Three slides (2 apterous pupae, 1 apterous adult) from *Populus fremontii*, NE, Hartington, Feb. 12, 1894, coll. B. B. Boyd (6158), USNM. Apterous adult incomplete, but fortunately parts present in excellent condition. Plate drawn entirely from single specimen.

Body (fig. A). At least 265 long, but genitalia with styli and aedeagus broken short at base of genital capsule; widest, 112, at mesothorax.

Head

Head capsule. Width at genae 67; distance from apex to postoccipital ridge 24; 1 pair of midcranial setae, 2 pairs of interocular setae, and 1 pair of genal setae; dorsal eyes larger than ventral eyes, former 12 in diameter and 15 apart, latter 10 in diameter and 11 apart.

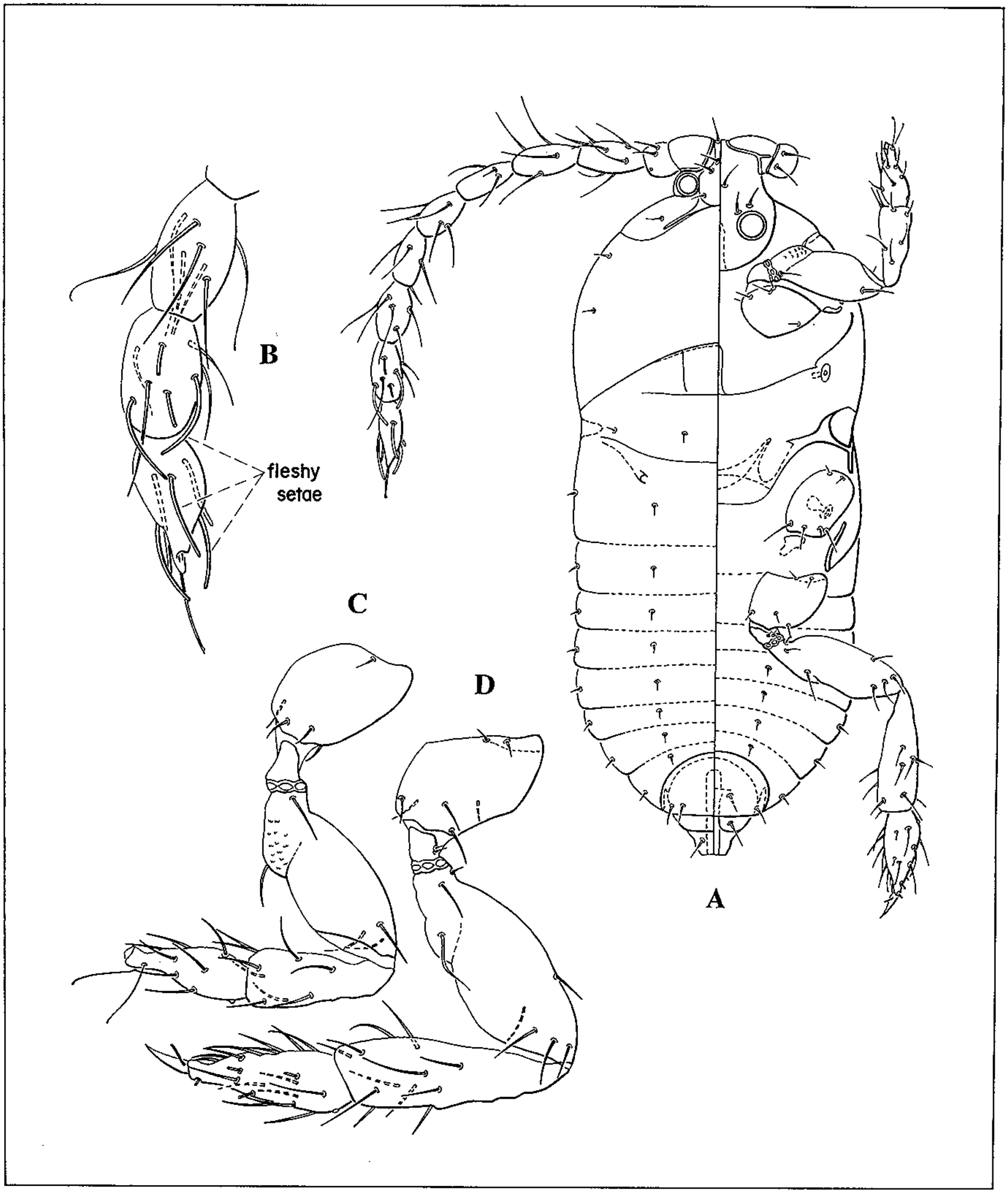

Plate 16. - *Chionaspis ortholobis* Comstock, Apterous Morph

Antennae (fig. B). Ten-segmented; pedicel with 4 setae; each flagellar segment with 4-8 setae, most noticeably shorter than segment bearing them; penultimate flagellar segment with at least 2 fleshy setae, and terminal segment with 1 claviform seta; length of antennal segments from single specimen as follows:

Scape	Pedicel	F1	F2	F3	F4	F5	F6	F7	F8	Total	F8/F1
17	9	25	24	22	20	20	22	21	24	204	0.96

Thorax

Distance from postoccipital ridge to postnotal sclerite of mesothorax 96.

Prothorax. With 2 pairs of marginal setae; lacking dorsomedian setae; longitudinal median ridge of prosternum 25 long.

Mesothorax. Prescutum 23 long, 29 wide; scutellar margins indistinct; each tegula with 1 seta; mesosternum with indistinct margins, 107 wide; precoxal ridge lacking setae; wings absent.

Metathorax. Bears 1 pair of dorsomarginal setae; hamulohalteres absent.

Legs (figs. C&D). Protibiae without spurlike setae; tibiae without bifurcate fleshy setae; anterior face of metafemur with 4 setae visible; greatest width of metatrochanter-femora about 1/3 its length; length of legs, and of segments comprising them, as follows:

Segment	Coxa	Troch.	Femur	Tibia	Tarsus	Claw	Total
Pro-	36	31	37	34	24	--	162+
Meso-	32	--	--	--	--	--	---
Meta-	29	31	45	49	32	12	198

Abdomen

Abdominal segments 1-8. Greatest width 109; length from postnotal sclerite of mesothorax to basal ridge of penial sheath 116; ventromarginal setae present on segment 5.

Genitalia. Genital capsule 31 long from basal ridge of penial sheath to base of genital styli; genital styli and aedeagus lacking, and obviously broken off at base, in specimen at hand; genital capsule with 2 pairs of setae on ventral side, 1 anterior to other.

Affinities and discussion. Apterous males of *C. ortholobis* are separated from other apterous *Chionaspis* by their following combination of characters: 1) antennae 10-segmented; 2) each genal lobe bears only 1 seta; 3) prothorax without dorsomedian setae; and 4) metatrochanter-femora with width/length ratio of about 1/3.

CHIONASPIS PINIFOLIAE (FITCH)

Color fig. 15. Plate 17

Known only from winged morph. Also described by Shour (1986), and no significant morphological differences were found between his and our samples.

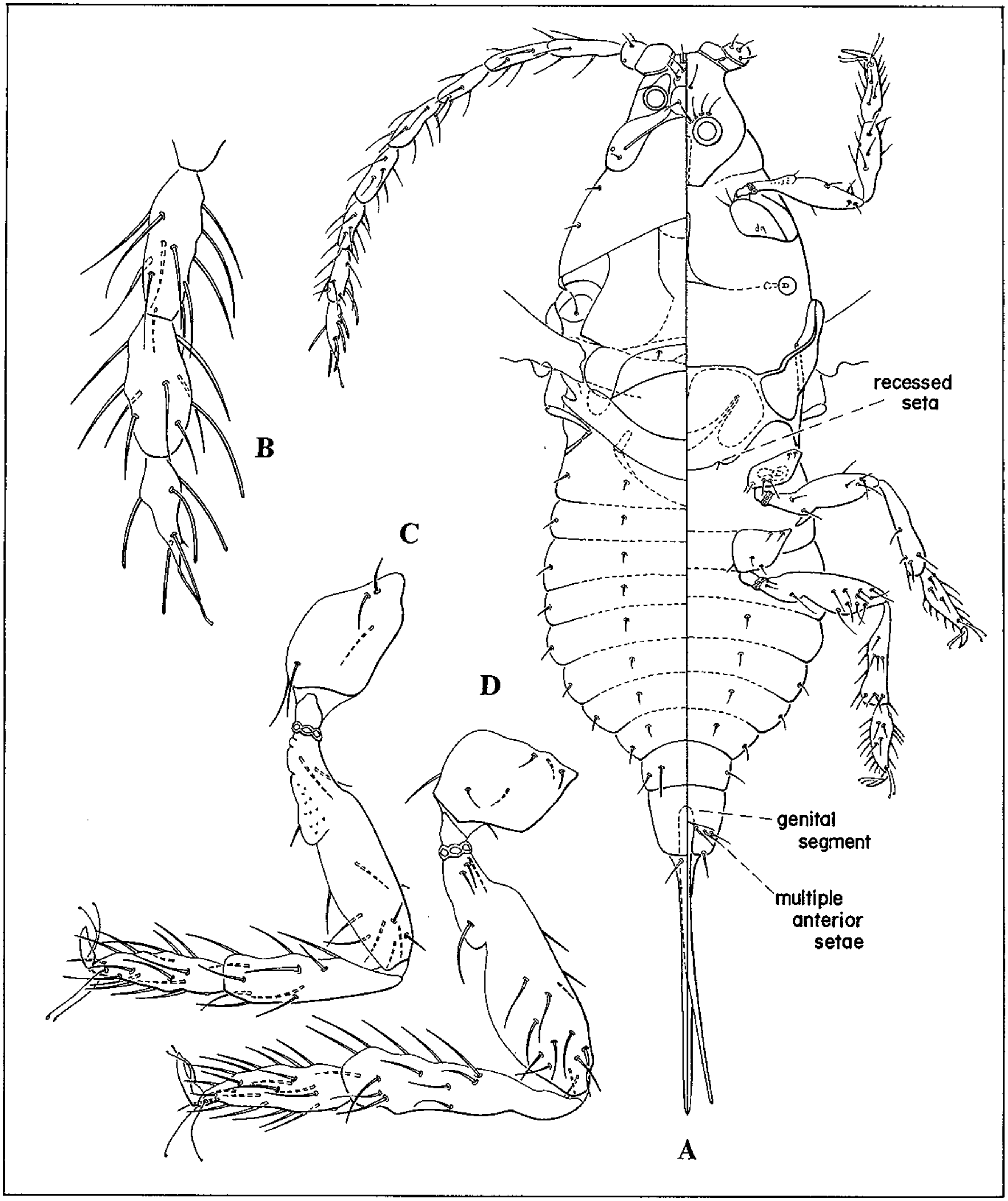

Plate 17. - *Chionaspis pinifoliae* (Fitch), Winged Morph

DESCRIPTION OF WINGED MORPH

Illustration. Nine slides (9 winged adults) in lot for drawing from *Pinus michoacanae* cones, **Mexico,** Uruapan, State of Michoacan, Jan. 1981, coll. A. del Rio M, USNM. Excellent specimens; entire drawing made from one.

Body (fig. A). 902 (860-973) long, including genitalia; widest, 235 (212-259), at mesothorax.

Head

Head capsule. Width at genae 99 (81-116); distance from apex to postoccipital ridge 48 (42-53); 1 pair of midcranial setae, 4 pairs of interocular setae, and 1 pair of genal setae; dorsal eyes smaller than ventral eyes, former 20 (19-20) in diameter and 25 (20-27) apart, latter 23 in diameter, and 13 (9-16) apart.

Antennae (fig. B). Ten-segmented; pedicel with 5 setae; each flagellar segment with 6-10 setae, most noticeably shorter than segment bearing them; penultimate flagellar segment with 1 fleshy seta, and terminal segment with 1 claviform seta; length of antennal segments from 5 specimens as follows:

Scape	Pedicel	F1	F2	F3	F4	F5	F6	F7	F8	Total	F8/F1
18 (16-21)	21 (21-21)	74 (60-82)	57 (48-62)	56 (48-58)	54 (44-60)	56 (44-60)	51 (42-57)	48 (39-53)	45 (34-51)	480 (394-511)	0.61 (0.57-0.62)

Thorax

Distance from postoccipital ridge to postnotal sclerite of mesothorax 343 (312-365).

Prothorax. With 2 pairs of dorsomarginal setae; lacking dorsomedian setae; longitudinal median ridge of prosternum 82 (69-118) long.

Mesothorax. Prescutum 64 (48-76) long, 71 (58-92) wide; scutellum 25 (21-30) long, 100 (92-106) wide; each tegula with 1 seta; mesosternum 120 (104-139) long, 160 (158-174) wide; precoxal ridge bearing 1 pair of recessed setae; wings present and fully developed.

Metathorax. With 1 pair of dorsomarginal setae; hamulohalteres present; length of haltere 43 (42-46), of hamulus 29 (23-34).

Legs (figs. C&D). Protibiae lacking spurlike setae; tarsi lacking fleshy bifurcate setae; anterior face of metafemur with 11 setae visible; greatest width of metatrochanter-femora between 1/3 and 1/4 its length; length of legs, and of segments comprising them, based on 5 specimens, as follows:

Segment	Coxa	Troch.	Femur	Tibia	Tarsus	Claw	Total
Pro-	36 (33-37)	60 (53-62)	82 (71-88)	74 (63-83)	51 (47-60)	22 (20-23)	324 (277-355)
Meso-	38 (37-39)	59 (53-62)	83 (72-95)	94 (84-104)	56 (48-62)	23 (23-23)	349 (320-363)
Meta-	35 (33-36)	58 (53-62)	95 (92-97)	96 (88-102)	61 (56-67)	25 (25-25)	371 (349-384)

Abdomen

Abdominal segments 1-8. Greatest width 226 (201-241); length from postnotal sclerite of mesothorax to basal ridge of penial sheath 239 (206-260); ventromarginal setae present on segment 5.

Genitalia. 275 (241-295) long from basal ridge of penial sheath to apex of aedeagus, and 72 (65-81) wide at basal ridge of penial sheath; genital capsule with from 2 to 4 pairs of setae on ventral side (1-3 pairs anteriorly and 1 pair posteriorly).

Material studied. One slide (3 w) from *Pinus strobus*, **OH**, Piedmont, July 21, 1976, coll. C. J. Hay (76-9062, 97), USNM; 1 slide (4 w) from *Pinus palustris*, **TX**, Liberty County, May 1, 1918, Coccidae of Texas (T593) UCD.

Affinities and discussion. Winged males of *C. pinifoliae* distinguished from all other *Chionaspis* by having the following characters: 1) precoxal ridge of mesothorax bearing 1 pair of recessed setae; or 2) anterior face of metafemora bearing 8 or more setae. In many specimens genital capsule also with unique setation: 1 or 2 pairs of adventitious setae found anteriorly on ventral side in addition to normal pair.

DISCUSSION OF PHENETIC SIMILARITY OF ADULT MALES BASED ON CLUSTER ANALYSIS

We originally intended to analyze the relationships among males of *Chionaspis* using the phylogenetic methodology of Hennig (1978). However, we soon realized that the males of *Chionaspis* are far too poorly known for these cladistic methods to be applied with any degree of certainty. This lack of knowledge is true on every level. We lack representatives altogether for some species, and lack morphs for other species, not to mention that in many cases we do not even know whether these morphs exist or not. In addition, we lacked intact specimens for some of the species. To further complicate matters, we are not sure whether or not the various morphs are seasonal forms or perhaps host- or site- induced variations, and we have no information on the plesiomorphy or apomorphy of many of the characters. For this reason we have merely analyzed the similarity of the forms we do have, based on overall phenetic similarity. Specifically, we generated the two phenograms presented below using the 1985 version of Ward's Minimum Variance Cluster Analysis (SAS Institute, 1985). Separate cluster analyses were performed for both the fully winged and brachypterous/apterous forms.

In the minimum variance cluster analysis, data are first formed into a matrix with *s* rows, representing species, and *n* columns, representing characters. The *s, n* element in this matrix is a number, perhaps a measurement, representing the development of a character in a particular species. The computer plots the coordinates for each species in an n-dimensional graph. The sum of the squares for the distance between each of these points representing a species and the centroid of a given group of species is defined as the "within-cluster dispersion." The minimum variance method unites clusters "whose fusion yields the least increase in within-cluster dispersion" (Pielou, 1984).

It is obvious that using characters represented by numbers of vastly different magnitudes will result in the unwarranted hegemony of one character over another, and hence it is often advisable to transform the data in some fashion. In our two analyses this transformation was done by defining all characters in terms of presence or absence. Characters were assigned a 0 if present and a 1 if absent. A complete matrix was required for the analysis to work; hence we could only include characters that could be ascertained as being present or absent in all species.

The cluster analysis for the winged males included 11 species and was based on 29 characters, given in the data matrix in Table 1. That is, the computer generated 11 points (representing the species) in a 29-dimensional space (with each dimension representing a character), and then, in a series of steps, grouped these points into clusters, with each more inclusive cluster being the one in which the within-cluster dispersion or variance was least. Table 2 outlines the sequence followed by the computer in uniting the 11 species into clusters, and indicates the within-cluster dispersion (R-squared) for the given clusters. The resulting phenogram is given in Figure 1.

The cluster analysis for the brachypterous/apterous males included six species and was based on 18 characters given in the data matrix in Table 3. The sequence followed by the computer in uniting clusters, and the resulting within-cluster dispersion, is given in Table 4. The phenogram is shown in Figure 2.

The two phenograms are not congruous. This discrepancy is to be expected considering the lack of knowledge commented on in the introduction to this section. Both phenograms agree, however, in placing *C. americana* and *C. kosztarabi* at some distance from the remaining species, reinforcing our intuitive belief that these two species are the farthest removed from the rest of the species. We have presented these phenograms with the belief that they are better than no indication of similarity at all, and vastly better than what under the present circumstances could only be an unsupported and most likely erroneous phylogenetic hypothesis.

The reader should also consult the "Discussion of the Adult Female Phylogeny Based on Cluster Analysis" at the end of the study on adult females. Although that study and the one presented here were done in conjunction with each other, the difficulties in correlating the various male morphs with those of the females, or with factors which have the the potential for inducing changes in morphology, such as host site or generation, have been insurmountable due to the limited amount of data. Perhaps at a later date when much more data have become available, someone will undertake the now largely futile task of constructing a meaningful and lasting phylogenetic tree.

Table 1. Data matrix for known winged males of North American *Chionaspis*. Only characters definitely either present or absent in all species studied were used. Abbreviations used for both species and characters are given in lists following the table. 0 = present; 1 = absent.

	SPECIES										
CHARACTER	AM	CO	ET	FU	GL	HE	KO	LO	NY	OR	PI
AFS	0	0	1	1	1	0	1	1	1	1	0
AP3	1	1	0	1	0	0	1	1	1	0	1
AP4	0	1	1	1	1	1	0	1	0	1	1
AP5	1	0	1	0	1	1	0	1	1	1	0
ASG	1	1	1	1	1	1	1	1	1	1	0
ASS	0	0	0	1	1	0	0	0	1	0	0
BFS	0	0	0	0	0	0	1	1	0	0	1
CS2	0	1	1	1	1	1	1	1	1	1	1
GS2	0	1	0	1	0	1	1	1	1	1	1
HS2	0	1	1	1	1	1	1	1	1	1	1
IS2	1	1	0	1	1	1	1	1	1	1	1
IS4	0	1	1	0	1	0	1	1	1	1	0
IS5	1	0	1	1	0	1	0	0	0	0	1
LTT	0	1	0	0	0	1	0	0	0	1	0
MF3	0	1	1	1	1	1	1	0	1	1	1
MF4	1	1	1	1	1	0	1	1	1	0	1
MF5	1	1	1	1	0	1	1	1	1	1	1
MF6	1	1	1	0	1	1	0	1	0	1	1
MF7	1	0	0	1	1	1	1	1	1	1	1
MF11	1	1	1	1	1	1	1	1	1	1	0
PS1	0	1	1	1	1	1	1	1	1	1	1
PS2	1	0	0	0	0	0	1	0	0	0	0
PS3	1	1	1	1	1	1	0	1	1	1	1
RSM	1	1	1	1	1	1	1	1	1	1	0
SMF	0	0	0	0	0	0	0	1	0	1	1
SP	0	1	1	1	1	1	1	1	1	1	1
TS1	1	1	1	1	0	0	0	1	1	1	0
TS2	0	0	0	0	1	1	1	0	0	0	1
VMS	1	0	0	0	0	0	0	0	0	0	0

Abbreviations for species:

AM *americana*
CO *corni*
ET *etrusca*
FU *furfura*
GL *gleditsiae*
HE *heterophyllae*
KO *kosztarabi*
LO *longiloba*
NY *nyssae*
OR *ortholobis*
PI *pinifoliae*

See next page for abbreviations for characters.

Abbreviations for characters

AFS	Antenna with penultimate segment bearing fleshy setae
AP3	Antennal pedicel with 3 setae
AP4	Antennal pedicel with 4 setae
AP5	Antennal pedicel with 5 setae
ASG	Genital segment with more than one pair of anterior setae on ventral surface
ASS	Flagellar segments of antennae longer than most of the setae they bear
BFS	Bifurcate fleshy setae present on metatarsi
CS2	Antenna with terminal segment bearing 2 claviform setae
GS2	Genae each with 2 dorsal setae
HS2	Head anterioventrally with 2 pairs of setae
IS2	Interocular area between simple eyes with 2 pairs of setae
IS4	Interocular area between simple eyes with 4 pairs of setae
IS5	Interocular area between simple eyes with 5 pairs of setae
LTT	Metatibiae and metatarsus with combined length greater than that of metacoxa and metafemora
MF3	Anterior surface of metafemora with 3 setae
MF4	Anterior surface of metafemora with 4 setae
MF5	Anterior surface of metafemora with 5 setae
MF6	Anterior surface of metafemora with 6 setae
MF7	Anterior surface of metafemora with 7 setae
MF11	Anterior surface of metafemora with 11 setae
PS1	Pronotum with 1 pair of marginal setae
PS2	Pronotum with 2 pairs of marginal setae
PS3	Pronotum with 3 pairs of marginal setae
RSM	Mesothorax with pair of recessed setae on precoxal ridge
SMF	Metatrochanter-metafemora four or more times longer than wide
SP	Spurlike setae on protibiae
TS1	Tegulae each with 1 seta
TS2	Tegulae each with 2 setae
VMS	Abdominal segment 5 with ventromarginal setae

Table 2. Outline of sequence followed by computer in uniting North American species of *Chionapis*, as represented by fully winged males, into clusters, and the dispersion (R-squared) of the clusters thus formed. Clusters with higher numbers were joined first. The semi-partial R-squared is the variance of the smaller of the two clusters that have been combined. CL=cluster; species abbreviations as in Table 1.

Cluster Number	Clusters Joined	No. of Species in New Cluster	Semi-partial R-Squared	R-Squared
10	FU & NY	2	0.027771	0.972229
9	HE & OR	2	0.041318	0.930911
8	CO & LO	2	0.058326	0.872585
7	CL8 & CL10	4	0.067885	0.804700
6	ET & GL	2	0.076238	0.728462
5	CL6 & CL9	4	0.091591	0.636871
4	CL7 & CL5	8	0.095354	0.541516
3	CL4 & KO	9	0.117673	0.423843
2	CL3 & PI	10	0.167848	0.255995
1	AM & CL2	11	0.255995	0.000000

Table 3. Data matrix for known reduced-wing (brachypterous/apterous) males of North American *Chionaspis*. Only characters definitely either present or absent in all species studied were used. List of abbreviations used for both species and characters is given following the table. 0 = present; 1 = absent.

	SPECIES					
CHARACTER	AM	GL	KO	LI	NY	OR
BW	0	1	1	1	1	1
MF3	1	1	1	0	1	1
MF4	1	0	0	1	1	0
MF5	0	1	1	1	1	1
MF6	1	1	1	1	0	1
BFS	0	1	1	0	0	1
SMF	0	0	1	1	0	1
AP3	1	0	1	1	1	1
AP4	0	1	0	0	0	0
MSD	1	1	0	1	1	1
TS1	1	1	0	0	0	0
PS2	1	1	1	1	1	0
PS3	0	0	0	0	0	1
IS2	1	1	1	0	1	0
IS3	1	0	0	1	1	1
IS4	0	1	1	1	1	1
IS5	1	1	1	1	0	1
GS2	1	0	1	1	1	1

Abbreviations for species

AM	*americana*	KO	*kosztarabi*	NY	*nyssae*
GL	*gleditsiae*	LI	*lintneri*	OR	*ortholobis*

Abbreviations for characters

BW	Brachypterous wings
MF3	Anterior surface of metafemora with 3 setae
MF4	Anterior surface of metafemora with 4 setae
MF5	Anterior surface of metafemora with 5 setae
MF6	Anterior surface of metafemora with 6 setae
BFS	Bifurcate fleshy setae present on metatarsi
SMF	Metatrochanter-metafemora four or more times longer than wide
AP3	Antennal pedicel with 3 setae
AP4	Antennal pedicel with 4 setae
MSD	Prothoracic dorsum with 1 pair of median setae
TS1	Tegulae each with 1 seta
PS2	Pronotum with 2 pairs of marginal setae
PS3	Pronotum with 3 pairs of marginal setae
IS2	Interocular area between simple eyes with 2 pairs of setae
IS3	Interocular area between simple eyes with 3 pairs of setae
IS4	Interocular area between simple eyes with 4 pairs of setae
IS5	Interocular area between simple eyes with 5 pairs of setae
GS2	Genae with 2 dorsal setae

Table 4. Outline of sequence followed by computer in uniting species of *Chionaspis*, as represented by reduced-wing males, into clusters, and the dispersion (R-squared) of the clusters thus formed. Clusters with higher numbers were joined first. The semi-partial R-squared is the variance of the smaller of the two clusters that have been combined. CL = cluster; species abbreviations as in Table 3.

Cluster Number	Clusters Joined	No. of Species in New Cluster	Semi-partial R-squared	R-squared
5	LI & OR	2	0.137037	0.862963
4	GL & KO	2	0.139352	0.723611
3	CL5 & NY	3	0.187037	0.536574
2	AM & CL3	4	0.241435	0.295139
1	CL2 & CL4	6	0.295139	0.000000

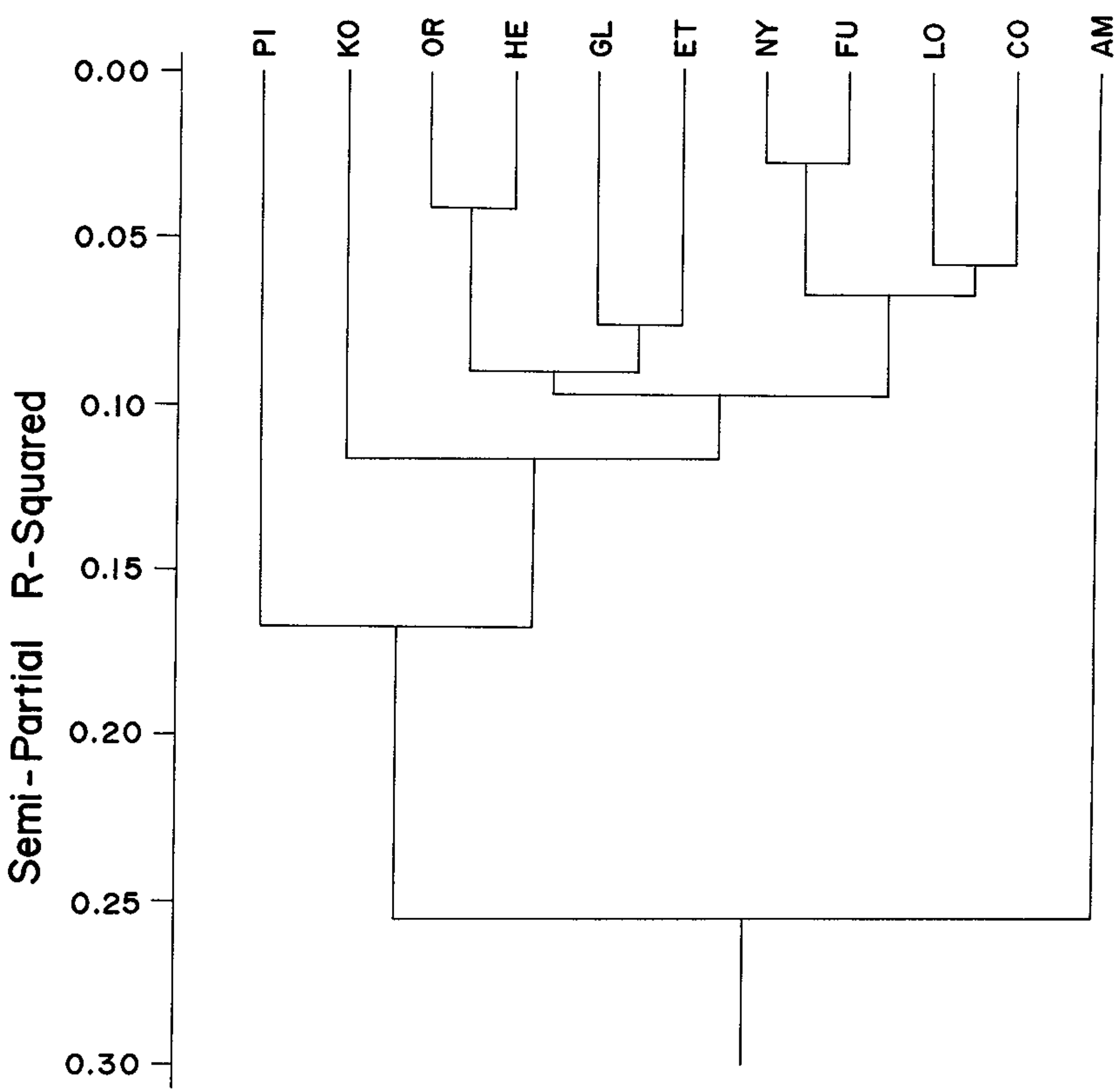

Figure 1. Phenogram indicating phenetic similarity of 11 species of fully-winged males of North American species of *Chionaspis*. The semi-partial R-squared is the variance of the smaller of the two clusters that have been combined. Species abbreviations as in Table 1.

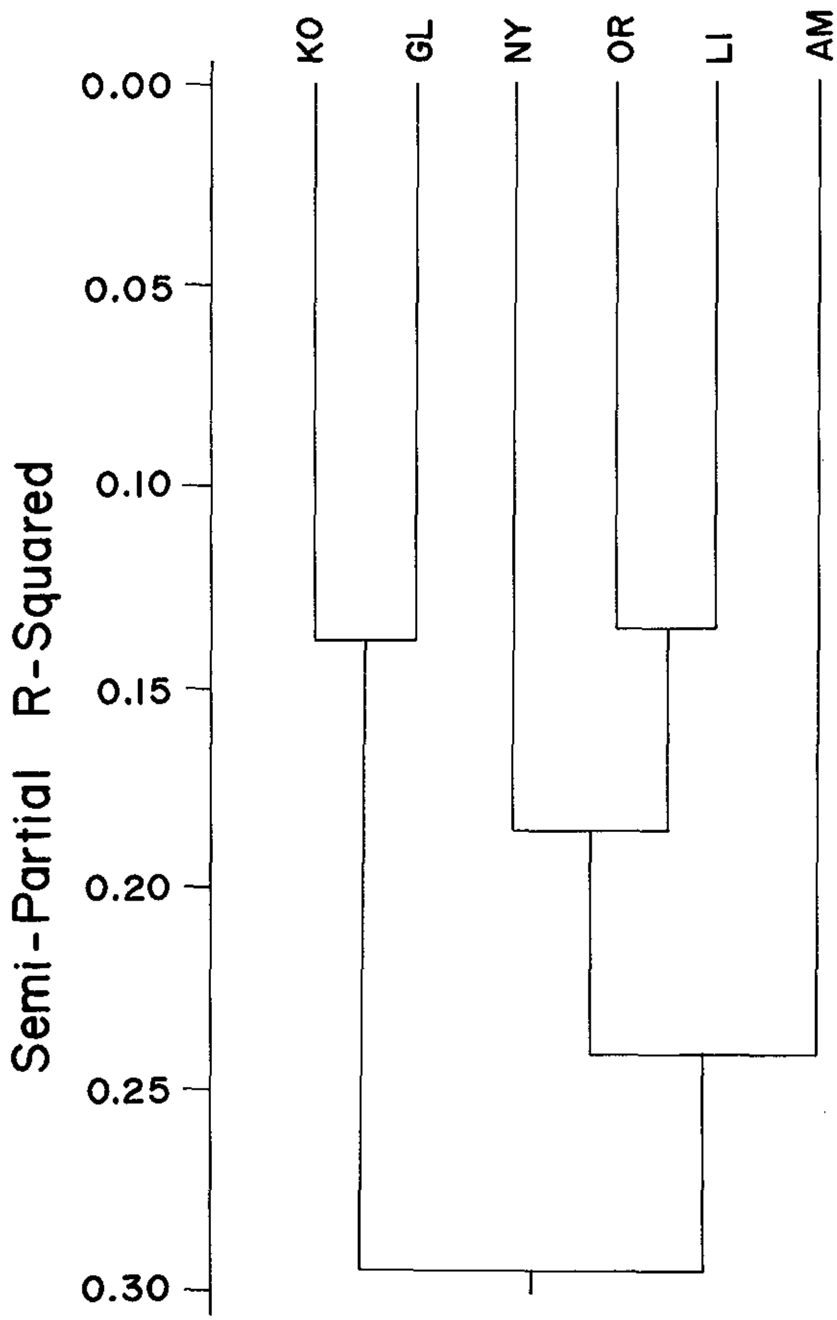

Figure 2. Phenogram indicating phenetic similarity of six species of reduced-wing (brachypterous/apterous) males of North American species of *Chionaspis*. The semi-partial R-squared is the variance of the smaller of the two clusters that have been combined. Species abbreviations as in Table 3.

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