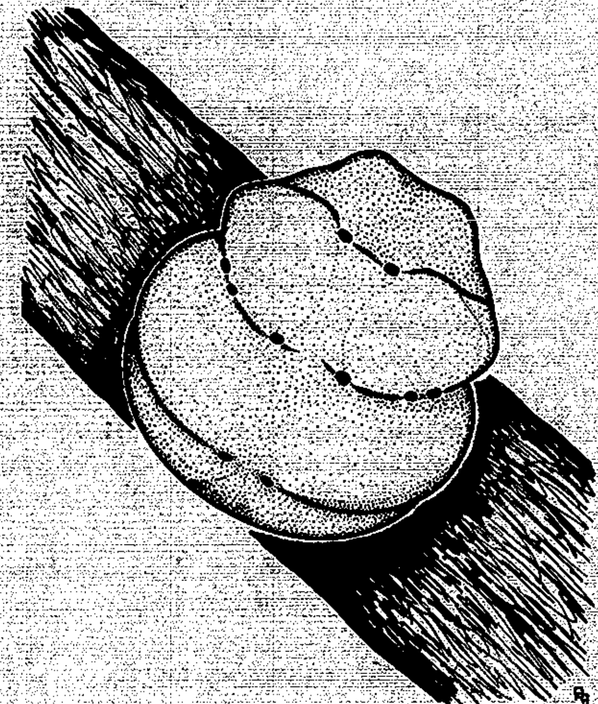
REPRINT

128463

Studies on the

Morphology and Systematics of Scale Insects—No. 12

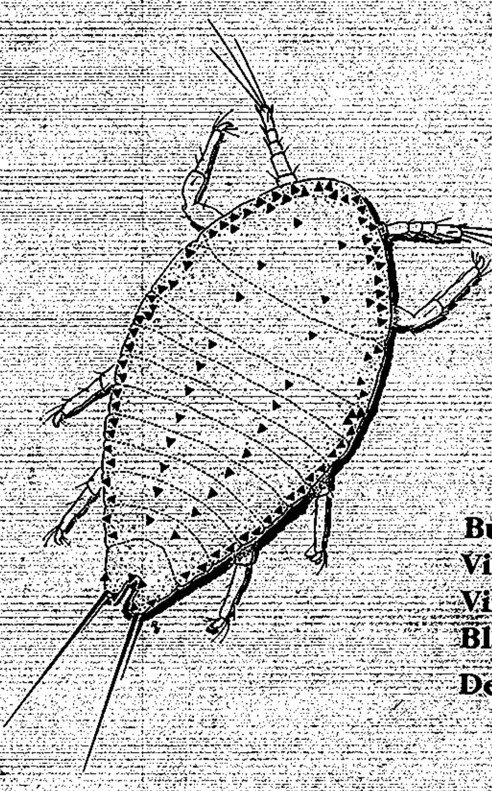


- **Revision of the Family Kermesidae (Homoptera) in the Nearctic Region Based on Adult and Third Instar Females**

Stephen W. Bullington and Michael Kosztarab

- **A Morphological and Systematic Study of the First and Second Instars of the Family Kermesidae in the Nearctic Region (Homoptera: Coccoidea)**

Ronald G. Baer and Michael Kosztarab



Contribution No. 1 to the National Biological Survey

Bulletin 85-11
Virginia Agricultural Experiment Station
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061
December 1985

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

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. 1

to a

NATIONAL BIOLOGICAL SURVEY

Studies on the

Morphology and Systematics of

Scale Insects - No. 12

I. REVISION OF THE FAMILY KERMESIDAE (HOMOPTERA) IN THE NEARCTIC REGION BASED ON ADULT AND THIRD INSTAR FEMALES

by

Stephen W. Bullington and Michael Kosztarab

II. A MORPHOLOGICAL AND SYSTEMATIC STUDY OF THE FIRST AND SECOND INSTARS OF THE FAMILY KERMESIDAE IN THE NEARCTIC REGION (HOMOPTERA:COCCOIDEA)

by

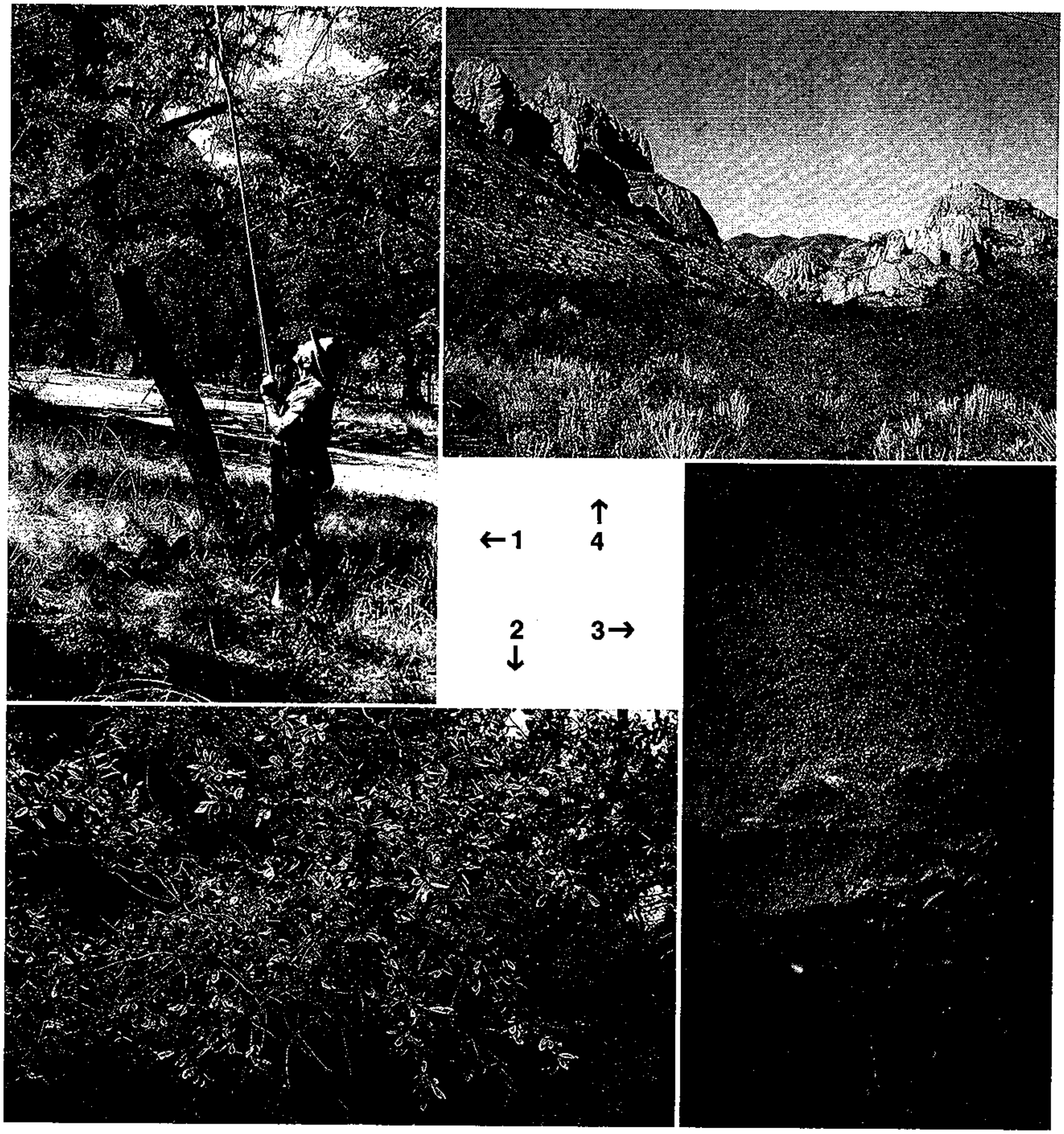
Ronald G. Baer and Michael Kosztarab

Agricultural Experiment Station Bulletin No. 85-11
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

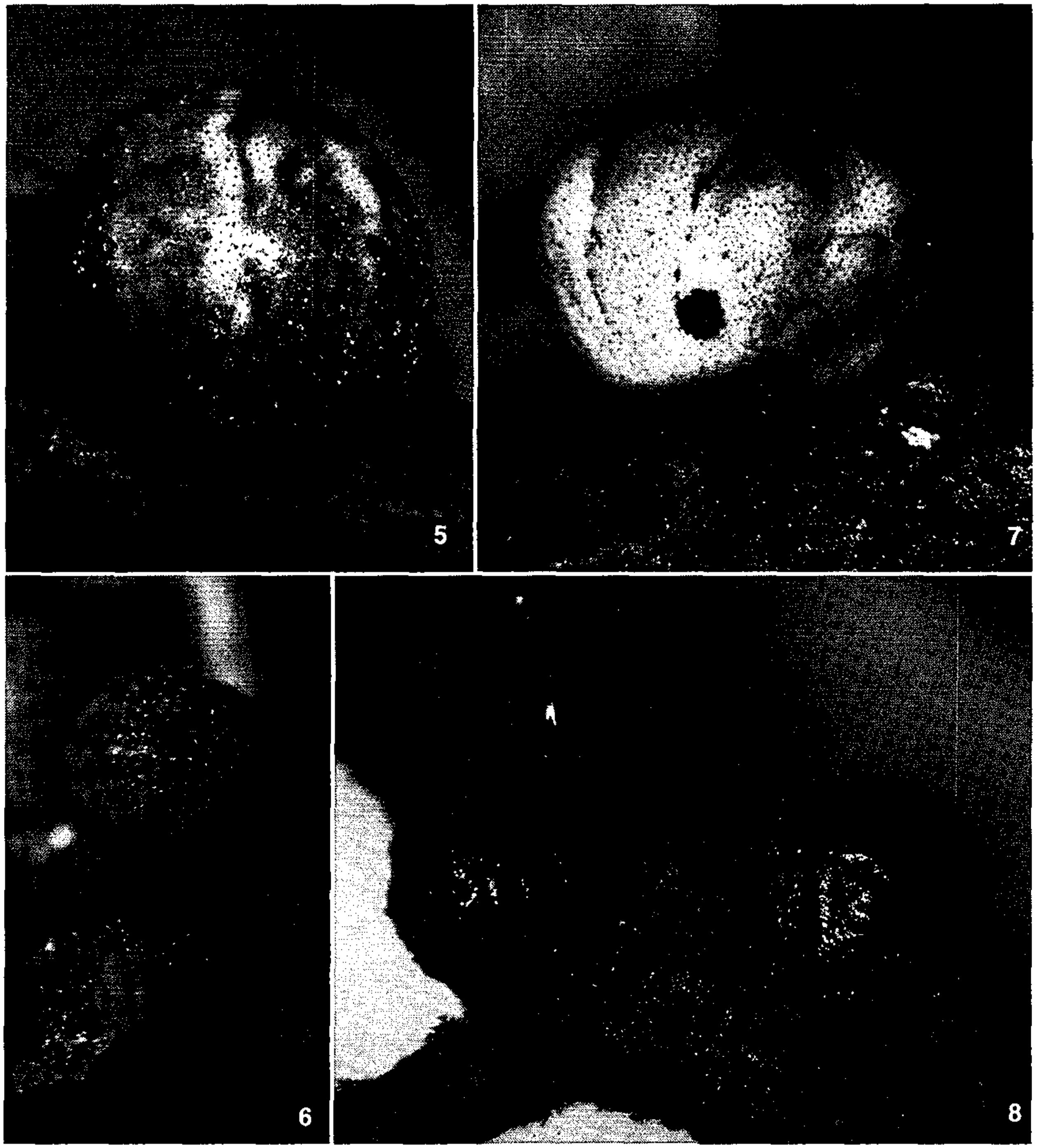
1985

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.

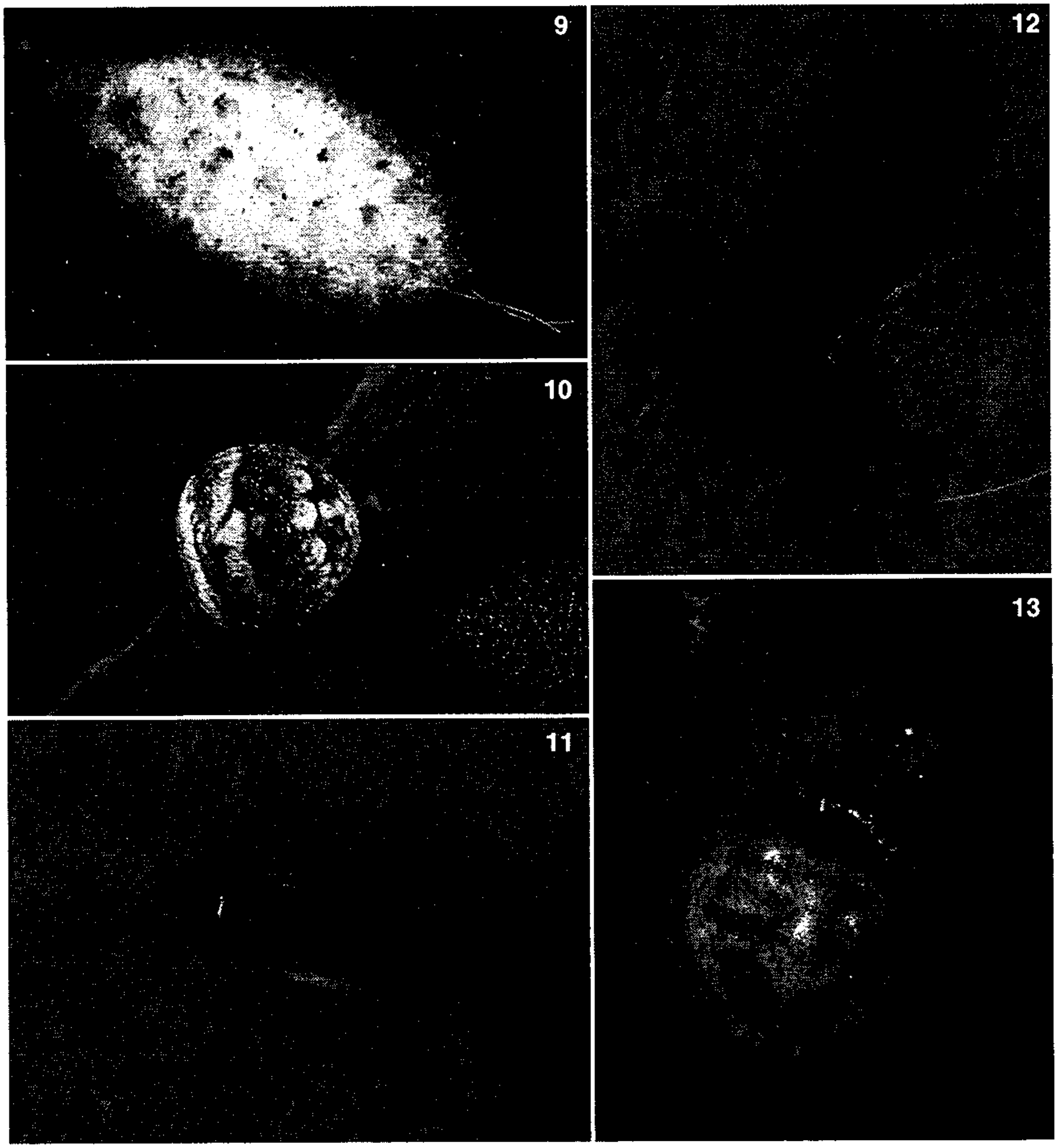
COMPOSITION AND PRESSWORK BY
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
BLACKSBURG, VIRGINIA



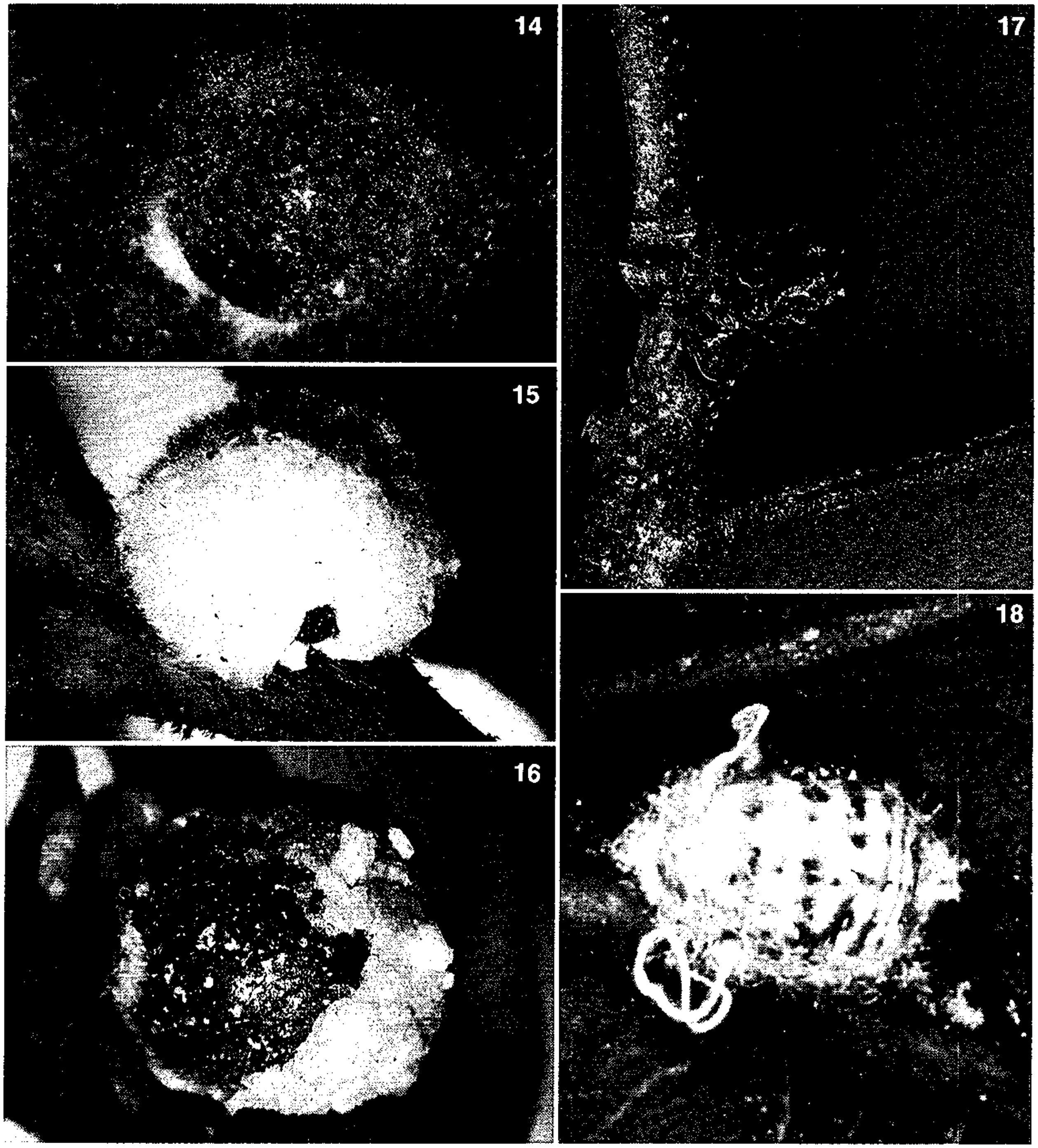
Color figs.: 1. Collecting *Olliffiella cristicola* Cockerell leaf galls in Arizona by using an extension tree trimmer (Photo B. Roth). - 2. *Allokermes cueroensis* (Cockerell) causing flagging and die-back on live oak in Florida (Photo A. B. Hamon). - 3. *Allokermes kingi* (Cockerell) first instars migrating to tree trunk (Photo A. B. Hamon). - 4. A typical scrub oak habitat in Southwest United States where the largest number of Kermesidae species are found (Photo M. Kosztarab).



Color figs.: 5. *Allokermes branigani* (King) postreproductive female (Photo R. J. Gill). - 6. *Allokermes cueroensis* (Cockerell) postreproductive female (Photo R. J. Gill). - 7. *Allokermes essigi* (King) postreproductive female (Photo R. J. Gill). - 8. *Allokermes essigi* (King) young adult females tended by ant (Photo R. J. Gill).



Color figs.: 9. *Allokermes essigi* (King) male test (Photo R. J. Gill). - 10. *Allokermes kingi* (Cockerell) postreproductive female (Photo J. O. Howell). - 11.&12. *Allokermes kingi* (Cockerell) adult male, dorsal and lateral views (Photos A. B. Hamon). - 13. *Kermes rimarum* Ferris postreproductive females (Photo R. J. Gill).



Color figs.: 14. *Kermes shastensis* Ehrhorn female beginning wax formation. - 15.&16. *Kermes shastensis* Ehrhorn postreproductive females, one with completed layer of wax secretion, other with wax layer partly removed (Photos R. J. Gill). - 17. *Kermes sylvestris* (Cockerell & King) postreproductive female (Photo R. G. Baer). - 18. *Nanokermes pubescens* (Bogue) female forming wax tubes from pores in the anterior spiracular furrows (Photo D. Hilburn).

REVISION OF THE FAMILY KERMESIDAE (HOMOPTERA) IN THE NEARCTIC REGION BASED ON ADULT AND THIRD INSTAR FEMALES*

by

Stephen W. Bullington**
Graduate Research Assistant

and

Michael Kosztarab
Professor of Systematic Entomology

Department of Entomology
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

*This research was supported by the National Science Foundation (Grant DEB 76-09676; also BSR-8415644) and the Agricultural Experiment Station, Virginia Polytechnic Institute and State University (Project No. 3239131).

**Now doctoral candidate in Entomology Section, University of Wyoming, Laramie, Wyoming 82071.

CONTENTS

ABSTRACT

The family Kermesidae in North America is revised for the first time, based on slide-mounted, newly-molted young adult females. Fifteen species are redescribed, four are synonymized, and four are described as new. A literature review is given for these and 14 other species for which slide-mounted specimens were not available. Two new genera, *Allokermes* and *Nanokermes*, are proposed and described, and with the genera *Kermes* and *Olliffiella* are placed in the family Kermesidae. The third instar of one species in each genus is described and illustrated. Keys are given to the genera, based on both third instar females and newly-molted adult females, and to the species in each genus. Known host plants and geographical distribution records are listed for each species. The brood chamber of *Allokermes rattani* Ehrhorn is described and illustrated, and the mechanism for the escape of the first instars from the brood chamber is illustrated. Using Hennig's (1965) method, the phylogenetic inter-relationships among the genera are determined.

ACKNOWLEDGMENTS

The authors wish to extend appreciation to Dr. James McD. Grayson, former head of the Department of Entomology at this university, for providing assistance for this study, and to Drs. Robert L. Pienkowski and E. Craig Turner, Jr., for their critical evaluations of the first draft of this manuscript.

The authors are also indebted to the following persons for providing specimens for study and other useful assistance: Dr. John W. Beardsley, University of Hawaii; Mr. Raymond J. Gill, California Department of Agriculture; Dr. Avas B. Hamon, Florida Department of Agriculture; Dr. Douglass R. Miller, United States Department of Agriculture, Systematic Entomology Laboratory; Dr. Richard L. Penrose, Oregon Department of Agriculture; and Mr. Blane Zirilli, Extension Agent, Fairfax County, Virginia. Other persons and institutions providing specimens are listed in the Abbreviations. Ants associated with Kermesidae in North America were determined by Dr. Roy R. Snelling, Los Angeles County Museum of Natural History.

Our thanks are also extended to Dr. Frank Louis Carle, Mr. Walter I. Knausenberger, and Ms. Mary Rhoades for numerous helpful discussions, advice and counsel, and the latter for extensive help with the preparation of the final copy of this publication.

Finally, the authors wish to express their appreciation to Ms. Catherine Habegger for retyping of the final manuscript, and to Ms. Mary C. Holliman for editing of this publication.

Financial assistance for this research was provided to the authors by the National Science Foundation (Grant DEB-7609676; also BSR-8415644) and the Virginia Agricultural Experiment Station (Project 2024390).

INTRODUCTION

Boitard (1828) proposed the genus *Kermes* for some scale insects resembling galls. Although coccidologists have argued over the name *Kermes*, none of them has challenged the group's generic status. Taxonomic work on the genus *Kermes* has been neglected because of the short time when processable specimens are available each year and because the specimens are difficult to mount on slides.

When the early workers, listed below, collected *Kermes*, they collected only post-reproductive females. To an average collector, these sclerotized females may seem to be a part of the plant on which they are found, for their globular bodies are still on the branches and twigs in mid-winter, presumably four to five months after they died. The old females are especially conspicuous after leaf fall.

Riley (1881) described the first species in the genus from North America, *Kermes galliformis*. By 1914, 27 of the 31 North American species of *Kermes* had been described in 23 papers. All early descriptions were based on the external characters of the post-reproductive female: size, shape, and color pattern. King (1900b) presented morphological synopses for 15 species of *Kermes*, and Cockerell (1900) prepared a key to 13 species.

Post-reproductive female *Kermes* are too sclerotized to require liquid preservatives, too brittle to be placed on pins, and too large to be glued to paper points. Therefore, from 1881 to about 1920, workers stored their specimens in pill boxes or envelopes, to be studied under a dissecting microscope or with a hand lens. The collection at the United States National Museum is a legacy from this period, comprising over 500 pill boxes.

The size, shape, and color pattern of post-reproductive females may vary considerably within the same *Kermes* species. Specimens collected from the same tree on the same day may be from one-half to one-third the size of others; spherical, wedge-shaped, or asymmetrical; and pale, dark, patterned, or unmarked. Some of this variation is correlated with the varied habitat of the adult females, which, although restricted to oak and chinquapin, may be found on leaf surfaces, on branches, in forks between twigs and buds, in wounds, or in the bark of the trunk.

The heavily sclerotized cuticle allows the post-reproductive female to withstand weather fluctuations. A specimen collected in November appears different from a specimen of the same species collected in June: in five months water and sunlight have effaced the original color and texture of the cuticle.

King, Cockerell, and Ehrhorn probably realized that descriptions based on the post-reproductive female's color pattern, size, and shape could not be depended upon to separate the species of *Kermes* and, as an addendum to many of their descriptions in later papers, each described the post-reproductive females' color changes when placed in a solution of potassium hydroxide (KOH).

Ferris (1920) was the first worker to actually include statements in his publication to the effect that (1) new morphological characters were needed to differentiate the species of *Kermes*, (2) these new characters were only to be found on slide-mounted specimens, and (3) mounting the old, post-reproductive females of *Kermes* on slides would yield unsatisfactory specimens. A post-reproductive female's cuticle will not clear when soaked in KOH. It will absorb the stain intended for the pores and setae when placed in staining solution, and will result in a slide mount too thick to be studied at the required magnification (ca. 2000 X).

Ferris (1920) used newly collected topotype specimens to redescribe *Kermes cockerelli* Ehrhorn from slide-mounted specimens using microscopic characters. He illustrated the first, second, and third instar females, all of which, since they have unsclerotized cuticles, can be made into slide-mounts with only the pores, setae, and other specialized cuticular structures stained. Ferris mistook the third instar female for the newly molted adult female, which also has an unsclerotized cuticle, as in the case of *Olliffiella secunda* Ferris.

The newly-molted adult female *Kermes* may be as small as 3 mm in diameter--small in comparison to the 10 mm in diameter post-reproductive females. Collecting these females is possible for only a few weeks each year. Often workers did not recognize the newly-molted adult females as *Kermes*. For example, Cockerell (1898b), based on external characters, described a shriveled, newly-molted adult female *Kermes* as a *Lecanium*, and in the same year described the post-reproductive females of the same species as *Kermes grandis*. Only four more recent papers deal in detail with the microscopic characters of slide mounted specimens of North American *Kermes*. Ferris (1955b) redescribed in more detail the adult female of *K. cockerelli* and described as new species *K. emoryi* and *K. rimarum*.

McConnell and Davidson (1959) described the slide-mounted adult male, newly-molted adult female, and several preliminary stages of *Kermes pubescens* Bogue. Hamon *et al.* (1976) described all stages, including the newly-molted adult female, of *Kermes kingi* Cockerell using microscopic characters of slide-mounted specimens. Baer (1980) described *K. kosztarabi*, based on first instars, as a new species.

Early descriptions of the Palearctic *Kermes* species were based on the external appearance of the post-reproductive females. Later descriptions and redescriptions have for the most part been based on microscopic characters of slide-mounted first instars. One can collect first instars that are excellent for slide mounting when found trapped within dead post-reproductive females. These first instars, which are not distended due to feeding and growth, are often present in large numbers.

Based on microscopic characters of slide-mounted first instars, Kuwana (1931) revised the Japanese *Kermes* and Balachowsky (1953) revised the European and Mediterranean *Kermes*. Both Kuwana and Balachowsky, although they considered the post-reproductive females only as a means to secure trapped first instars, did provide keys to the species based on external characters of the post-reproductive females.

Borchsenius (1960) prepared the most comprehensive treatment of *Kermes* to date. In his book, he included a key to all the USSR species based on the external characters of post-reproductive females as well as, for some of these species, descriptions of the microscopic characters of slide-mounted first instars, adult males, and newly-molted adult females. Sternlicht (1969), when describing the Mediterranean species *Kermes bytinskii*, illustrated the microscopic characters of newly-molted and slide-mounted adult females. In 1972 he illustrated the microscopic characters for both third instar females and newly-molted adult females of *Kermes williamsi* from Britain. Baer and Kosztarab (1985), following Kuwana's and Balachowsky's example, studied the morphology of first and second instars of the Nearctic species.

Our study is the first revision of North American Kermesidae based on the microscopic characters of newly-molted adult females. We have redescribed 14 North American species, and describe four as new. New synonymy was established for: (1) *Kermes emoryi* Ferris; (2) *K. waldeni* King; both (1) and (2) as synonyms of *Allokermes galliformis* (Riley); (3) *Lecanium tubuliferum* Cockerell, as synonym of *Allokermes grandis* (Cockerell); and (4) *K. andrei* King as synonym of *K. sylvestris* Cockerell and King. A number of misidentifications that resulted in erroneous literature records were corrected.

We have provided notes for 14 other species for which no specimens from type localities were available for study. We propose two new genera. In addition, we have described and illustrated third instar females of one species in each of the new genera, as well as in *Kermes* Boitard and *Olliffiella* Cockerell. The latter two genera are not closely related. We have included all four genera in the subfamily Kermesinae, tribe Kermesini. The microscopic characters of newly-molted adult females in *Olliffiella cristicola* Cockerell have also been redescribed and illustrated.

During the course of this study we found that the microscopic morphological characters of slide-mounted pre-reproductive adult females of any given species of Kermesidae vary with the stage of maturation of the specimen. So extensive are the changes accompanying maturation that, if one had before him a newly-molted adult female and a gravid female, and no intermediate stages, the person would be inclined to recognize two different species. Some macroscopic changes indicating maturation of a representative kermesid species, *Allokermes kingi* (Cockerell) have been described. We hope this description will enable users of this study to choose specimens of a similar age as those we have illustrated. The brood chamber of *Allokermes rattani* (Ehrhorn) is also illustrated.

Kermesid-associated organisms such as ants, parasites, and predators were collected and preserved, and most were identified to species with the help of specialists. Separate publications will present conclusions made on such associations.

MATERIALS AND METHODS

Collecting (Color fig. 1). Adult females and third instar females (kermesids) are sessile, and are restricted to oaks (*Quercus* spp.) and chinquapins (*Chrysolepis* spp.). Newly-molted adult females may be collected from May to August, although material suitable for making slide mounts may be collected for only a few weeks in any locality. Adult and third instar females, usually found on new twigs, are occasionally found on old growth twigs or in crevices in the trunk. In several species these are found on the upper surfaces of leaves or petioles. Females of *Olliffiella* are found in leaf galls.

The third instar females and newly-molted adult females may be hard to see on twigs and branches. A successful collecting technique has been to clip twigs bearing post-reproductive females from the previous season, place them in a plastic bag, and examine them later with a 20 X magnifying lens. Third instar females will relax their grip on a twig if dampened with 70% ethyl alcohol (EtOH). They can then be pried off the twig more easily and with less risk of damage.

Field preservation. Specimens should be collected in 70% EtOH (preferably hot) and left there for at least 24 hours prior to mounting. They can be left in EtOH indefinitely.

Permanent preservation. To identify a specimen, one must usually examine it as a slide-mount at magnifications up to 2000 X. A phase contrast microscope is preferable, as its mechanism heightens the contrast between the specimen's cuticular structures and the remainder of its body contents. To prepare a specimen for study, one must pass it through a series of reagents to separate, clean, and preserve its cuticle and concurrently stain the pores, ducts, setae, and other cuticular structures. Third instar females and newly-molted adult females make the best mounts. Specimens were mounted as follows (in sequence):

1. placed in 10% KOH at room temperature for 1 or 2 days
2. pierced with a sharp pin and flattened with a spatula
3. transferred to 70% EtOH for 10 to 15 minutes
4. transferred to tetrahydrofuran for 10 to 15 minutes
5. transferred to Essig's Aphid Fluid (to which 3 drops of double stain were added) and heated at ca. 77° C for 10 to 15 minutes[1]
6. transferred to 70% EtOH for 10 to 15 minutes
7. transferred to 100% EtOH for 10 to 15 minutes
8. transferred to clove oil for 10 to 15 minutes
9. mounted dorsal side up in Canada Balsam on a microscope slide, and
10. transferred into a drying oven at 40° C and kept for ca. 2 weeks.

Use of coverslip props is not practical since they make the mount too thick to be observed on oil immersion.

---

[1] For the formula of Essig's Aphid Fluid and double stain, see Wilkey (1962).

Slides with inadequately stained specimens were soaked in xylene until the coverglass could be removed. After being removed from the slide, specimens were placed into 70% EtOH for several minutes, then into 100% EtOH for 10 to 15 minutes, and finally re-stained beginning with step 3 above.

Material. Specimens stored in pill boxes, in alcohol, or mounted on slides were borrowed from the institutions and individuals listed under "**Collections and Collectors.**" All suitable lots were mounted on slides. Slide-mounted lots are listed in two sections, one labeled "**Type material studied**" at the beginning of each description; the other labeled "**Additional material studied**" near the end. In each section, the studied lots are arranged alphabetically by host, locality, collection date, and collector(s). For each entry, the number of slides, number of specimens (in parentheses) and repository are listed after the collector(s). Under "**Type material studied**" are given all the lots from the type locality, including the lot with the neotype, if one was selected. All other materials are included under "**Additional material studied**".

Measurements. Measurements are rounded up to the nearest micron. They were made with an ocular micrometer fitted to a Zeiss RA phase contrast microscope. In each description the measurements of the illustrated specimen come first, then, when possible, the average and range of 10 specimens randomly selected, when available from the type lot.

Illustrations. Each plate has a central body outline of the whole slide-mounted specimen. These central drawings are not in proportion from plate to plate because enlarging them to fill the entire space allows a more detailed indication of the distribution of their dermal structures. Actual specimen sizes are given in the text. The left half of the drawing represents the dorsal surface; the right half, the ventral surface.

Although the dermal structures were drawn as small as practical, they are drawn on a larger scale than the body outline--otherwise they would have been visible only in aggregates. This larger scale of the pores and setae relative to the body outline makes them appear crowded. The sterna, already crowded with pores and setae in the adult female, are small compared to the body outline. Drawing the pores and setae of the sterna would have resulted in an incomprehensible mass of detail. Therefore, we have indicated only the sternal margins on the drawings, leaving out the details. Each dermal enlargement in the drawing's upper left or lower right corner represents the pore, duct, and setal distribution within a circle 24.8 mm in area. Around the central outline and dermal enlargements, we have enlarged representative pores and setae to 433 X; eyes, antennae, anal rings, and anal setal patterns to 273 X, allowing direct size comparisons between enlargments of the same magnification on different plates.

Because the central outline's shape is correlated with the size, shape, distribution, and density of the structures within it, we drew each plate illustration from only one individual. As there is no perfect slide mount, each drawing is somewhat stylized. We selected all the individuals that were illustrated to be at about the same stage of maturation by noting the degree that their false venters were developed.

Because the sterna are crowded with pores and setae, pouched, folded, and convoluted in the newly-molted females, comparisons between the sterna of newly-molted adults of different species are difficult. The sterna are similar within each genus. Therefore, we illustrated the sterna for only the first named species in each genus. The sternal illustrations are on a separate plate at a larger magnification than the tergal illustrations. The sternal enlargements are scaled as in the other drawings.

Literature citations. There are comprehensive literature citations and short reviews in three different sections. Under "**Synonymy**" are citations for the original description, also for any other combination of generic and specific names, and for known misidentifications. Latter citations consist of the name, the author(s), the date, and the page number, and are listed chronologically. Under "**Questionable identifications in literature**" are included citations in which a name appeared in conjunction with a host, locality, date, or collector other than that of the type lot. The latter citations are considered unreliable because of kermesids' extreme plasticity of body shape and the lack of reliable taxonomic characters used by the early investigators who studied and described unmounted post-reproductive females. These citations are listed alphabetically by host, then by locality. Under "**Other literature citations**" are included all other citations where only the name was mentioned . These are listed by author, then date.

Indices. Indices to scale insect taxa and host plants appear at the end of the second article. Authors of scientific names for plants are given only in the index to host plants.

ABBREVIATIONS

Collections and Collectors[2]
(Names of curators appear in parentheses).

ABH A. B. Hamon
ACAH Arizona Commission of Agriculture and Horticulture; Phoenix (J.E. May)
AFS A.F. Satterwait
AHH A. H. Hollinger
AK A. Koebele
ALQ A. L. Quaintance
AMNH American Museum of Natural History, New York, NY (R.T. Schuh)
AU Auburn University; Auburn (M. L. Williams)
BHW B. H. Walden

---

[2] Collectors who have collected three or more lots of material.

CAES	Connecticut Agricultural Experimental Station; New Haven (M. McClure)
CAS	California Academy of Sciences; San Francisco (D. C. Rentz)
CDA	California Department of Agriculture; Sacramento (R. J. Gill)
CGW	C. G. Williams
CHR	C. H. Ray
CKH	C. K. Hickman
CPG	C. P. Gillette
CSU	Colorado State University; Fort Collins (H.E. Evans)
DRM	D. R. Miller
DSIR	Department of Scientific and Industrial Research; Nelson, New Zealand (J. M. Hoy and C. Butcher)
EEB	E. E. Bogue
EJB	E. J. Branigan
EME	E. M. Ehrhorn
EOE	E. O. Essig
ERS	E. R. Sasscer
FDA	Florida Department of Agriculture; Gainesville (A. B. Hamon)
FLC	F. L. Carle
FMS	F. M. Schott
FMT	F. M. Trimble
GAD	G. A. Dean
GBK	G. B. King
GF	G. Frankie
GFF	G. F. Ferris
HFD	H. F. Dietz
HM	H. Morrison
IAE	Institute of Agricultural Entomology; Protici, Italy (E. Tremblay and A. Tranfaglia)
IZ	Institute of Zoology of USSR; Leningrad (E.M. Danzig)
JBN	J. B. Norton
JF	J. Fletcher
JGS	J. G. Sanders
JK	J. Kotinsky
JMA	J. M. Amos
JOH	J. O. Howell
JSH	J. S. Houser
JWB	Collection of John W. Beardsley; Honolulu, HI
KSU	Kansas State University; Manhattan (H.D. Blocker)
LC	L. Childs
LH	L. Hanning
LPW	L. P. Wehrle
LRH	L. R. Hanning
MK	M. Kosztarab
MLW	M. L. Williams
MMK	M. and M. Kosztarab
NMSU	New Mexico State University; Las Cruces (W. A. Iselin and J. and J. Zimmerman)
NWC	N. W. Capron
OEB	O. E. Bremner

OHSU	Ohio State University; Columbus (C. Triplehorn)
ORSU	Oregon State University; Corvallis (J.D. Lattin)
PANS	Philadelphia Academy of Natural Sciences, PA (W. W. Moss)
QLS	Q. S. Lowry
RB	R. Beshear
RFW	R. F. Wilkey Collection, Arthropod Slide Mounting Service; Bluffton, IN
RGB	R. G. Baer
RJG	R. J. Gill
RLP	R. L. Penrose
RWD	R. W. Doane
SEM	Snow Entomological Museum, University of Kansas; Lawrence (G. W. Byers)
SWB	S. W. Bullington
SWRS	Southwest Research Station; Portal, AZ (V. Roth and R. Morse)
TDAC	T. D. A. Cockerell
UCD	University of California, Davis (R. O. Schuster)
UMN	University of Minnesota, St. Paul (P. J. Clausen)
USNM	United States National Museum (Natural History); Washington, DC and Beltsville, MD (D. R. Miller).
VPI	Virginia Polytechnic Institute and State University; Blacksburg (M. Kosztarab).
WAI	W. A. Iselin
WJB	W. J. Baerg

In cases where the abbreviated collector(s) name in the **"Material studied"** sections appears in parentheses, proper identification could not be established.

States. Names for states and countries in the species descriptions are capitalized and in boldface type.

AL	Alabama
AR	Arkansas
AZ	Arizona
CA	California
CO	Colorado
CT	Connecticut
DC	District of Columbia
DE	Delaware
FL	Florida
GA	Georgia
HI	Hawaii
IA	Iowa
IL	Illinois
IN	Indiana
KS	Kansas
LA	Louisiana
MA	Massachusetts
MD	Maryland
MI	Michigan
MN	Minnesota
MO	Missouri
MS	Mississippi
NC	North Carolina
NH	New Hampshire
NJ	New Jersey
NM	New Mexico
NY	New York
OH	Ohio
OK	Oklahoma
OR	Oregon
PA	Pennsylvania
RI	Rhode Island
SC	South Carolina
TN	Tennessee
TX	Texas
VA	Virginia
WI	Wisconsin

Other Abbreviations

B+Z	Biology and Zoology	mi.	miles
C	Centigrade or Celsius	mm	millimeters
ca.	about	Mt.(s).	Mount or Mountain(s)
Ckll.	Cockerell	N	North
Co.	County	Natl.	National
coll.(s).	collector(s)	NE	northeast
Cr.	Creek	no.	number
dia.	diameter	Pk.	Park
E	East	Rd.	Road
elev.	elevation	ref.	reference
fig.(s).	figure(s)	Rt.	Route
fr.	from	S	South
Ft.	Fort	St.	Saint
Hosp.	Hospital	Str.	Street
Hwy.	Highway	Univ.	University
KOH	Potassium hydroxide	W	West
let.	letter	Zool.	Zoological

NOTES ON SYSTEMATICS, BIOLOGY, DISTRIBUTION AND ECONOMIC IMPORTANCE OF KERMESIDAE

Family Kermesidae Signoret, 1875. Kermesites (Signoret, 1875) was considered the first family-group name (Williams, 1969). This designation was based on the genus *Kermes* Boitard (1828). Since the original designation of the family, the genus *Kermes* has been placed in various families including the Coccidae (Maskell, 1894; Cockerell, 1896b, 1899a,b; Fernald, 1903), the Kermidae (Ferris, 1937), the Lecanidae (Balachoswky, 1948, 1950a,b), the Dactylopiidae (Ferris, 1955b) and the Kermococcidae (Borchsenius, 1960).

Lobdell (1929) first designated the name Kermesidae in place of the Eriococcidae based on the Law of Priority citation with the type-genera. However, the name Kermesidae was never accepted as a replacement for the Eriococcidae. Williams (1969) stated that the family name should be Kermesidae based on the type-genus *Kermes* Boitard. There are now eight genera at least provisionally assigned to this family.

The adult females of the eight genera included in the Kermesidae have their derm highly sclerotized, unlike those in the closely related family Eriococcidae which usually have an unsclerotized derm.

First and second instars reveal distinct morphological characters which correspond to the grouping through pre-reproductive female morphology into eight genera. However, some of the North American kermesids can be separated only through the first instars while others can be separated only through adult females. Beardsley (1983), based on a comparison of the morphology of the adult males, believes that the family Kermesidae is not closely related to the Eriococcidae.

The family in the Nearctic Region includes *Allokermes*, new genus; *Kermes* Boitard; *Nanokermes*, new genus; and *Olliffiella* Cockerell. Not included are the Palearctic *Fulbrightia* Ferris, *Nidularia* Targioni-Tozzetti, *Physeriococcus* Borchsenius, and the Oriental *Reynvaania* Reyne which seem to fall into groups that may deserve separate tribal or subfamily status.

Etymology. The family was named for the type genus, *Kermes*, the first described in this family.

Economic importance. *Nanokermes pubescens* is responsible for most of the reported damage in North America. Garman (1905) found it on burr oak (*Quercus macrocarpa*) in Kentucky and believed this scale insect caused twig die-back. Baerg (1955) noted that in Arkansas post oak (*Q. stellata*) terminals infested with 90 or more of these scale insects were shed. McConnell and Davidson (1959) reported heavy *N. pubescens* infestations with both "flagging," or the death and browning of terminal leaves, and leaf distortion. Some of the damage attributed to *N. pubescens* might have been caused, at least in part, by *N. folium* n. sp., not recognized as a separate species by earlier workers.

Hamon *et al.* (1976) observed *Allokermes kingi* causing flagging of both red oak (*Q. borealis*) and black oak (*Q. velutina*) in Virginia. Flagging occurred in some cases even when only a single *A. kingi* female was present at the base of a leaf petiole. Hamon (personal communication) observed *A. cueroensis* causing flagging and die-back of live oak (*Q. virginiana*) in Florida (Color fig. 2). In Hungary, Kozar (1974) reported *Kermes quercus* damaging forest trees.

Genus Allokermes Bullington and Kosztarab, 1985. The genus was separated from *Kermes* on the basis of the slide-mounted pre-reproductive females. Type-species: *Kermes galliformis* Riley, 1881.

Eleven North American species are included in this genus at present.

Hamon *et al.* (1976) studied the biology of the Nearctic species, *Allokermes kingi*, found on red and black oaks in Virginia. Each female deposits an average of 2820 eggs on trees during late July and early August. The eggs hatch between September and November. The first instars migrate and overwinter in crevices on the limbs and trunk (Color fig. 3). They molt in April of the following year. Second instar males may migrate to a lower area of the trunk or to debris under the tree where they transform into prepupae, pupae, and adult males. The second instar females migrate to the new growth and usually settle at the base of the leaf petioles. They molt into third instars in early June. The latter transform into adults in mid-June. After mating, the females develop into highly sclerotized, gall-like individuals. The shape of the females is correlated with habitat: usually spherical on a twig, wedge-shaped when between a twig and a bud, or asymmetrical when in a cluster of buds. Color varies from patterned to uniform and from light tan to dark brown. Size may vary between 5-7 mm in diameter and 4-6 mm in height.

Genus Fulbrightia Ferris, 1950. Ferris (1950) stated that the monotypic genus *Fulbrightia* does not resemble *Olliffiella*, although both have gall-making habits. However, he did mention that they both may be derived from *Kermes*. Ferris placed this Palearctic genus in the Eriococcidae and, later, Hoy (1963) confirmed its placement. Type species: *Fulbrightia gallicola* Ferris, 1950.

The biology of the Palearctic species *F. gallicola* was discussed by Ferris (1950). He assumed that the first or second instar female settled near a bud on the twig. While developing, it causes distortion of the entire twig. All lateral twigs beyond the point of infestation are dwarfed. The leaves are reduced in size and each twig with its leaves forms a short cone. The female becomes buried among the swollen bases of several of these short cones.

Genus Kermes Boitard, 1828. Latreille (1798) suggested the name "Kermes" as a common or group name in the Coccoidea, but Boitard (1828) first designated *Kermes* as a generic name for some scale insects resembling galls. Some of the synonyms for the genus *Kermes* include *Kermococcus* Silvestri (1911) and *Talla* von Heyden 1860 (Lindinger, 1933). Although workers have argued over the name *Kermes*, the group's generic status has never been challenged. Type-species: *Kermes roboris* (Fourcroy, 1785).

Balachowsky (1942, 1948) placed the genus *Kermes* with the eriococcids and the pseudococcids. Ferris (1955b) linked the genus *Kermes* with the eriococcids. The genus *Kermes* is the type-genus of the family Kermesidae. Hoy (1963) listed 59 species in this genus, but a number of these are now synonyms, while others have been assigned to the genera *Allokermes* and *Nanokermes* by us. Kosztarab and Kozar (1985) treated five species of *Kermes* from Central Europe.

The biology of *Kermes quercus* L., a bark-inhabiting Palearcic species, is discussed in detail by Nassonov (1910) and Saakyan-Baranova and Muzafarov (1972). Each female deposits between 120-1,200 eggs during mid-June. The first instars settle in bark crevices near the old females. The nymphs then molt at the end of August. The overwintering stage of both sexes is the second instar. At the beginning of spring, the second instar males migrate to the bark surface where they transform into prepupae, pupae, and adult males. The second instar females remain in the fissures of the bark and molt in the spring. The third instar females molt to become young females in mid-May, at which time mating takes place and the females rapidly increase in size and become globular. Kozar (1974) reported *K. quercus* from Hungary as a pest of young forest trees.

Genus Nanokermes Bullington and Kosztarab, 1985. *Nanokermes* was separated from the genus *Kermes* on the basis of pre-reproductive adult females. Type species: *Kermes pubescens* Bogue, 1898. Three North American species are assigned to this genus at present.

The biology of *Nanokermes pubescens* has been discussed in part by Garman (1905), Houser (1918), McDaniel (1930), Baerg (1955) and McConnell and Davidson (1959). It is apparent to us that the biological information from these sources which is summarized below often included data not only for *pubescens*, but also for *folium* which is often found intermixed with individuals of *pubescens*, and is described as new in this study. Eggs are laid from late June for about a month. From early July first instars exit from under the female and migrate to the trunk and limbs of the host, where they feed and overwinter. Their color changes from lemon yellow at hatching to an orange as winter approaches. They first molt when the leaf buds unfold. Second instar males remain on the trunk or limbs and transform into prepupae, pupae, and adult males under white waxy-felted cocoons. The second instar females migrate to the new growth. They either settle near the bud or on a petiole or midvein on the upper surface of the leaf. They molt to become third instars in mid-May, and to become adults in late May. They become smooth, globular, heavily sclerotized and reddish-brown during the first week of June. Although only ca. 2.5 mm in length, a few adult females feeding on a young leaf petiole or midvein can cause serious distortion due to unequal development of the leaf. If several specimens feed in one area, "flagging" or death of the leaf or twig may result. The tree as a whole apparently is not seriously affected.

Genus Nidularia Targioni-Tozzetti, 1869. Synonym: *Querceticoccus* Lindinger, 1933. Koteja (1980) proved its relationship with *Kermes* based on adult females and first instar nymphs. We agree with his conclusions. Type-species: *Coccus pulvinatus* Planchon, 1864.

The genus *Nidularia* is considered here monotypic, until the status of *N. balachowskii* Bodenheimer is clarified. It is restricted to oaks, and has been reported to date from *Quercus coccifera, Q. ilex, and Q. ithaburensis.* Distribution is circum-Mediterranean, including: Algeria, Portugal, Spain, France, Italy, Israel and Turkey. No records are available on its economic importance.

Genus Olliffiella Cockerell, 1896. Cockerell (1896a) described *O. cristicola* and placed it in the Coccidae. Ferris (1955b) stated that *Olliffiella* is essentially a species of *Kermes* that has adapted a gall-making habit. Ferris (1955b) and Hoy (1963) placed this genus in the Eriococcus group. Type-species: *Olliffiella cristicola* Cockerell, 1896.

Two species were included in the genus *Olliffiella: cristicola* and *secunda.* Both are gall-formers on oaks, the former in the southwestern United States and the latter in Mexico. Hosts of *cristicola: Quercus emoryi,* seldom *Q. hypoleucoides;* of *secunda,* an unknown oak. Observations on the biology of *O. cristicola* are given by Cockerell (1896a), Ferris (1919), and Kosztarab (1982).

The galls, located on the undersurface of the leaf, are 10-12 mm long, 6-8 mm wide at base, compressed laterally to 5-9 mm, and taper into a sharp point. The gall opening is an elongate slit parallel to the midrib on the upper surface of the leaf. Two to four galls may be on a single leaf; occasionally two galls are fused. Dry galls are hard and woody. The female fills the lower or pointed end of the cavity of the gall and lies with its dorsum toward the opening. The overall shape of the female is conical, conforming to the shape of the cavity with a heavily sclerotized, flat, circular dorsum and a membranous or slightly sclerotized venter. It remains questionable how the first instars escape from under the female and through the opening of the gall. Nymphs that were found inside the gall, on the leaves, or near bud regions were used for this study. No information is available on the overwintering stage, on the instar starting the gall, or on the males. *O. cristicola* habitat in Arizona is given in Color figure 4.

Ferris (1955a) stated that the females of *O. secunda* form galls on leaves similar to the galls formed by *O. cristicola*. Ferris' (1955a) *secunda* description was erroneously based on third instar nymphs. Unfortunately, certain developmental stages are lacking for both species in this genus. Further studies are needed to determine if *secunda* is a valid species. The second author attempted to re-collect topotype material for *secunda* in 1978, without success.

Genus Physeriococcus Borchsenius, 1959. Borchsenius (1959) allied this monotypic genus close to the genus *Kermococcus*, a synonym of *Kermes*. Hoy (1963) confirmed its placement in the family. Type-species: *Physeriococcus cellulosus* Borchsenius, 1959.

Borchsenius (1959) and Wang (1982) mentioned very little on the biology of this Palearctic species. Hosts include *Lithocarpus* sp. and *Quercus* sp. The females develop on the branches or near the bud region. The body of the female is globular and the exoskeleton is highly sclerotized, with polygonal and oval clear areas. It is known only from Yunnan Province of China.

Genus Reynvaania Reyne, 1954. This monotypic genus was placed by its describer close to *Fulbrightia* in Eriococcidae. Adult females of *Reynvaania* differ from *Fulbrightia* by the lack of small 8-shaped pores, absence of legs, and presence of two transverse rows of large ("robust") setae just posterior to anal ring. According to Reyne (1954), the first instars show considerable differences in their morphology. Type-species: *Reynvaania gallicola* Reyne, 1954. It is a bud gall producer; restricted to oak, *Quercus lineata* Bl., collected at an altitude of 1000 to 1600 m in Java and Sumatra (Indonesia).

In summary, the biology of very few species in the Kermesidae has been studied in detail. The first instars or "crawlers" provide dispersal for each species. Females develop through three nymphal instars by sucking plant sap and reducing the overall vigor of the tree. Symptoms of damage are distortions of the leaves and petioles, gall formation, and "flagging" or dieback of the terminal leaves and buds. In small trees where "flagging" occurs, chemical control may be needed and the dead twigs must be pruned, sometimes reducing the economic and aesthetic value of the tree.

A REVIEW OF MORPHOLOGICAL CHARACTERISTICS OF THE ADULT FEMALE IN THE FAMILY KERMESIDAE

Kermesidae with the **terga** fused, terga after final molt expanding greatly, concurrently increasing in thickness and sclerotization dorsally, while ventrally growing inward to separate sternum from substrate (Plates 3 B-F, 4 A). Tubular ducts restricted to tergum, eriococcid type, distal bulblike expansion almost spherical and cup within it parallel-sided and deep (Plate 5 D), ducts densely packed in a zone about margins of tergum except in region posterior to vulva, and producing secretions to fasten insect securely to substrate. Disc pores scattered evenly over tergum, resembling highly integrated bilocular disc pores sunk deep within membranous tube, and occasionally, when specimens have been inadequately cleared, with long, filamentous distal extensions projecting inward. Multilocular disc pores abundant between vulva and anus. Setae small, stout, conical to lanceolate, in at least four rows of 12 setae each, paralleling tubular duct band.

Sterna distinct, membranous, deeply invaginated along thoracic sutures, pouched along abdominal margins, and during oviposition becoming invaginated, except for a thin medial partition (Plate 3 H, lateral view; 4 C, cross section) on which the legs are found. The invaginated sternum fills nearly the entire body cavity. When eggs have hatched and first instars have departed, a hollow, gall-like shell (Plates 3 H, 4 C) remains. Antennae reduced, but never absent, indistinctly segmented, positioned anteriolaterally to clypeolabral shield, but within tubular duct zone, having no direct contact with outside and serving no apparent function in this stage. Legs retaining all five segments, sometimes greatly reduced in size or with segmentation indistinct, useless for locomotion. Spiracles unusually large, on prothorax and mesothorax. Quinquelocular and 7-locular disc pores numerous, more on thorax than abdomen; 10-locular disc pores restricted to sternum.

GENERAL MORPHOLOGY

Field Characters of Post-reproductive Female

Plates 1 and 2

Body shape (Plate 1). The body, which is typically ovoid (fig. A), has a shallow to pronounced longitudinal medial depression (fig. B). This depression is sometimes confluent with two or three transverse incisions, giving the insect a multilocular appearance (fig. C). Many females become almost spherical prior to oviposition (fig. D). *Kermes sylvestris* (Ckll. and King) is pyriform (fig. E). If the specimen was taken from a wound in the bark or from a fork between two twigs, it may be either asymmetrical or wedge-shaped.

Position of the anus (Plate 1). The anus and its associated setae, invisible to the naked eye, may be surrounded by a dark spot. Several rows of similar dark spots may converge upon the anal spot (fig. F). The function of the spots, many of which are associated with a dermal pit or invagination, is unknown. Perhaps the pattern that the spots form serves to guide the males during courtship or attendant ants in search of honeydew, much as flower patterns guide bees to nectar.

The anus may be located in one of three positions: about one-third of the insect's height up the posterior derm (fig. B, dark spot), just above the junction of the dorsum with the substrate (fig. E, dark spot), or at the junction of the dorsum with the substrate (fig. A, dark spot).

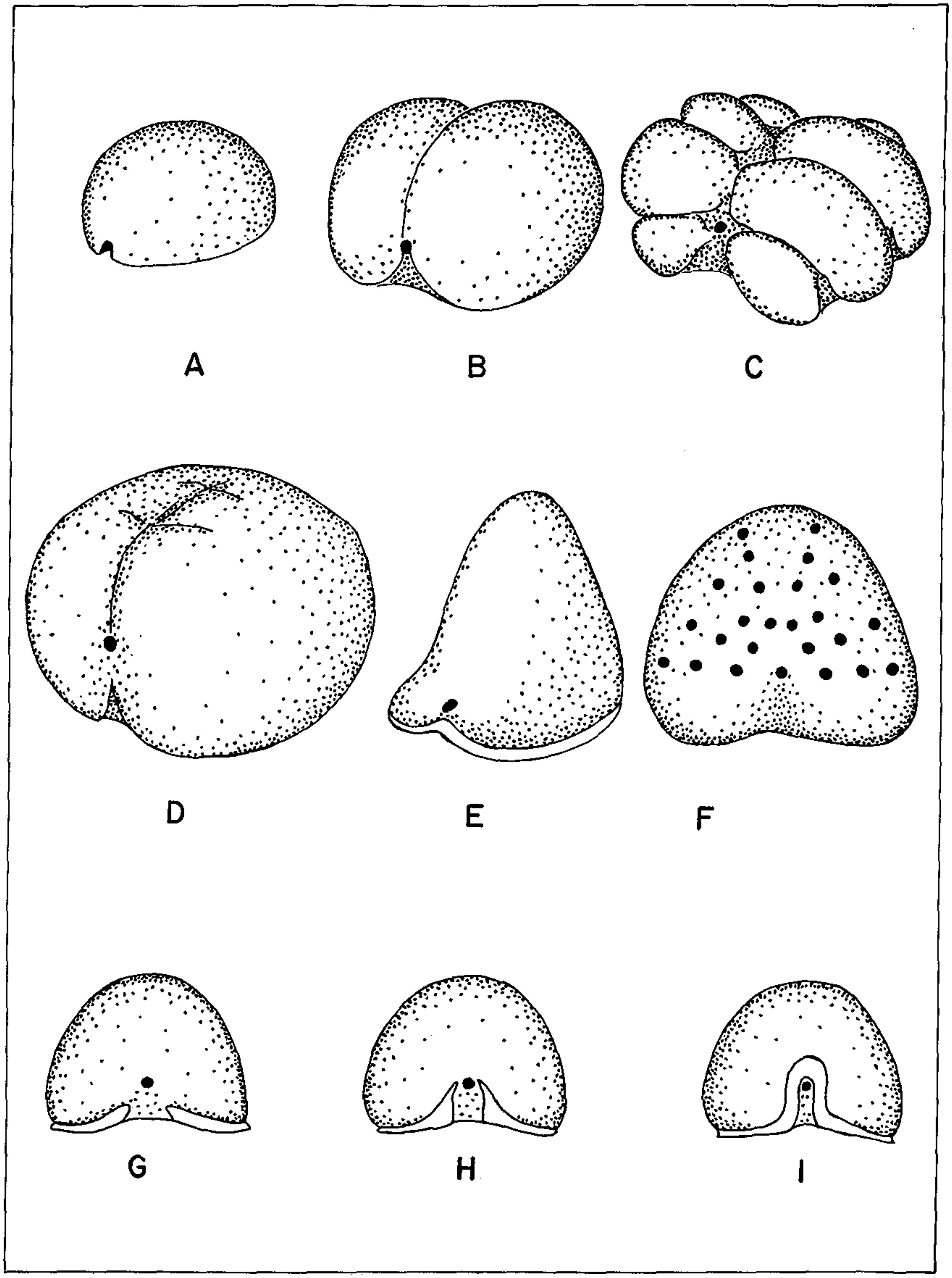


Plate I.- External morphology of the adult female

Body color. Body color varies considerably, from black to dark brown to light tan suffused with yellow. Specimens bleached by the action of the weather may be almost white. In all kermesids the derm is covered with minute black specks, the openings of the simple disc pores. Larger black spots, sometimes found within the transverse incisions, surround openings to the spinescent 8-shaped pores.

Body secretions. Several species of *Kermes* secrete a white or yellowish wax through the multilocular disc pores on their mid-dorsum. A hardened droplet of wax surrounds each pore opening. If these droplets are closely packed, they may coalesce to form a "bloom" that obscures the ground color. In only one species, *Kermes shastensis* Ehrhorn, is enough wax produced to form a test or shell covering the derm (Plate 2, fig. F). In *K. shastensis* young females, the wax appears white, soft, and fluffy and can easily be teased into thin strands with a needle. It is also sticky, especially so if heated, and has a texture similar to the texture of cotton. In *K. shastensis* old females, this wax is consolidated into a hard, brittle shell, possibly as a result of being exposed to sunlight. The wax never solidifies on young specimens that have been brought indoors.

Many species have a waxy strip, produced by multilocular disc pores, sealing the juncture between the dorsum and the substrate. Dorsally, the strip may be well defined or may grade into sparsely distributed wax droplets on the mid-dorsum; posteriorly, it may be incomplete (Plate 1, fig. G), may turn dorsally and end at the anal ring (fig. H), or turn dorsally and extend over the anal ring (fig. I).

In some species an anterior spiracular furrow is present. Its presence is indicated by a band of white wax on each side of the body that is perpendicular to the substrate and that is about one-third the body length back from the anterior end of the body. This wax band is secreted by multilocular disc pores.

A mucous-like wax, present in a wide strip between the ventral tergum and the substrate, is secreted by tubular ducts and probably serves to fasten the insect to the substrate. Several species have another wax type that is produced by a second type of tubular duct. Each of these ducts secretes a strand-like filament of wax (Plate 2, fig. G). These filaments, which stand upright, resemble pubescence when viewed *en masse*. They always form a broad strip around

---

Plate 2. Postreproductive female Kermesidae: Figures A-*Allokermes branigani* (King), B-*A. essigi* (King), D-*A. kingi* (Cockerell), E-*Kermes rimarum* Ferris, F-*K. shastensis* Ehrhorn, G-*Nanokermes folium* Bullington and Kosztarab, J-*Olliffiella cristicola* Cockerell. Note pointers indicating a chalcid wasp, and several emergence holes on the female exoskeletons.

Prereproductive females: Figure C-*Allokermes kingi* (Cockerell) clustered at the base of a bud and shoot forking.

Galls produced by *Olliffiella cristicola* Cockerell, Figures H and I. Note pointers on leaf of *Quercus emoryi*.

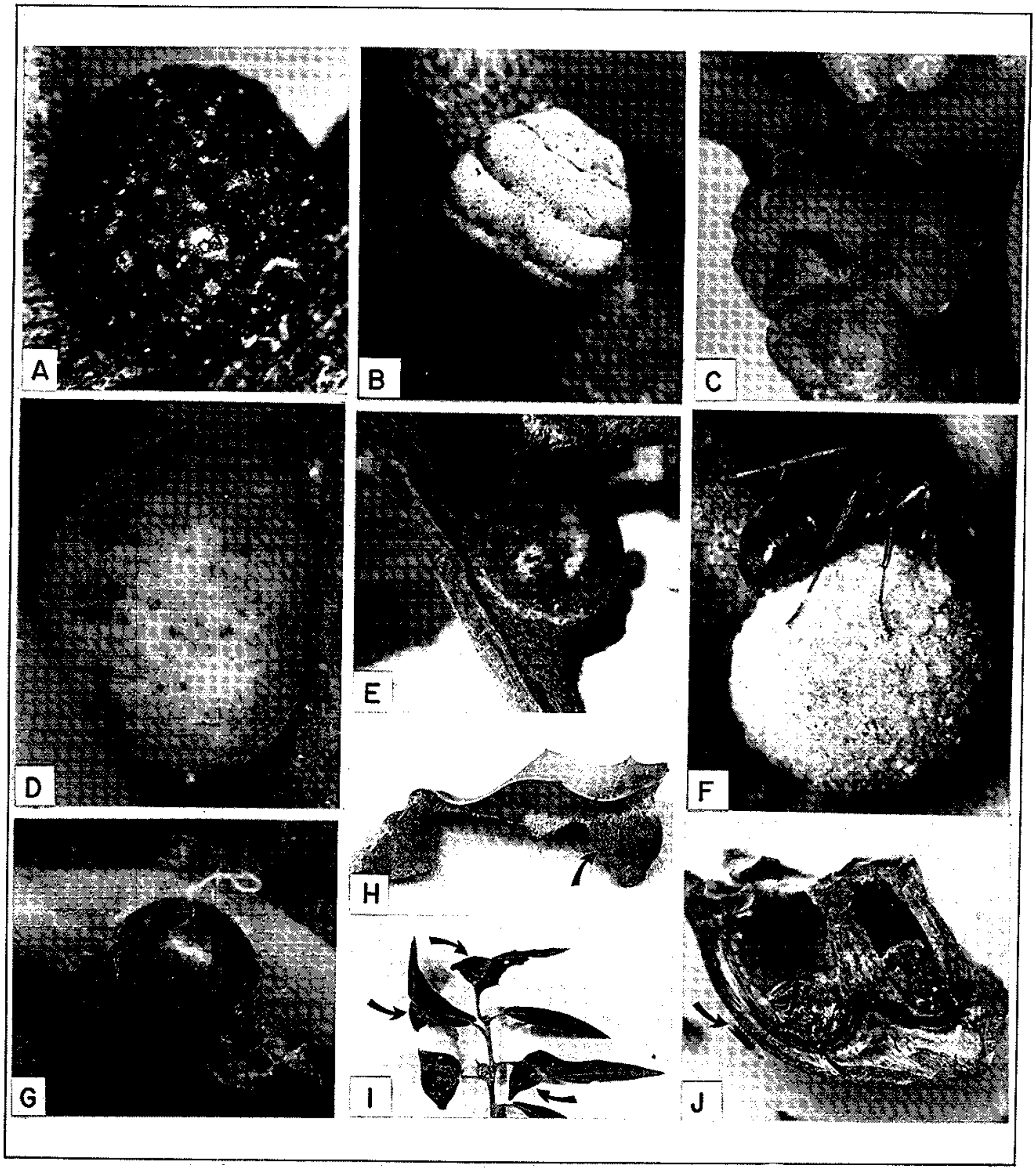


Plate 2.- Representative Kermesidae

the anterior and lateral dorsal margins, and may also be found on the middle and posterior dorsum, sometimes by the thousands.

Additional Characters

Plates 3 and 4

False venter (Plate 3). In the third instar female (easily distinguished from third instar males, which are prepupae), the terms dorsum and venter can be used synonymously with the terms tergum and sternum. Just after eclosion, however, two lobes of the anterior tergum and two lobes of the posterior tergum begin to grow under the sternum to form a false venter. An auxiliary medial lobe is sometimes present posteriorly. By the time the adult is ready for oviposition, these lobes have enlarged and have met one another mid-ventrally, sealing the sternum off from the substrate. The juncture of the lobes is sealed by wax secreted by multilocular disc pores on the sternum. The lobes' development in *Allokermes kingi* (Ckll.) is illustrated. Figure A is a ventral view of a third instar female. Figures B through F are ventral views of successive stages in the development of the lobes in the adult female.

The labium, compressed between the two anterior lobes, with these sometimes forms the posterior terminus of a mid-ventral ridge or keel. The ridge's development may be very pronounced in specimens that have been taken from forks between twigs.

Brood chamber (Plate 3). Just prior to oviposition, the false venter completely separates the sternum from the substrate (fig. G). The true venter, or sternum, is small compared to adult body size, is pouched along the lateral abdominal margins, and is deeply invaginated along the thoracic margins.

As the eggs are laid, they are entrapped in the space between the sternum and the false venter. Because the outer body shell is too heavily sclerotized to expand to make room for the newly laid eggs, the membranous sternum is forced to expand. Once egg laying is completed, the sternum has expanded to fill most of the body cavity (sagittal section, fig. H). No traces remain of the sternum's former segmentation. A thin medial partition encloses the remaining viscera. The legs are located on each side of this partition.

Provisions for the escape of the first instars (Plate 4). The false venter's lobes collapse and shrivel after oviposition, probably because the female dies (fig. B, compare fig. A). Fig. C is a cross section of the female following the collapse of the false venter. The cross section, taken at X-X' on fig. B, shows the rear half of the brood chamber. The collapse of the false venter forms a cavity or passage between the posterior ventral derm and the substrate connecting the brood chamber to the outside. This passage, shown in fig. C with a first instar crawling through it, is so narrow that only one or two first instars can crawl through it at a time.

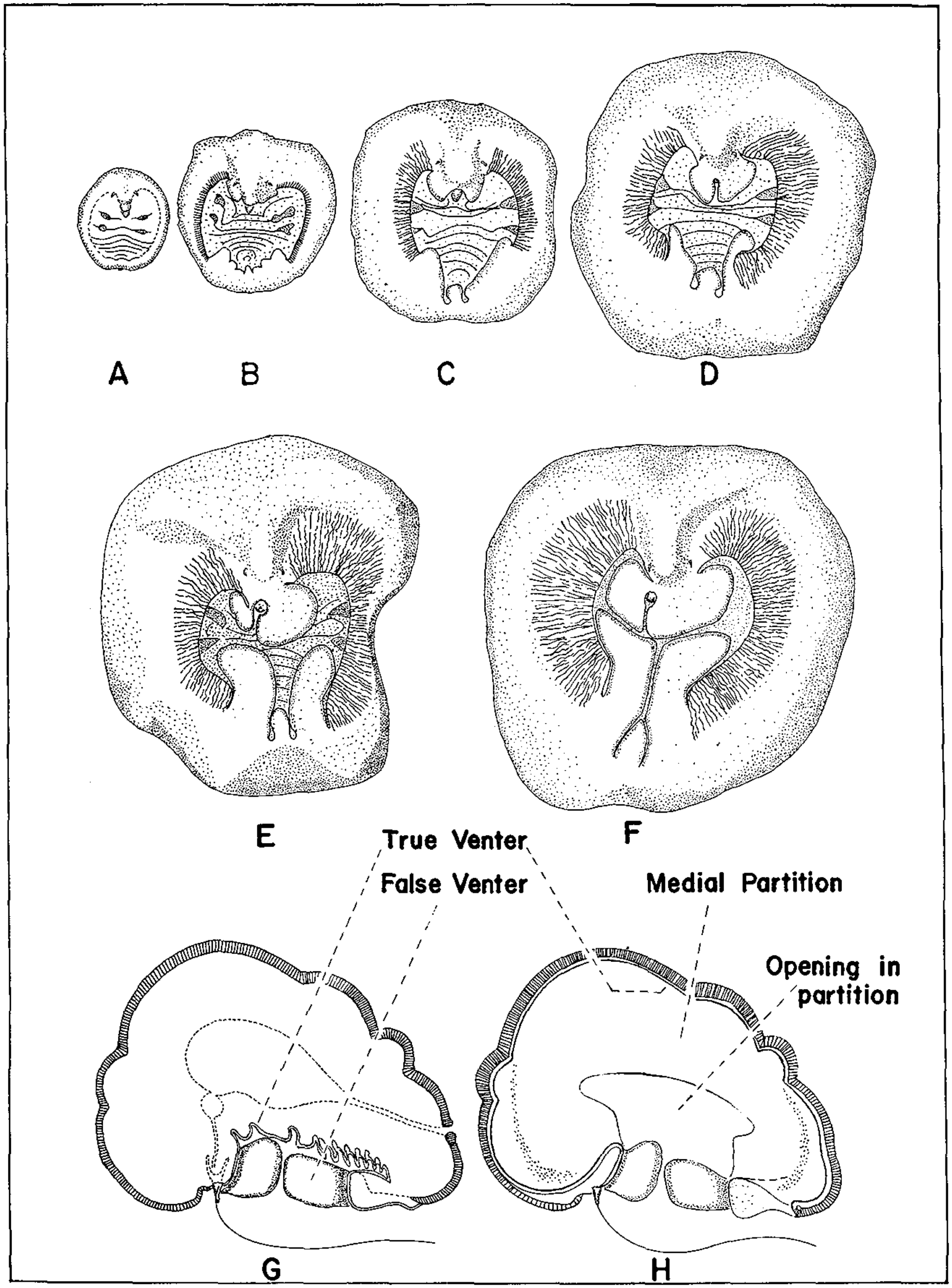


Plate 3.- *Allokermes kingi* (Cockerell)- development of the false venter

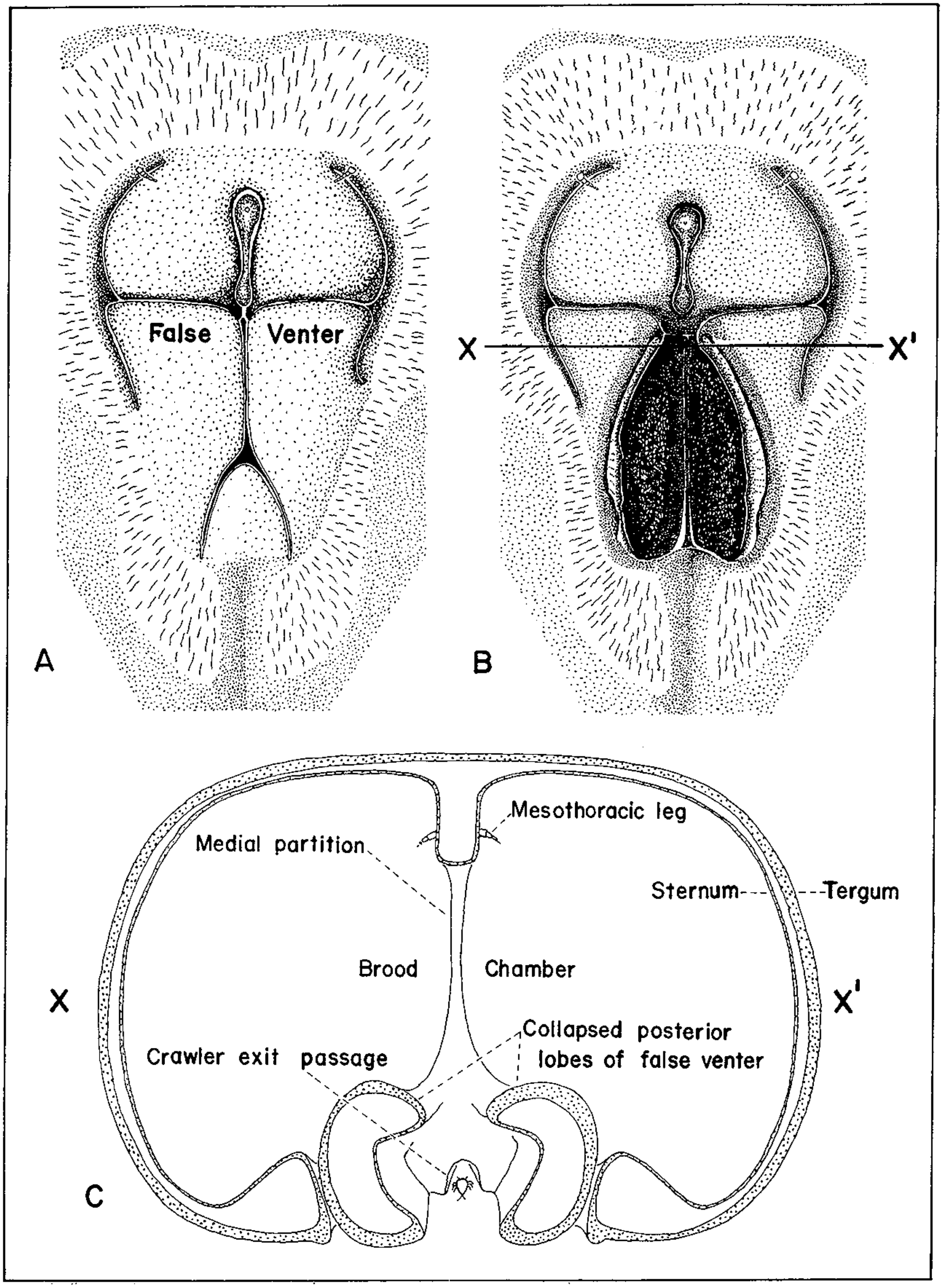


Plate 4.- *Allokermes rattani* (Ehrhorn)- brood chamber exit passag

Slide-mounted Pre-reproductive Adult Female

Tergum

Plate 5

Body shape (fig. A). The body of the flattened female, usually ovoid to circular, may resemble a rounded pentagon in young females of several species.

Eyes (fig. C). The eyes may be absent; or, if present, indicated by irregularly shaped plates, or eye bases, located anteriolaterally of the antennal bases and laterally of the tubular duct row. These bases may be associated with a lens or eye cap. Because the eye caps are rarely present in slide-mounted females, the function of the bases is unknown. The eye caps, found only on young specimens, may be more fragile in the older specimens, and thus more likely to be rubbed off when the specimen is being handled during mounting.

Tubular ducts. These ducts, found only on the tergum, are of two types. One type (fig. D) is distributed in a wide submarginal row around the anterior and lateral margins of the venter. Each duct consists of a membranous tube with a lightly sclerotized and bulb-shaped head enclosing an apical invagination or cup. A terminal membranous filament is probably present in all species, but disintegrates in some species by the action of KOH. This filament, which does not stain well enough to be obvious, can usually be found on the majority of ducts, if found on one. Rarely, the cup at the end of the duct may be everted or absent.

A second type (fig. E), less variable in structure than the first type, if present, is usually distributed in a wide row lateral to paralleling the submarginal row of tubular ducts, and is also distributed on the middle and posterior of the dorsal derm, where from 30 to many thousands may be found. The head of this second type of tubular duct is more heavily sclerotized, shorter, and stouter than the head of the first type. Only in a few of these ducts were terminal filaments observed.

Disc pores. These pores are composed of an outer sclerotized ring, a central sclerotized tube, and from three to ten spokelike partitions connecting the two. The circular spaces between the partitions are called loculi. A membranous tube, about the length of the pore itself, connects the outer ring's perimeter with the exterior body surface. Occasionally, one can see either a small membranous extension, one-fifth the pore width, to one side of the pore, or a membranous filament projecting from the central tube's distal extremity. The pores on the mid-derm may be wider or narrower than the pores in the marginal or pre-anal row. The number of types of pores with different numbers of loculi is a reliable taxonomic character.

Pore arrangement is an important taxonomic character. Pores are arranged in a lateral row, a pre-anal row, and a spiracular band. Only the pre-anal row is always present.

The pre-anal row is broad basally, extending between the posterior extremities of the submarginal tubular duct row. Apically, the pre-anal row may be shorter than wide or prolonged posteriorly into a strip of pores on each side, each strip usually reaching as far dorsally as the anal lobes, but sometimes extending further and curving inward to meet with the strip on the other half of the body above the anal ring. The strips may be either slender and composed of few pores or wide and composed of many pores.

The lateral row of disc pores, which has two parts (fig. F), may be present or absent. The first part in many species is composed of pores around the marginal setae. These pore and setal clusters resemble pseudococcid cerari. They differ from the pseudococcid cerari, however, in that the membrane surrounding them is not sclerotized. The second part, composed of evenly distributed pores lateral to the submarginal row of tubular ducts, may be slender or wide, sparse or dense. It may grade into disc pores on the mid-dorsum, or be absent.

Pre-anal and mid-dorsal enlargements. (figs. H and I, respectively). These enlargements have been provided to allow the reader to see what pore, duct, and setal types are present and in what proportions in each location. Each circular enlargement represents 24.8 mm square in area.

Spinescent 8-shaped pores (fig. J). These pores may be present or absent. A generalized spinescent 8-shaped pore consists of an oval to circular sclerotized ring, connected to the exterior body surface by a short membranous tube. From within this ring, two cone-shaped teeth project dorsally; two sac-shaped pits, ventrally. These teeth and pits may be either sclerotized or membranous. Some of these pores may lack either teeth or pits or may have these unequally developed. Spinescent 8-shaped pores vary greatly in size between species, but all those from a single individual or lot are similar.

Spinescent 8-shaped pores, found on the mid-dorsum, may be distributed either randomly or in three bands. Occasionally they are found in three short bands across the posterior dorsum.

Amorphous pores (fig. K). These are sclerotized pores without definite shape. They are variable in size. Their presence or absence is not constant for all specimens within a species or even for all specimens within a lot. Amorphous pores are probably remnants of distorted sclerotized tubular ducts. They tend to be found in older individuals. The smaller of these pores may be hard to distinguish from small spinescent 8-shaped pores. When present, the amorphous pores are distributed in bands across the mid-dorsum, often intermixed with spinescent 8-shaped pores. The structure or presence of these pores is not considered a reliable character.

Setae. The general setal pattern on the tergum appears to be two setal bands on each side of the body, but the extent that the setae in the bands are integrated to form rows varies, as does the number of setae per row. The setae may appear to be distributed randomly; their position is uncertain from specimen to specimen because the derm is folded and wrinkled. Setae are also prone to

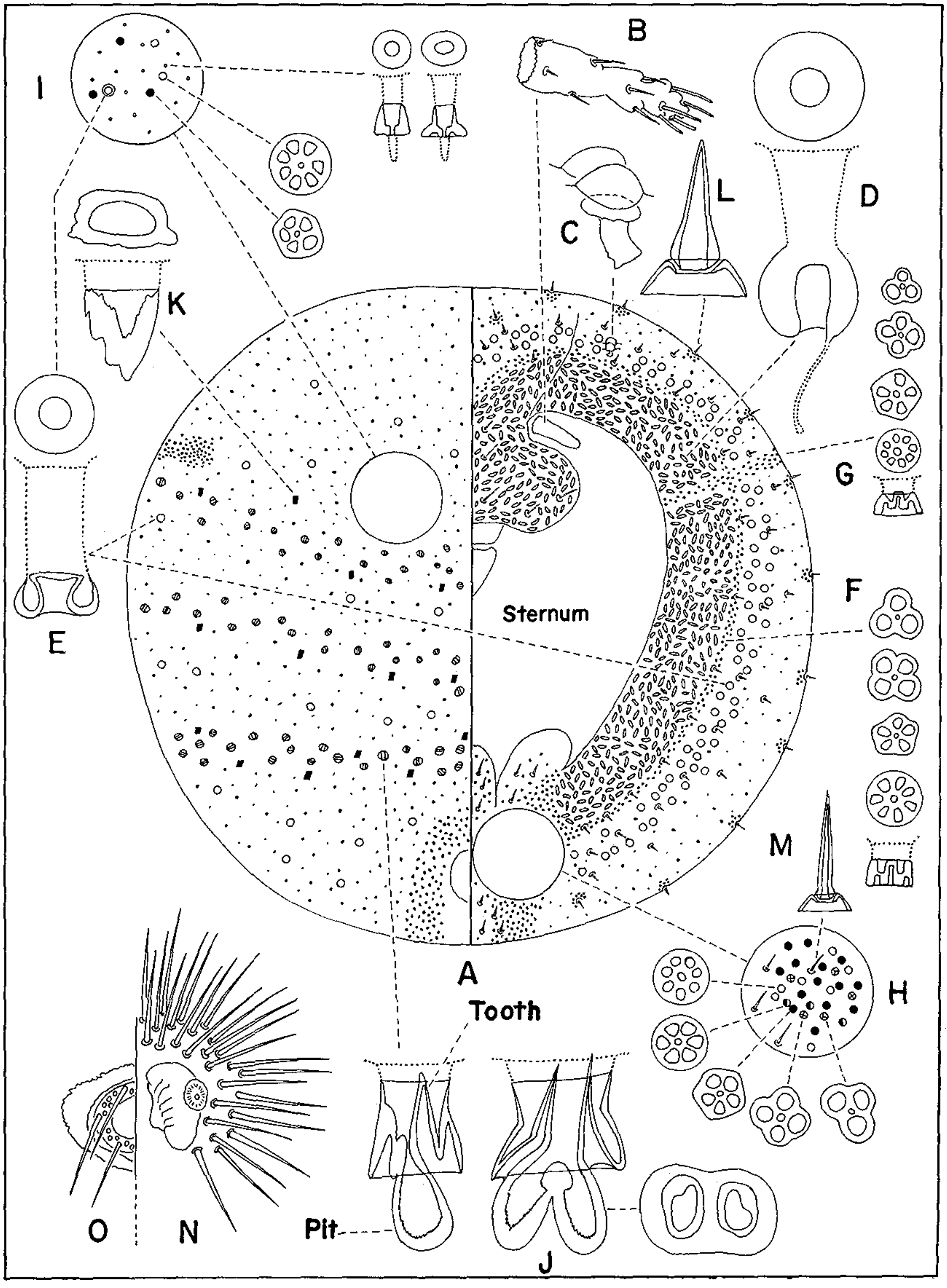


Plate 5.- General morphology of the adult female, tergum

break off at their bases. We do not consider the number and position of the tergal setae a reliable character.

The pre-anal setae are located within the confines of the pre-anal row of multilocular disc pores. The anal setae, located on the anal lobes, are larger than the pre-anal or marginal setae. In most species there are between 11 and 32 anal setae to each side of the body. A few species have only one or two: these are very stout.

We consider the marginal (fig. L), pre-anal (fig. M), and anal setal length to be a reliable morphological character. The anal setae vary least in length or width; the pre-anal setae, most. In some species the pre-anal setae are slightly longer the further they are located from the posterior margin of the sternum; therefore, the pre-anal setal enlargements have always been taken from the same part of the pre-anal multilocular pore row.

Anal lobes (fig. N). These may surround the anal ring, be located ventral to it, or be located dorsal to it. If situated either around or ventral to the anal ring, they are usually membranous. If located dorsal to the anal ring, they are triangular, platelike, and sclerotized.

Anal ring (fig. O). A few species have an areolate anal ring, each half bearing three long setae. We believe this anal ring has been retained by the adult from the third instar within an indistinctly sclerotized circum-anal encasement. In some species, an areolate anal ring is not present in either the third instar female or the adult. Some of this latter group of species have the circum-anal sclerotization similar to the sclerotization in the former group, whereas others have the circum-anal sclerotization broad and flattened, forming a substitute anal ring. The length and width of the anal ring or circum-anal sclerotization are reliable taxonomic characters.

Sternum

Plates 5, 12, 23, and 26

The membranous sternum is crowded with pores and setae. The pore and setal positions are uncertain from specimen to specimen, as the derm is folded and wrinkled. Only structures that were large and conspicuous were measured.

Antennae (Plate 5, fig. B). The antennae, usually several times longer than wide, are indistinctly segmented. In several species the antennal exuviae of the first, second, and third instars are never shed. The antennae, which vary in size within a species, always bear fleshy setae apically, and pointed, stout setae basally.

The antennae often separate from their bases because of coverslip pressure. The orientation of these separated antennae with respect to each other and from slide to slide is uncertain. And we find it hard to see the antennal details and, thus, reliable characters.

Labium (fig. A, posterior surface; fig. B, anterior surface). The labium, conical in shape, is usually flattened on the slide-mount. It has four segments; the apical two are nearly always fused, and the basal two are sometimes fused. The length and width of the labium were measured.

A crumena, an elongate sac for the stylets when they are retracted, is attached to the posterior rim of the labium. The crumena may not be visible.

Spiracles (figs. C, D). These are always present on the pro- and mesothoracic segments. All the spiracles are similar in structure (Plate 12 C), consisting of an oval peritreme enclosing two opposing lips. The atrium, or opening between these lips, connects to a wide tube extending beneath and to one side of the peritreme. The length of the spiracle along this tube and the width of the spiracle along the long diameter of the peritreme were measured.

Legs (figs. E, F, G). Leg length varies among species and legs may be oriented in any direction on a slide. Leg chaetotaxy or segmentation was not considered a reliable character because the setae tend to break off and the segmentation is indistinct. When leg length was measured, trochantin (Plate 12 E) and claw length were included.

KEY TO FAMILIES OF COCCOIDEA RELATED TO KERMESIDAE
Based on Characteristics of Adult Females

1. Hind legs reduced to an oval cluster pore plate, other legs entirely absent; anal ring sclerotized, platelike with 4 setae, surrounded by a few short stout setae . . . . Cryptococcidae

   Six legs almost always present; anal ring not surrounded by short stout setae; if setae present, those long and slender 2

2. Disc pores, usually quinqueloculars, in large clusters, scattered on dorsum; dorsal setae truncate; anal opening appears as a transverse slit often with a sclerotized bar anteriorly, on Cactaceae (*Opuntia* and *Nopalea*) only . . . . Dactylopiidae

   Disc pores usually not arranged in clusters as above; dorsal setae seldom truncate; anal opening variable; on different hosts 3

3. Tubular ducts always present; disc pores of various types; body of different shapes; abdominal lobes variable; legs, when present, usually similar in size; on a variety of host plants; with almost worldwide distribution 4

Tubular ducts absent; only multilocular (seldom quinquelocular) disc pores present; body turbinate or seldom circular; abdominal lobes often pincher-like; anterior legs always smallest; all gall inhabitants on *Eucalyptus* in Australia . . . . Apiomorphidae

4. Microtubular ducts usually present; ventral tubular ducts, when present, scattered over venter; without simple disc pores on mid-dorsum; anal ring usually with pores and setae; often with cruciform pores on venter; anal lobes usually protruding; on various herbaceous and woody hosts . . . . Eriococcidae

   Microtubular ducts absent; 1 or 2 types of tubular ducts always present, usually arranged in a wide submarginal band on tergum; with simple disc pores on mid-dorsum; anal ring, if present, without pores and seldom with setae (*Allokermes*); cruciform pores absent; without protruding anal lobes; associated only with Fagaceae (oaks and chinquapin) . . . . .Kermesidae

KEY TO THE GENERA OF THE NEARCTIC KERMESIDAE

Adult Females

1. With 1 tubular duct type; anal lobes membranous, low, mound-like in side view, and indistinct, each bearing from 11 to 38 long slender setae; spiracular furrow apparently absent; lateral setae more than 1.5 times longer than wide at base (except *K. nudus* & *K. rimarum*) 2

   With 2 tubular duct types (pl. 28 D,E); anal lobes sclerotized, each roughly triangular and bearing single, stout, medially projecting seta (pl. 29 K); spiracular furrow occasionally present, extending onto dorsum, and lined with disc pores; lateral setae short, less than 1.5 times longer than wide at base (pl. 29 I) . . . . *Nanokermes*, new genus, p. 87

2. Dorsum with heavily sclerotized, spinescent 8-shaped pores (pl. 5 J), these ranging from 4µ to 39µ; disc pores, if present laterally, and not covering entire dorsum, evenly distributed in marginal band 3

Dorsum without the above heavily sclerotized spinescent 8-shaped pores; disc pores always present laterally and, if not covering entire dorsum, then clustered about marginal setae (pl. 20 D) . . . . *Kermes* Boitard, p. 68

3. Large tubular ducts and disc pores forming a wide band along dorsal margin; without the pair of longitudinal rows of large setae on mid-dorsum; 8-shaped pores replaced by pit or tooth-shaped pores on mid-dorsum, these randomly distributed; anal lobes surrounding anal opening, forming circular prominence bearing setae on both dorsal and ventral surfaces; anal ring broad, flattened and distinct (pl. 11 I, J). . . . . . . *Allokermes*, new genus, p. 28

Without a wide band of ducts along dorsal margin; with large setae forming a pair of longitudinal rows on mid-dorsum; 8-shaped pores distributed evenly and densely on mid-dorsum; anal lobes ventral to anal opening (pl. 30 J, on dorsal surface appear to be posterior to anal opening), without definite margins, and bearing setae only on their ventral surfaces; anal ring narrow, cordlike, and indistinct (*Olliffiella cristicola*, pl. 30). . . . . *Olliffiella* Cockerell, p. 102

Third Instar Females

1. With 1 type of tubular duct; anal lobes low, moundlike in side view, each bearing from 13 to 34 equally long, slender setae; anal ring not areolate, without setae. 2

With 2 types of tubular ducts; anal lobes prominent, conelike, each bearing at its apex one long seta and several shorter, lanceolate ones (pl. 27 K); anal ring areolate and bearing 3 long setae per side (pl. 27 M). . . . . . *Nanokermes*, new genus, p. 92

2. Anal lobes ventral to anal opening (pl. 24 I, on dorsal surface of plate, illustrations appear to be posterior to anal opening), without definite margins, and bearing most setae on their ventral surfaces. 3

Anal lobes surrounding anal opening (pl. 13 H, I) and forming circular prominence bearing many setae on both dorsal and ventral surfaces . . . *Allokermes*, new genus, p. 50

3. Lateral multilocular disc pores evenly distributed in marginal row (pl. 32 D) . . . . *Olliffiella* Cockerell, p. 106

Lateral multilocular disc pores clustered about marginal setae (pl. 24 C) . . . . *Kermes* Boitard, p. 84

DESCRIPTION OF ALLOKERMES, NEW GENUS

Type: *Kermes galliformis* Riley

Adult female (Plate 11). With 1 tubular duct type (fig. B); mid-dorsum with pit- or tooth-shaped pores, these heavily sclerotized, ca. 4µ to 39µ long (fig. F), if smaller distributed randomly, if larger, in 3 or more distinct transverse bands; spiracular furrow absent; multilocular disc pores, if present laterally, not covering entire dorsum, evenly distributed in marginal band (fig. C); anal lobes membranous, surrounding anal opening, forming circular prominence, each half bearing 13 to 34 long, slender setae (fig. I); anal ring broad, flattened, and with margins distinct from surrounding derm, and not enclosing third instar anal ring (fig. J).

Third instar female (Plate 13). With 1 tubular duct type (fig. C); spiracular furrow absent; multilocular disc pores absent in lateral band; anal lobes membranous, surrounding anal opening, forming circular prominence, each half bearing 13 to 34 long, slender setae (fig. H); anal ring flattened, with margins distinct from surrounding derm, and deeply creased longitudinally (fig. I).

Remarks. This genus apparently is restricted to the Nearctic Region. Species are restricted to *Quercus* spp. and *Chrysolepis* spp. and specimens are found in healing wounds, on bark, in forms of twigs, or on branches.

Etymology. *Allokermes* literally means "other-Kermes."

KEY TO THE ADULT FEMALES OF *ALLOKERMES*

1. Pre-anal band of multilocular disc pores never extending dorsally from posterior end as far as anal ring (pl. 6 A) 2

Pre-anal band of multilocular disc pores extending dorsally from posterior end at least as far as anal ring (pl. 18 A) 3

2. Lateral row of multilocular disc pores present (pl. 6 C); spinescent 8-shaped pores with median tooth (pl. 6), these distributed in 3 transverse bands on mid-dorsum. . . . . *branigani* (King), p. 30

Lateral row of multilocular disc pores absent; spinescent 8-shaped pores without teeth (pl. 9 E), these distributed evenly on mid-dorsum. . . . . . *essigi* (King), p. 39

3. Pre-anal row of multilocular disc pores extending dorsally to above anal ring, encircling it (pl.18 A) 4

   Pre-anal row of multilocular disc pores extending dorsally to anal ring but not above it. 7

4. Lateral row of multilocular disc pores present (pl. 17 C); spinescent 8-shaped pores with small teeth 5

   Lateral row of multilocular disc pores absent; spincescent 8-shaped pores without teeth (pl. 18 E) . . . . *rattani* (Ehrhorn), p. 67

5. Multilocular disc pores present on mid-dorsum (pl. 16 E); median lobe of false venter with few or no multilocular disc pores 6

   Multilocular disc pores absent on mid-dorsum; median lobe of false venter with 25 to 40 multilocular disc pores (pl. 10 A) . . . . *ferrisi,* new species, p. 42

6. Quinquelocular disc pores sparsely distributed (about 3 per 25 mm square area) on mid-dorsum (pl. 16 E); anal lobes without lateral gland . . . . *kingi* (Ckll.), p. 58

   Quinquelocular and 7-locular disc pores densely distributed (about 20 per 25 mm square area) on mid-dorsum (pl. 17 E); anal lobes with lateral gland (pl. 17 J) . . . . *nivalis* (King and Ckll.), p. 64

7. Spinescent 8-shaped pores with pits (pl. 5 J); median lobe of false venter with few or no multilocular disc pores (pl. 7 A) 8

   Spinescent 8-shaped pores without pits (pl. 15 F); median lobe of false venter with 25 to 40 multilocular disc pores . . . . *grandis* (Ckll.), p. 57

8. Spinescent 8-shaped pores longer than broad, resulting in slide mounts with most pores lateral surface up; spinescent 8-shaped pore loculi either not visible or indistinct (pl. 11 F) 9

   Spinescent 8-shaped pores broader than long, resulting in slide mounts with most pores dorsal surface up; spinescent 8-shaped pore loculi visible and distinct (pl. 7 F) . . . . *cueroensis* (Ckll.), p. 33

9. Spinescent 8-shaped pores with teeth, or if without teeth and resembling double pits, this only in young specimens and pits equal in depth; lateral multilocular disc pores present but not in a narrow dense band. 10

   Spinescent 8-shaped pores without teeth, resembling double pit with pits unequal in depth (pl. 14 F); lateral multilocular disc pores present in a narrow dense band (pl. 14 C) . . *gillettei* (Ckll.), p. 53

10. Spinescent 8-shaped pores small or absent (pl. 8 F), distributed evenly on mid-dorsum; no pores on median lobe of false venter; lateral multilocular disc pores forming a single row (pl. 8 C); anal lobe setae from 26µ to 30µ long (pl. 8 I) . . . . . . *dubius*, new species, p. 36

    Spinescent 8-shaped pores with long teeth (pl. 11 F), distributed in 3 or more transverse bands on mid-dorsum; several pores on median lobe false venter; lateral multilocular disc pores sparsely distributed and forming a wide band (pl. 11 C); anal lobe setae from 54µ to 91µ long (pl. 11 I) . . . . *galliformis* (Riley), p. 45

DESCRIPTIONS OF SPECIES OF *ALLOKERMES*

ALLOKERMES BRANIGANI (KING)

Color fig. 5. Plate 2A

Suggested common name: Branigan's Kermes.

Synonymy: *Kermes branigani* King, 1914b:100, 101.
Kermes nigropunctatus, Ferris, 1920:27; Essig, 1926:276 (misidentification?).

Post-reproductive female. King (1914b) described the post-reproductive female as:

> Globular in shape, 5 mm. long, 6 mm. wide, 5 mm. high. The color is light cream, nearly white, often with bluish cast, with four broad, transverse bands of very light yellowish brown. Segmentation distinct; the sutures slightly depressed and marked by small round black dots. Surface shiny and thickly covered with minute black specks. . . . There is a short, very distinct groove posteriorly reaching to the anus.

YOUNG ADULT FEMALE
Plate 6

Type material studied. Topotypes from *Quercus chrysolepis*, **CA**, Placer Co., Foresthill, Paragon (Bath) Mine, Jul. 11, 1975, coll. RJG, 1(1), CDA; Jun. 1, 1976, coll. RJG, 4(4) CDA, 2(2), VPI, 1(1) USNM, 1(1) UCD.

Tergum

Description. Body (fig. A) circular 3220, 2947 (1860-3710) long, 3400, 2850 (1980-3400) wide.

Tubular ducts (fig. B). Head bulb-shaped, 10, 11 (10-13) wide.

Multilocular disc pores. Lateral row (fig. C) with quadrilocular and quinquelocular pores distributed in narrow band paralleling lateral row of tubular ducts; pre-anal row with sparsely distributed 3-, 4-, 5-, 6-, and 7-locular pores extending on each side of body from the posterior end of lateral row of tubular ducts to point about two-thirds of distance toward anal lobes, never extending as far as anal ring; median lobe of false venter with several pores.

Pre-anal enlargement (fig. D). With ca. 1 trilocular, 1 quadrilocular, 14 quinquelocular, 1, 6-locular and 4, 7-locular disc pores, also 4 setae.

Mid-dorsal enlargement (fig. E). With ca. 8 simple disc pores.

Spinescent 8-shaped pores (fig. F). 10, 11 (10-12) long, with single median tooth, pits absent or poorly developed; distributed in several transverse bands on mid-dorsum.

Amorphous pores (fig. G). Present on mid-dorsum.

Setae. Marginals (fig. H) 32, 26 (21-32) long, pre-anals (fig. I) 20, 17 (14-17) long, anals 94, 81 (67-101) long.

Anal lobes (fig. J). Usually sclerotized, each with 20, 23 (20-27) setae.

Anal ring (fig. K). 124, 109 (91-124) long, 173, 178 (156-185) wide.

Sternum

Antennae. Elongate, segmentation obscure, 124, 138 (105-173) long.

Labium. 198, 195 (146-235) long, 142, 152 (136-186) wide.

Spiracles. Anterior spiracles 124, 121 (104-136) long, atria 93, 78 (34-93) wide; posterior spiracles 155, 147 (124-161) long, atria 124, 124 (104-161) wide.

Legs. Prothoracic legs 241, 210 (173-241) long, mesothoracic legs 250, 234 (186-272) long, metathoracic legs 192, 225 (186-260) long.

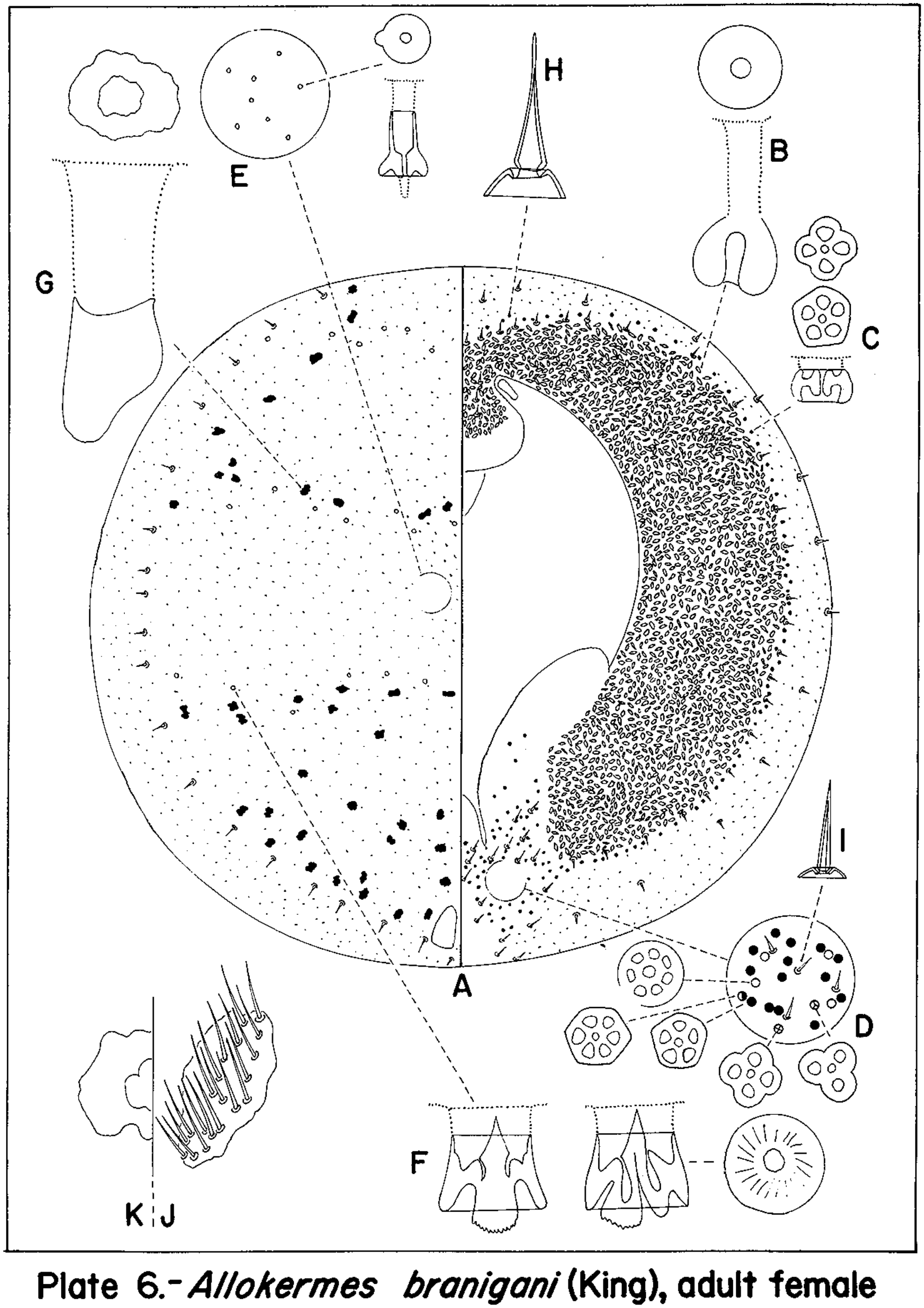


Plate 6.- *Allokermes branigani* (King), adult female

Additional material studied. *Quercus chrysolepis*, **CA**, Groveland, 0.5 mi. outside of town on State Rt. 120, Jul. 1, 1976, colls. MMK, 6(12) VPI; **CA**, Santa Clara Co., Alma Cr., Jul. 16, 1922, coll. GFF 2(4) UCD; Santa Clara Co., Stevens Cr., coll. GFF, 1(1), UCD; Tuolumne Co., Confidence, May 25, 1920, coll. H. E. Burke, 3(5) UCD, Jul. 31, 1919, coll. R. D. Hartman, 2(4) UCD, 3(3) VPI; Siskiyou Co., Shasta Springs, Jul. 2, 1976, coll. MK, 1(1), VPI. On *Q. wislizenii*, **CA**, Santa Clara Co., Stevens Cr., Nov. 22, 1914, 1(1) UCR.

Questionable identifications in literature. *Quercus chrysolepis*, **CA**, Shasta Co., near Redding, coll. LC (Essig, 1915:114). *Q. grisea*, **TX**, Brewster Co., Big Bend Natl. Park, Jun. 15, 1976, coll. MK (Kosztarab, 1977:81).

Other literature citations. Balachowsky, 1950a:344; Essig, 1914b:189; Ferris, 1955b:195; MacGillivray, 1921:198.

Remarks. This species was found on *Quercus chrysolepis* in California. *K. nigropunctatus* (Ehrhorn and Cockerell) might be a synonym of it.

A. branigani can apparently be distinguished from all other *Allokermes* by the following combination of characters: 1) pre-anal row of multilocular disc pores not extending as far dorsally as anal lobes; 2) lateral row of multilocular disc pores present; and 3) spinescent 8-shaped pores with a single median tooth and distributed in three transverse bands on mid-dorsum.

Etymology. King named this species in honor of E. J. Branigan.

ALLOKERMES CUEROENSIS (COCKERELL)

Color figs. 2, 6

Suggested common name: Live-oak Kermes.

Synonymy: *Kermes galliformis* var. *cueroensis* Ckll., King, 1900b:79.
Kermes cueroensis, King 1903a:21

Post-reproductive female. King (1900b) described the post-reproductive female as:

> Large, transverse diameter 8 mm, convex, with no median constriction; brownish-white, obscurely marbled with very pale gray, with linear transverse brown bands, somewhat wavy, and thickened at intervals; surface minutely speckled with brown dots.

YOUNG ADULT FEMALE
Plate 7

Type material studied. Topotypes from *Quercus virginiana*, **TX**, Cuero, Jun. 12, 1976, colls. MMK, 4(6), VPI. Syntypes from *Quercus* sp., **TX**, Cuero, Jun. 2, 1898, coll. C. T. H. Townsend, 4(4), KSU. One of the 1898 specimens has been marked as the lectotype, others as paralectotypes.

Tergum

Description. Body (fig. A) circular, 2750, 2810 (2540-3090) long, 2660, 2170 (2480-2850) wide.

Tubular ducts (fig. B). Head 11, 10 (9-11) wide.

Multilocular disc pores. Lateral row (fig. C) with trilocular, quadrilocular, and quinquelocular pores confined to wide strip paralleling lateral row of tubular ducts; pre-anal row with pores extending on each side of body from posterior end of lateral row of tubular ducts to area adjacent to anal lobes, ending abruptly; absent on median lobe of false venter.

Pre-anal enlargement (fig. D). With ca. 19 quinquelocular 4, 7-locular disc pores, 5 setae.

Mid-dorsal enlargement (fig. E.). With ca. 10 simple disc pores.

Spinescent 8-shaped pores (fig. F). 20, 21 (18-25) long, teeth usually shorter than pits; distributed in several transverse bands on mid-dorsum.

Setae. Marginals (fig. G) 20, 20 (15-22) long; pre-anals (fig. H) 22, 31 (22-40) long; anals 49, 51 (44-54) long.

Anal lobes (fig. I). Each with 20, 19 (15-24) setae.

Anal ring (fig. J). 91, 87 (62-111) long; 136, 114 (94-136) wide.

Sternum

Antennae. Reduced, segmentation obscure, 93, 94 (68-105) long.

Labium. 198, 167 (136-198) long; 105, 116 (99-148) wide at base.

Spiracles. Anterior spiracles 136, 127 (111-136) long, atria 62, 88 (62-105) wide; posterior spiracles 155, 173 (155-186) long, atria 155, 120 (105-155) wide.

Legs. Prothoracic legs 129, 119 (62-173) long; mesothoracic legs 124, 108 (74-136) long; metathoracic legs 136, 126 (111-136) long.

Additional material studied. *Quercus alba*, **MI**, Muskegan Co., Aug. 4, 1944, coll. Driesbach, 1(1), USNM. *Q. virginiana*, FL, Miami, Dec. 27, 1974, coll. CHR, 1(1), AU; St. Petersburg, Ft. DeSoto State Park, Apr. 28, 1977, colls. E. W. Miller and CKH, 10(10) FDA; Jun. 14, 1977, colls. CKH, E. W. Miller, and ABH, 22(27) FDA, 21(57) VPI; Jun. 18, 1970, coll. CKH, 7(7), AU; St. Petersburg, Sep. 10, 1976, coll. CKH, 3(3), FDA; **GA**, Clinch Co., May 10, 1977, coll. R. Beshear, 7(7), VPI; **MS**, Long Beach, yard of Gulf View Motel, Jun. 9, 1976, colls. MMK, 4(4), VPI; Meridan, Oct. 1922, coll. R. W. Harned,

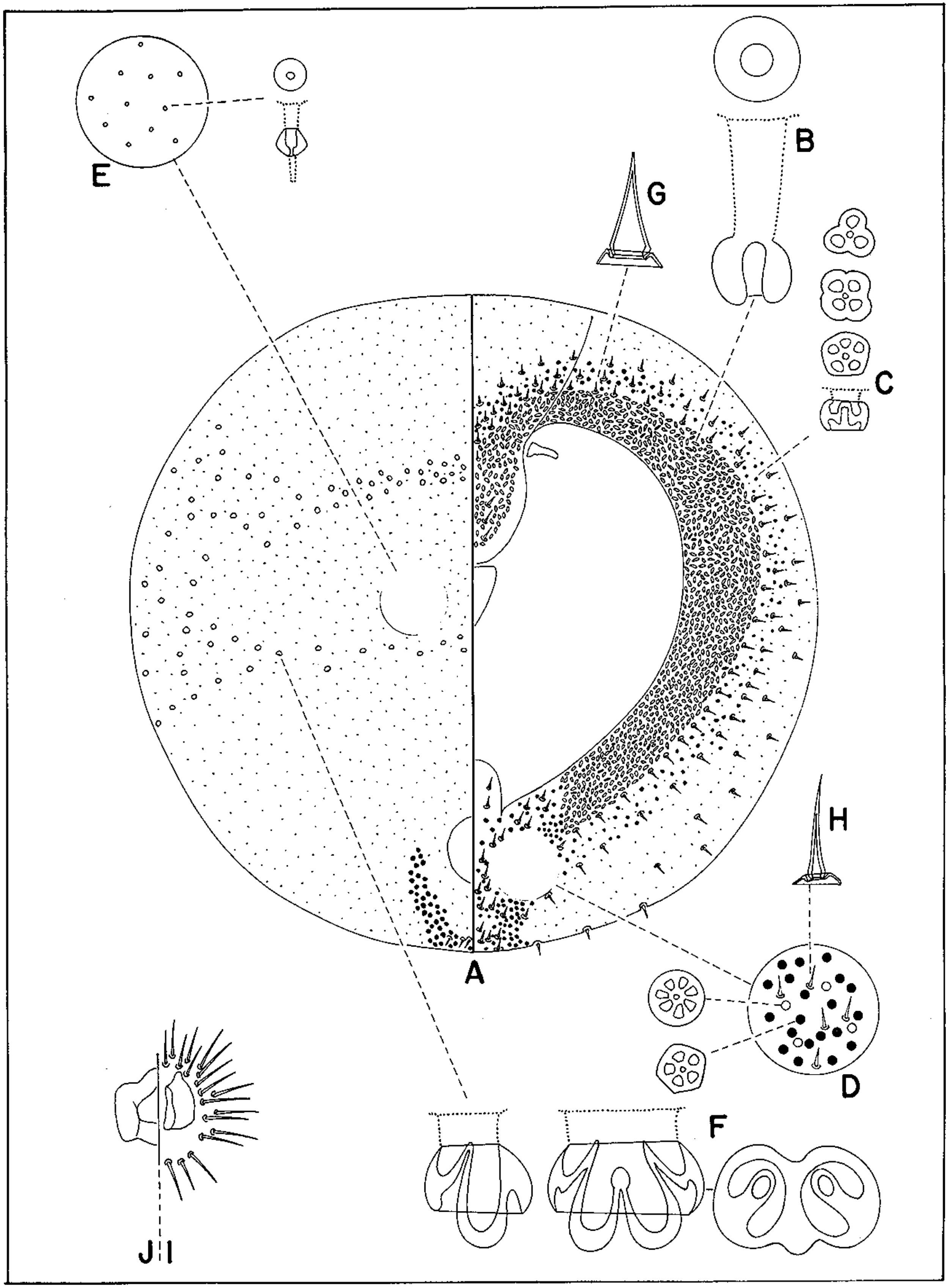


Plate 7.- *Allokermes cueroensis* (Ckll.), adult female

1(1), UCD; **SC**, Branfort, Jul. 6, 1896, 1(1), USNM; Charleston, Hampton Park, Jun. 26, 1939, coll. Halcombe, 7(7) USNM, 3(3) UCD, 4(4) VPI; Charleston, Jul. 8, 1933, coll. P. U. Siggers, 2(6) USNM, 1(1) VPI; **TX**, 1918, coll. AHH, 3(3), UCD; grounds of Welder Wildlife Foundation, Jun. 12, 1976, colls. MMK, 3(5), VPI. *Quercus* sp., **FL**, Miami, Sep. 8, 1973, coll. CHR, 9(11), AU; Dec. 25, 1974, coll. CHR, 3(3), VPI; Dec. 27, 1974, coll. CHR, 2(2) AU, 2(2) VPI; Pinellas Co., Jun. 4, 1970, coll. CKH, 4(8), VPI; St. Petersburg, Ft. Desoto State Park, June 4, 1970, coll. CKH, 3(3), FDA; Tampa, May 12, 1971, coll. E. R. Simmons 3(3), FDA; **SC**, Charleston, Jul. 28, 1922, coll. W. M. Jennings, 1(1), USNM; TX, El Paso, Mt. Franklin, Jun. 1921, coll. GFF, 3(3), UCD; Noxubee Swamp, May 26, 1928, coll. R. M. Smith, 1(1) UCD.

Other literature citations. Balachowsky, 1950a:344; Fernald, 1903:61; Ferris, 1955b:197; Hoy, 1963:143; King, 1903a:21, 22.

Remarks. Except for one questionable record, this species, which is probably found all along the Gulf and Atlantic coasts from Texas to New Jersey, seems to be restricted to *Quercus virginiana*. The questionable record, from Michigan on *Q. alba*, is probably another undescribed species, but apparently cannot be distinguished from *A. cueroensis* on the basis of slide-mounted adult females.

A. cueroensis can apparently be distinguished from all other *Allokermes* by the following combination of characters: 1) pre-anal row of multilocular disc pores extending dorsally to anal ring only, median lobe of false venter without disc pores and 2) spinescent pore loculi distinct, pores with well-developed pits, broader than long, and usually when mounted having their dorsal surfaces up.

Etymology. Cockerell named this species for the type locality, Cuero, Texas.

ALLOKERMES DUBIUS, NEW SPECIES

Suggested common name: Southern Red-oak Kermes.

Post-reproductive female. Unknown.

YOUNG ADULT FEMALE

Plate 8

Type material. Holotype and paratype material from *Quercus falcata*, **MS**, New Augusta, Aug. 27, 1930, coll. H. Dietrich, 6(10), UCD, holotype, 1(2) USNM.

Tergum

Description. Body (fig. A) circular, 1240, 2583 (1070- 5660) long, 1120, 2540 (936-5560) wide.

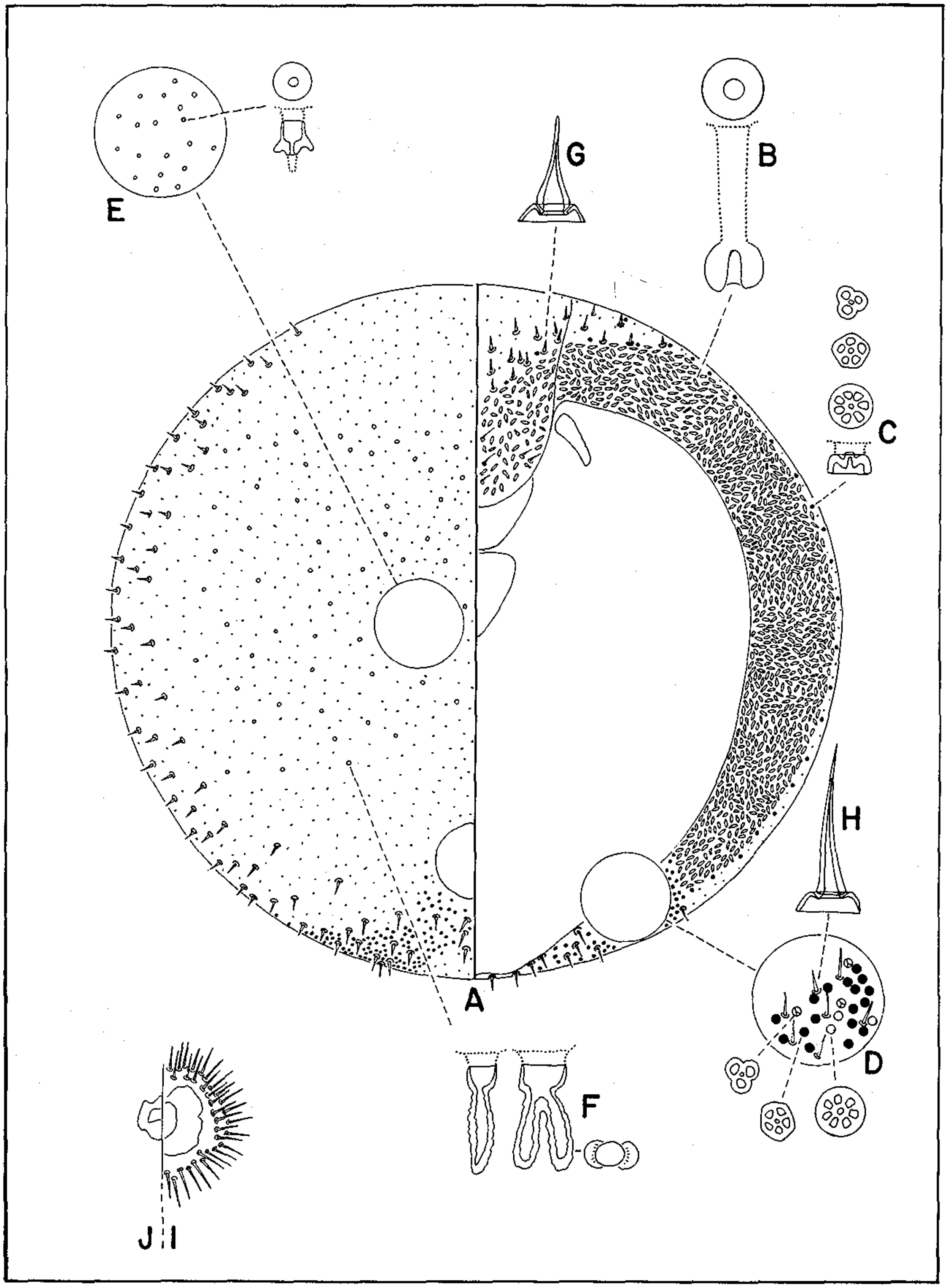


Plate 8.-*Allokermes dubius*, new species, adult female

Tubular ducts (fig. B). Head 7, 8 (6-10) wide.

Multilocular disc pores. Lateral row (fig. C) reduced, on each side of body with ca. 25 trilocular, quinquelocular, and 7-locular pores arranged in a single row paralleling lateral row of tubular ducts; pre-anal row with trilocular, quinquelocular, and 7-locular pores extending on each side of body from posterior end of lateral row of tubular ducts to area adjacent to anal lobes, ending abruptly; median lobe of false venter without pores.

Pre-anal enlargement (fig. D). With ca. 3 trilocular disc pores, 17 quinquelocular disc pores, 3, 7-locular disc pores, and 7 setae.

Mid-dorsal enlargement (fig. E). With ca. 19 simple disc pores.

Spinescent 8-shaped pores (fig. F). 9, 18 (9-28) long, teeth either subequal to pits and strongly convergent at tips or absent, pits equal in length, strongly divergent at tips; distributed evenly on mid-dorsum.

Setae. Marginals (fig. G) 12, 14 (9-22) long; pre-anals (fig. H) 25, 18 (13-25) long; anals 38, 44 (26-70) long.

Anal lobes (fig. I). Each with 15, 18 (15-23) setae.

Anal ring (fig. J). 49, 57 (34-79) long, 67, 73 (43-104) wide.

Sternum

Antennae. Reduced, segmentation obscure, 88, 86 (74-95) long.

Labium. 162, 159 (124-212) long, 111, 119 (37-155) wide at base.

Spiracles. Anterior spiracles 86, 106 (74-148) long, atria 65, 66 (44-88) wide; posterior spiracles 118, 121 (74-173) long, atria 76, 90 (64-123) wide.

Legs. Prothoracic legs 140, 127 (99-171) long; mesothoracic legs 143, 106 (63-143) long; metathoracic legs 89, 93 (65-118) long.

Remarks. This species is known only from a single lot, but is probably widely distributed where its host, *Quercus falcata*, is found.

A. dubius can apparently be distinguished from all other *Allokermes* by the following combination of characters: 1) spinescent pores longer than broad, with elongate pits, and if with teeth, these subequal to pits in length, strongly convergent, and only present in older pre-reproductive specimens; 2) lateral multilocular disc pores few and in single row; 3) pre-anal row of multilocular disc pores with few or no pores extending medially onto median lobe of false venter, also with pores extending dorsally to area adjacent to anal lobes, but not above them; and 4) anal lobe setae ca. 44µ long.

Etymology. This species is named for the many morphological changes during its maturation process. These changes gave the impression that the type lot was a mixture of several species.

ALLOKERMES ESSIGI (KING)

Color figs. 7, 8, 9. Plate 2B

Suggested common name: Essig's Kermes.

Synonymy: *Kermes essigi* King, 1913a:205, 206.
Kermes nigropunctatus, Ferris, 1920:27; Essig, 1926: 276 (misidentification).
Talla nigripunctata, Lindinger, 1943:148.

Post-reproductive female. King (1913a) described the post- reproductive female as

> Light brown. 6 mm long, 6 mm broad and 5 mm high; surface shiny. Under normal conditions practically globular, of two distinct forms, one with a deep broad longitudinal constriction, with sides bulging, and four transverse bands of a light cream color. The constriction is not pallid, but of the same color as that of the scale, light brown. The entire surface is peppered with minute black specks. . . there are also several large black dots. . . . The other form is of the same color and markings, but distinctly gibbous.

YOUNG ADULT FEMALE

Plate 9

Type material studied. *Quercus agrifolia*, **CA**, Ventura Co., Santa Paula Canyon, 1910, coll. EOE, 3(3), UCD; Jul. 1911, coll. EOE, 1(1) VPI; Nov. 2, 1913, coll. EOE, 2(2) UCD, 2(2) VPI, 2(2) ORSU; Aug. 14, 1975, colls. RJG and R. F. Hobza 1(1) VPI. One of the 1910 specimens has been marked as the lectotype; the remaining 1910 specimens, as paralectotypes.

Tergum

Description. Body (fig. A) circular, 2260, 3230 (2260-4330) long, 2040, 3410 (2040-4950) wide.

Tubular ducts (fig. B). Head 10, 10 (8-11) wide.

Multilocular disc pores. Lateral row absent; pre-anal row with sparsely distributed quinquelocular and 7-locular pores extending on each side of body from posterior end of lateral row of tubular ducts to point about two-thirds of distance toward anal lobes, never extending as far as anal ring; median lobe of false venter with several pores.

Pre-anal enlargement (fig. C). With ca. 19 quinquelocular disc pores, 5, 7-locular disc pores, and 7 setae.

Mid-dorsal enlargement (fig. D). With ca. 21 simple disc pores.

Spinescent 8-shaped pores (fig. E). 17, 10 (4-17) long, without teeth, rim elongate and narrow, pits unequally developed and strongly divergent; distributed evenly on mid-dorsum.

Amorphous pores (fig. F). Present or absent on mid-dorsum.

Setae. Marginals (fig. G) 22, 22 (16-38) long; pre-anals (fig. H) 32, 22 (10-32) long; anals 74, 73 (42-99) long.

Anal lobes (fig. I). Each with 21, 22 (16-25) setae.

Anal ring (fig. J). 99, 90 (74-111) long, 99, 108 (94-143) wide.

Sternum

Antennae. Elongate, segmentation obscure, 142, 135, (124-179) long.

Labium. 143, 163 (136-197) long, 119, 142 (111-186) wide at base.

Spiracles. Anterior spiracles 111 long, atria 126 (106- 161) wide; posterior spiracles 173, 145 (74-179) long, atria 87, 113 (87-235) wide.

Legs. Prothoracic legs 192, 196 (130-290) long; mesothoracic legs 217, 206 (124-278) long; metathoracic legs 260, 238 (136-328) long.

Additional material studied. *Quercus agrifolia*, **CA**, Los Angeles Co., Pasadena, Jun. 17, 1967, coll. JWB, 3(5) JWB, 3(3) UCD, 3(3) VPI; Jul. 17, 1912, colls. Bridwell and Trimble, 1(4) UCD, July 19, 1912, 3(5) UCD; Orange Co., O'Neil Park, colls. Nesbit and French, 1(1), RFW; 7 mi. W of Winters, May 27, 1968, coll. JWB, 2(2) JWB, 1(1) VPI. *Q. kelloggii*, **CA**, Dunsmuir City Park, near Shasta Springs, Jul. 7, 1976, colls. MMK, 11(27), VPI; Yosemite Natl. Park, Curry Village, Jun. 30, 1976, colls. MMK, 16(36), VPI. *Q. wislizenii*, **CA**, Kernville, Mar. 29, 1950, coll. GFF, 3(3) UCD, 1(1) VPI; Putah Cr., 7 mi. W of Winters, May 17, 1968, coll. JWB, 17(19) JWB, 6(6) VPI; Sacramento Co., Carmichael, Amer. River, Oct. 19, 1977, coll: RJG, 4(4) VPI, 2(2) CDA; Solano Co., Jul. 5, 1976, colls. MMK and V. Beres, 2(4), VPI. *Quercus* sp., **CA**, Los Angeles Co., Claremont, Jul. 15, 1936, coll. J. D. Maple, 2(2) UCR; Sacramento Co., Carmichael, Amer. River, May 21, 1966, coll. RFW, 1(1) RFW, 1(1) CDA; 1913, 1(1), UCD; 1(1) UCD.

Questionable identifications in literature. *Q. agrifolia*, **CA**, Los Angeles Co., Pasadena, coll. P. H. Timberlake (Timberlake, 1916:584; Howard, 1919:256); Los Angeles Co., Pasadena, coll. R. S. Woglum (Essig, 1915:115, 116). *Q. palustris*, **CA**, Santa Paula and San Bernadino Co. (Hoy, 1963:144).

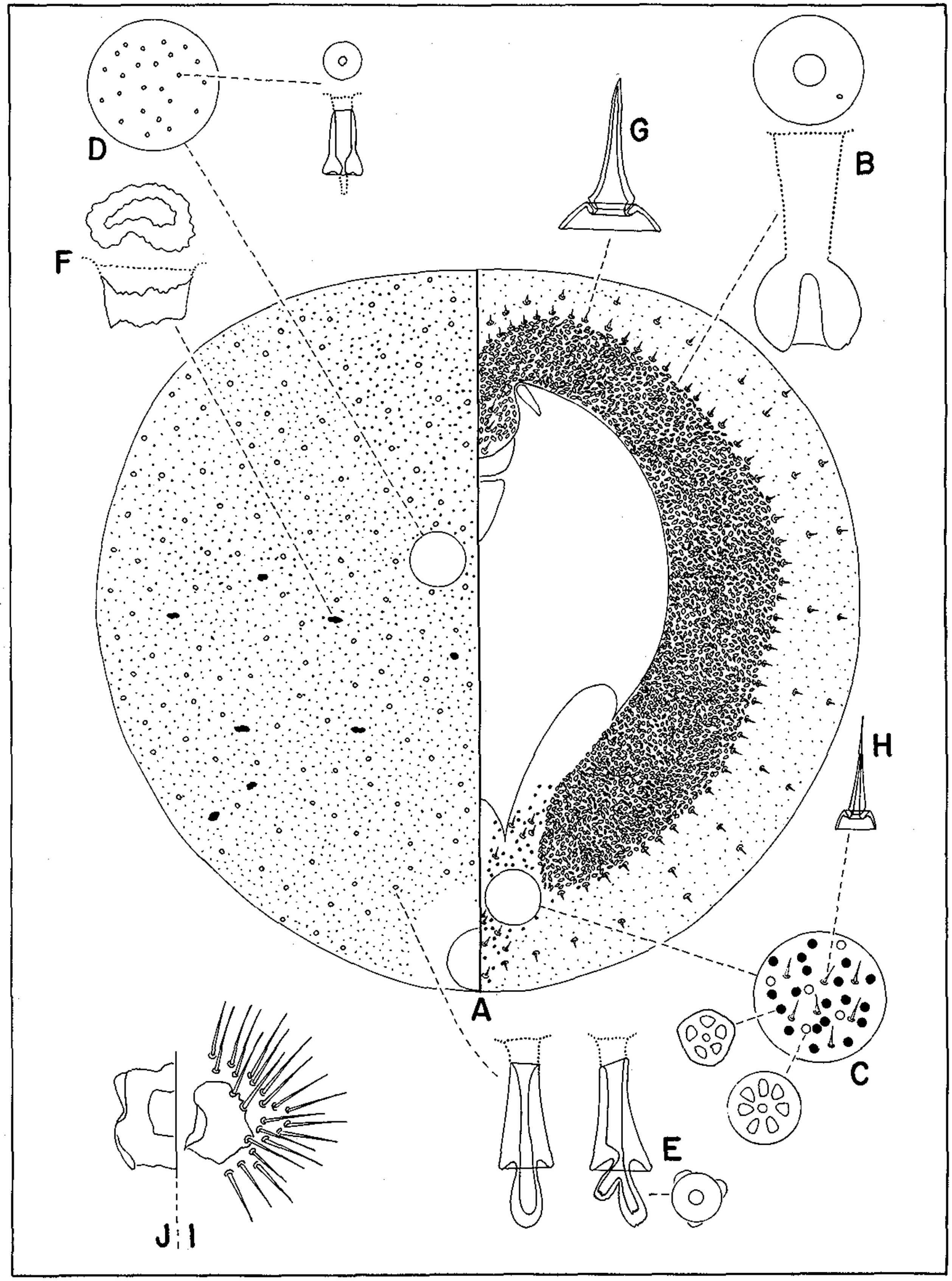


Plate 9.–*Allokermes essigi* (King), adult female

Other literature citations. Balachowsky, 1950a:344; Essig, 1915:114, 117; Ferris, 1955b:199; Fulmek, 1943:38; Hartman, 1916:93; King, 1914b:100, 101; MacGillivray, 1921:197; Ruhl, 1917:50.

Remarks. This species is found on *Quercus agrifolia, Q. kelloggi*, and *Q. wislizenii* in California.

A. essigi can apparently be distinguished from all other *Allokermes* by the following combination of characters: 1) lateral row of multilocular disc pores absent; 2) pre-anal row of multilocular disc pores not extending as far dorsally as anal lobes; and 3) spinescent 8-shaped pores without teeth and distributed evenly on mid-dorsum.

Etymology. King named this species in honor of E. O. Essig.

ALLOKERMES FERRISI, NEW SPECIES

Suggested common name: Ferris's Kermes.

Post-reproductive female. Unknown.

YOUNG ADULT FEMALE

Plate 10

Type material. Holotype and 1 paratype from *Quercus emoryi*, **NM**, Rio Arriba Co., Jun. 30, 1977, colls. L. Iselin and WAI, 1(2), USNM. All other specimens designated as paratypes. **AZ**, Oak Cr. Canyon, Indian Gardens, Jun. 26, 1976, colls. MMK, 3(5), VPI; 7 mi. E of Superior, Sep. 1, 1969, colls. P. F. Min and D. B. Carver, 10(10) CDA, 5(5) VPI, 3(3) USNM, 2(2) UCD. *Q. gambelii*, **NM**, Grant Co., Gila Wilderness Area, Black Canyon, Jul. 20, 1977, coll. WAI, 1(1), VPI. *Quercus* sp., **AZ**, 4 mi. W of Portal, Cave Cr. Canyon, near Sunny Flat, Jun. 22, 1967, coll. JWB, 3(5), JWB; top of Mt. on rd. E from Superior, 1940, coll. GFF, 5(5) UCD, 5(5) VPI; **CA**, Kings Co., Jul. 22, 1976, colls. Gilbert and Wragg, 5(5), CDA; San Joaquin Co., Stockton, Aug. 22, 1963, coll. B. Croce, 2(3), CDA; **CO**, Colorado Springs, 1919, coll. F. B. Herbert, 1(1) UCD.

Tergum

Description. Body (fig. A) ovoid or circular 2010, 2170 (2010-2320) long, 2040, 2200 (2040-2350) wide.

Tubular ducts (fig. B). Head 11 long, ca. 11 wide.

Multilocular disc pores. Lateral row (fig. C) with quinquelocular pores confined to wide strip paralleling lateral row of tubular ducts; pre-anal row with densely distributed quinquelocular and 7-locular pores extending on each side of body from posterior end of lateral row of tubular ducts to above anal lobes,

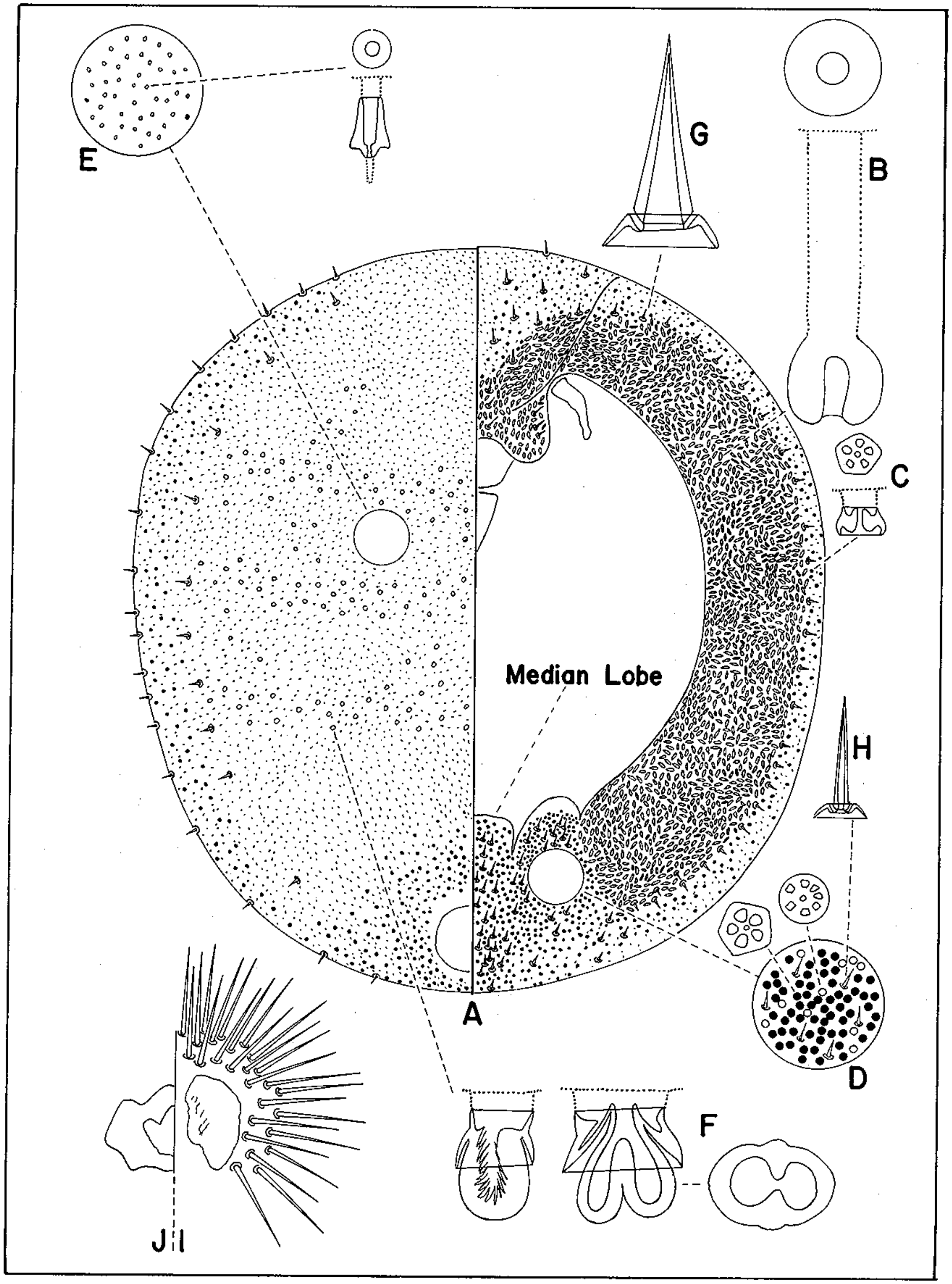


Plate 10.-*Allokermes ferrisi*, new species, adult female

with pores distributed less densely toward and above anal ring; median lobe of false venter with ca. 35 pores.

Pre-anal enlargement (fig. D). With ca. 57 quinquelocular disc pores, 10, 7-locular disc pores, and 6 setae.

Mid-dorsal enlargement (fig. E). With ca. 42 simple disc pores.

Spinescent 8-shaped pores (fig. F). 11, 15 (11-18) long, teeth usually shorter than pits; distributed in several transverse bands on mid-dorsum.

Setae. Marginals (fig. G) 22, 21 (20-22) long; pre-anals (fig. H) 17, 17 (16-17) long; anals 84, 94 (84-104) long.

Anal lobes (fig. I). Each with 25, 24 (22-25) setae.

Anal ring (fig. J). 62, 74 (62-86) long, 124, 130 (124-135) wide.

Sternum

Antennae. Elongate, segmentation obscure, 142, 173 (142-204) long.

Labium. 185, 195 (185-204) long, 198, 167 (136-198) wide at base.

Spiracles. Anterior spiracles 119, 140 (119-161) long, atria 99, 93 (87-99) wide; posterior spiracles 193, 196 (193-198) long, atria 124, 127 (124-130) wide.

Legs. Prothoracic legs 248, 242 (235-248) long; mesothoracic legs 248, 220 (191-248) long; metathoracic legs 241, 260 (241-278) long.

Remarks. This species is found on *Quercus emoryi* and *Q. gambelii* in the southwestern United States. *A. ferrisi* can apparently be distinguished from all other *Allokermes* by the following combination of characters: 1) lateral row of multilocular disc pores present, but not extending dorsally onto mid-dorsum; 2) pre-anal row of multilocular disc pores with ca. 25 to 40 pores extending medially onto median lobe of false venter, also with pores extending dorsally to above anal lobes, encircling them; and 3) spinescent 8-shaped pores with teeth.

Etymology. This species is named in honor of the late G. F. Ferris, whose collection provided many *Kermes* specimens for this study. He was also the first in North America to point out the special difficulties with the study of *Kermes* and the first to use slide-mounted specimens for a new species description.

ALLOKERMES GALLIFORMIS (RILEY)

Suggested common name: Pin-oak Kermes

Synonymy: *Kermes galliformis* Riley, 1881:482.
Kermes waldeni King, 1914d:150-151. New synonym.
Coccus galliformis, Cockerell, 1929:150.
Talla galliformis, Lindinger, 1933:143.
Talla waldeni, Lindinger, 1933:143.
Kermes emoryi Ferris, 1955b:197, 198. New synonym.

Post-reproductive female. Riley (1881) described the post-reproductive female as

> . . .average length 5 mm. Subspherical, usually somewhat broader than long, and often with a broad shallow constriction medio-dorsally. Attached by a broad, dark-brown cut or excavation, which is covered by a beak anteriorly and notched anally, the brown color extending to a point above the notch. Polished and smooth. Ground color pale yellowish, appearing under lens minutely and evenly speckled with brown; more or less suffused or mottled with gray or brown, the constriction, when present, generally dark. A series of about seven irregular rows of black punctations running across the scale, often connected by an irregular black line, and this again relieved by white or pale yellow. The three uppermost rows most distinct and constant.

YOUNG ADULT FEMALE

Type material studied. Topotypes from *Quercus palustris*, **MO**, Sikeston, May 28, 1976, coll. LRH, 1(1), VPI;, Jun. 3, 1976, coll. LRH, 1(1), VPI; Jun. 13, 1976, coll. LRH, 1(1), VPI; Jun. 15, 1976, coll. LRH, 3(5), VPI; Jun. 29, 1976, coll. LRH, 2(2), VPI; Jul. 6, 1976, coll. LRH 5(9), VPI; Jul. 16, 1976, coll. LRH, 3(14), VPI; Jul. 23, 1976, coll. LRH, 5(19) VPI, 2(12) USNM, 1(1) CDA, 1(4) UCD.

Tergum

Plate 11

Description. Body (fig. A) ovoid or circular, 2370, 3050 (1940-4150) long, 2360, 2830 (1610-4050) wide.

Tubular ducts (fig. B). Head 11, 11 (8-12) wide.

Multilocular disc pores. Lateral row (fig. C) with quinquelocular pores many, sparsely distributed in wide row, extending onto anterior and posterior dorsum, and absent on mid-dorsum; pre-anal row with densely distributed quinquelocular and 7-locular pores extending on each side of body from posterior end of lateral row of tubular ducts to area adjacent to anal lobes, ending abruptly; several pores present on median lobe of false venter.

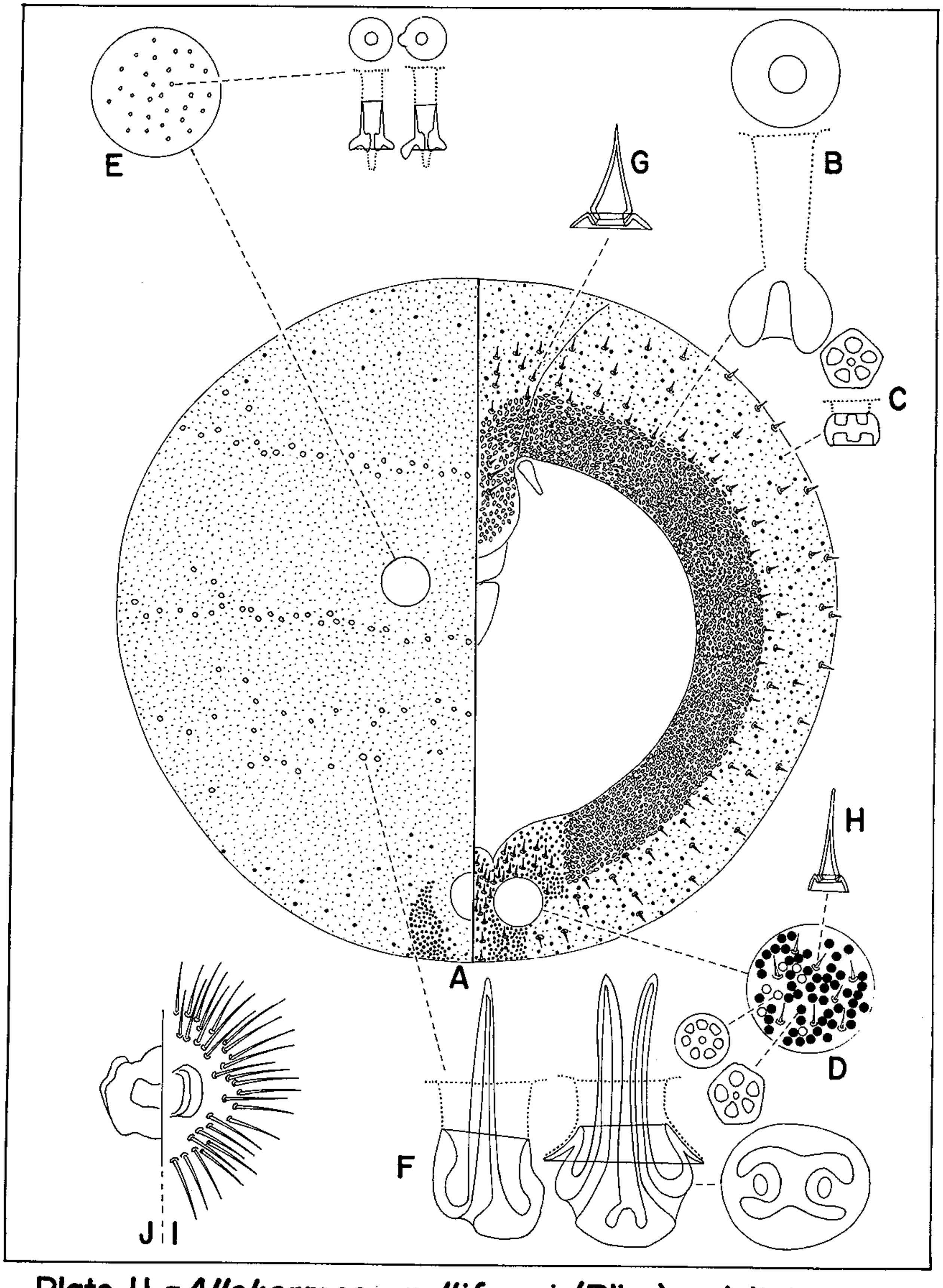


Plate 11.-*Allokermes galliformis* (Riley), adult tergum

Pre-anal enlargement (fig. D). With ca. 45 quinquelocular disc pores, 7, 7-locular disc pores, and 8 setae.

Mid-dorsal enlargement (fig. E). With ca. 22 simple disc pores.

Spinescent 8-shaped pores (fig. F). 32, 27 (19-34) long, teeth long, diverging at tips, pits small or undeveloped, occasionally subequal to teeth in length; distributed in 3 or more transverse bands on mid-dorsum.

Setae. Marginals (fig. G). 20, 18 (12-27) long; pre- anals (fig. H) 22, 19 (16-22) long; anals 74, 66 (54-91) long.

Anal lobes (fig. I). Each with 32, 22, (17-32) setae.

Anal ring (fig. J). 99, 104 (82-124) long, 130, 125 (105-155) wide.

Sternum

Plate 12

Antennae. Reduced, segmentation obscure, 105, 90 (66-111) long.

Labium. 186, 174 (155-193) long, 124, 128 (105-136) wide at base; 4 indistinct segments; anterior surface (fig. B) with 8 setae, posterior surface (fig. A) with 1.

Spiracles. Anterior spiracles (fig. C) 142, 142 (105-142) long, atria 106, 99 (80-119) wide; posterior spiracles (fig. D) 167, 150 (93-186) long, atria 161, 138 (96-161) wide.

Legs. A trochantin is associated with base of each leg. Prothoracic legs (fig. E) 59, 87 (59-114) long; mesothoracic legs (fig. F) 74, 88 (47-124) long; metathoracic legs (fig. G) 69, 89 (46-130) long.

Multilocular disc pores. Quinquelocular and 7-locular pores (fig. H) distributed in vicinity of spiracular atria, lacking elsewhere; 10-locular pores (fig. I) distributed in dense transverse band on each thoracic segment, each band beginning and ending at leg coxae and narrowing considerably, or disappearing, toward the center line of body, also distributed within intersegmental folds on all abdominal segments. As one progresses posteriorly, 10-locular pores become less randomly distributed and more concentrated into invaginations or pouches.

Abdominal setae (fig. J). Short and stout.

Abdominal derm (fig. K). Thickly beset with minute teeth, these only visible if specimen stained well.

Additional material studied. *Quercus arizonica*, AZ, Chiricahua Mts., Cave Cr., Cave Cr. Ranch, Jun. 21, 1967, coll. JWB, 9(9) JWB, 9(9) VPI; Chiricahua Mts., Jul. 11, 1940, GFF, 5(5) UCD, 3(3) VPI. *Q. borealis*, KS, Ft. Leavenworth

Military Reservation, Aug. 17, 1936, coll. E. R. Kell, 6(6) UCD, 6(6) VPI. *Q. douglasi*, **CA**, Tulare Co., East Orange Cove, Apr. 28, 1964, coll. H. Morrison, 1(1) CDA, 1(1) VPI. *Q. durata*, **CA**, Mt. St. Helena, 10 mi N of Calistoga, May 17, 1968, coll. JWB, 7(7) JWB, 7(7) VPI. *Q. emoryi*, **AZ**, Cochise Co., SW Research Station, 5 mi. W of Portal, elev. 5400 feet, Jul. 27, 1967, coll. MK, 2(2) VPI; Prescott, Jul., 1921, coll. RWD, 2(6), UCD; Santa Cruz Co., RR Ranch, N Patagonia, Jul. 21, 1974, coll. T. Halstead, 22(22), ACAH; **TX**, Chisos Mts., 1(1) UCD. *Q. falcata*, **LA**, New Iberia, Jun. 29, 1929, coll. H. K. Plank, 10(10) VPI; 5(5) USNM, 2(10) UCD. *Q. gravesii*, **TX**, Big Bend Natl. Park, Jun. 15, 1976, colls. MMK, 1(3), VPI. *Q. havardii*, **TX**, Comanche, Sep. 12, 1918, coll. AHH, 6(6) UCD; escarpment of the Statseel Plains near Quitaque, 1921, coll. GFF, 6(6) UCD. *Q. laevis*, **FL**, Levy Co., Rt. 24, Aug. 4, 1977, colls. FLC and SWB, 6(12), VPI. *Q. laurifolia*, **FL**, Wakuka Co., 16 mi. E of Co. line on Rt. 98, Aug. 5, 1977, colls. SWB and FLC, 4(4), VPI; **LA**, New Orleans, Jun. 10, 1905, coll. R. S. Cooks, 1(1) USNM, 1(1) VPI; **SC**, Charleston, Jun. 16, 1971, coll. MK, 7(26), VPI; **VA**, Arlington, 3519 Dinwiddie Street, Jun. 28, 1977, coll. Mrs. F. Halley, 12(24) VPI, 3(6) CDA. *Q. lobata*, **CA**, Davis, University of California, Shield's Grove Arboretum, Jul. 5, 1976, colls. MMK, 5(5) VPI. *Q.macrocarpa*, **KS**, Ft. Riley, Jul. 14, 1976, colls. MMK, 5(9) VPI. *Q. marilandica*, **NJ**, Ocean Co., Harrison Grove, Jul. 5, 1975, coll. DRM, 1(2) USNM; **TX**, near Goliad, 1921, coll. GFF, 3(5) UCD; **VA**, Amelia Co., Rt. 360, Aug. 14, 1963, colls. MK and D. Vest, 2(2) VPI. *Q. nigra*, **AL**, Lee Co., Auburn, Jun. 7, 1976, coll. MLW, 9(19) VPI; 1(1) AU; Lee Co., Auburn, S Gay Street, Jun. 7, 1976, coll. MLW, 15(15) AU, 16(16) VPI; tree near sidewalk across from Hardee's, Jun. 8, 1976, colls. MLW and MK, 10(37) VPI. **FL**, Alachua Co., Rt. 24, Aug. 1, 1977, colls. SWB and FLC, 6(8) VPI; Fellowship, Jun. 21, 1968, coll. E. W. Holder 3(3) FDA; Tallahassee, Aug. 31, 1972, coll. E. Nickerson, 1(1) FDA; **LA**, Baton Rouge, Jul. 15, 1907, coll. G. A. Runner, 3(3) USNM, 2(2) UCD, 5(5) VPI. *Q. oblongifolia*, **AZ**, Superior, Craig Ranch, Apr. 16, 1928, coll. A. A. Nichols, 1(1) UCD, 1(1) VPI. *Q. palustris*, **KS**, Topeka, Cage Park, Aug. 6, 1976, coll. H. E. Thompson, 2(2) USNM, 2(2) VPI; **MD**, College Park, Jul. 26, 1955, coll. H. S. McConnell, 1(1), USNM; **NJ**, Newark, Feb. 14, 1925, coll. F. M. Schott, 6(6) USNM, 3(6) UCD, 2(2) VPI. *Q. phellos*, **AL**, Elmore Co., Aug. 10, 1974, coll. CHR, 9(9) AU; *Q. shumardii* var. *texana*, **TX**, Chisos Mts., coll. GFF, 3(4) UCD. *Q. stellata*, **TX**, Bryan, May 3, 1919, coll. AHH, 2(2) UCD; Zanert Co., Wallace, Aug. 21, 1918, coll. AHH, 1(1) UCD. *Q. velutina*, **VA**, Craig Co., Broad Run, Jul. 22, 1967, coll. MLW, 4(4) VPI; Jul. 26, 1967, colls. MLW *et al.*, 4(4) VPI. *Q. virginiana*, **FL**, Leon Co., Oct. 17, 1973, coll. J. E. Nickerson, 7(12) VPI; Marion Co., Heagy Burry Park, Sep. 17, 1976, colls. CHR and L. R. Ray, 1(1) AU; **VA**, Virginia Beach, Seashore State Park, bay zone, Mar. 21, 1969, colls. J. O. Howell and MLW, 7(7) VPI. *Quercus* sp., **AL**, Jefferson Co., Dec. 5, 1975, coll. D. Bradford, 3(3) AU; **AZ**, Empire Mts., Apr. 4, 1937, coll. LPW, 5(5) UCD; Nogales, Jul. 13, 1934, coll. E. D. Ball, 2(2) UCD, 1(1) VPI; 5 mi. N of Prescott, Jul. 31, 1969, coll. MK, 10(10) VPI; 8 mi. E of Superior, Aug. 31, 1969, coll. D. B. Carver, 1(1) UCR; **CA**, Los Angeles, Mt. Lowe, Sep. 29, 1968, 6(6) IAE, 5(5) VPI. **CT**, Portland, Aug. 12, 1913, coll. BHW, 5(5) CAES, 4(4) VPI; **FL**, Miami, Dec. 25, 1974, coll. CHR, 3(3) VPI, 2(2) AU; **LA**, Baton Rouge, May 3, 1921, coll. W. Bradley, 1(2) UCD; New Orleans, Spanish Ft., Mar. 9, 1914, colls. Compere, Dietz, and Sasscer, 1(2) VPI; **MS**, Columbus, Jul.

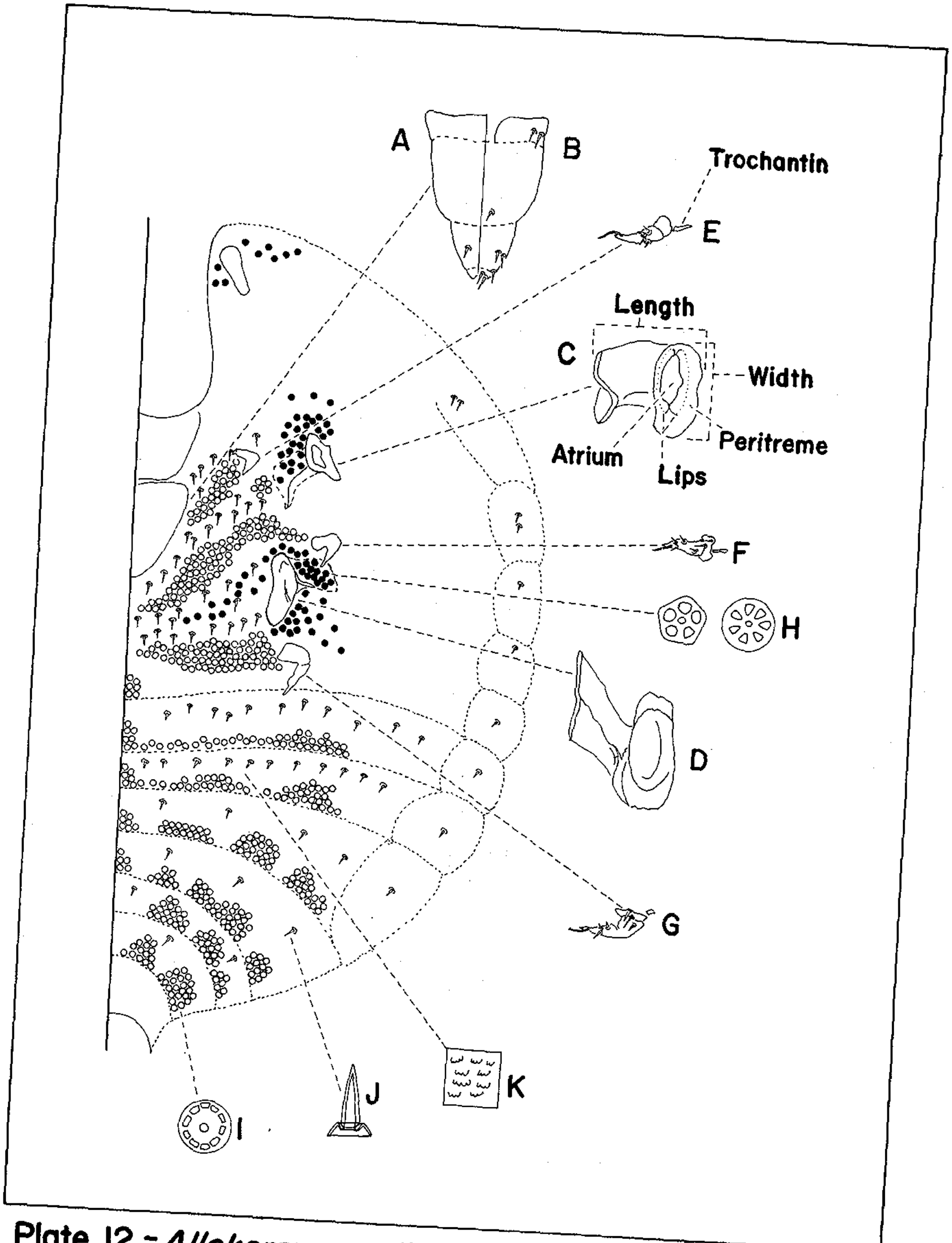


Plate 12.-*Allokermes galliformis* (Riley), adult sternum

12, 1930, coll. D. E. Williams, 2(5) UCD; Crystal Springs, Jun. 28, 1916, coll. C. M. Huber, 2(3) USNM; Lexington, Jul. 17, 1929, coll. Mrs. Johnson, 10(10) VPI, 5(5) USNM, 5(5) UCD. **NJ**, Bayonne, Aug. 18, 1908, coll. O. Farley, 5(5) VPI, 4(4) USNM; **OH**, Cleveland, Jul. 1913, coll. J. S. Houser, 1(1) OHSU; **PA**, Philadelphia, Aug. 16, 1919, coll. L. Morse, 1(1) USNM; **SC**, Lichtfield Beach, Jul. 7, 1968, coll. MK, 1(1) VPI; **TX**, Athens, Mar. 7, 1919, coll. AHH, 1(1) UCD; Chisos Mts., 1921, coll. GFF, 3(4) UCD; Corsicana, Aug. 30, 1918, coll. AHH, 2(2) UCD; between Decatur and Alvord, 1921, coll. GFF, 3(5) UCD; Edgewood, Aug. 23, 1918, coll. AHH, 4(6) UCD; Tyler, Jul. 10, 1918, coll. AHH, 11(11) UDC, 8(8) VPI; 1918, coll. Hall, 3(3) UCD; **VA**, Virginia Beach, Seashore State Park, Sep. 25, 1976, colls. MMK, 1(1) VPI; **MEXICO**, Chevela, elev. 1000 feet, Apr. 1926, coll. J. B. S. 4(9) UCD; Claxaca, Chivela, 1926, coll. GFF, 2(2) UCD.

THIRD INSTAR FEMALE

Plate 13

Type material studied. Topotypes from *Q. palustris*, **MO**, Sikeston, Jul. 6, 1976, coll. LRH, 2(8) VPI, 1(3) USNM.

Description. Body (fig. A) ovoid to circular, 1140, 1370 (1050-1730) long, 800, 1160 (800-1550) wide.

Tergum

Eyes (fig. B). Present, with 2 ocelli.

Tubular ducts (fig. C). Head 5, 5 (4-6) wide.

Quinquelocular disc pores. Lateral row absent; pre-anal row with pores extending on each side of body from posterior end of lateral row of tubular ducts to above anal lobes, ending abruptly.

Pre-anal enlargement (fig. D). With ca. 13 tubular ducts, 10 quinquelocular disc pores, 10 simple disc pores, and 7 setae.

Mid-dorsal enlargement (fig. E). With ca. 33 simple disc pores.

Setae. Marginals (fig. F) 10, 13 (10-17) long; pre-anals (fig. G) 20, 17 (11-30) long; anals 39, 50 (39-72) long.

Anal lobes (fig. H). Each with 26, 22 (16-26) setae.

Anal ring (fig. I). 99, 46 (32-99) long, 124, 50 (25- 124) wide.

Sternum

Antennae. Reduced, segmentation obscure, 111, 105 (93-123) long.

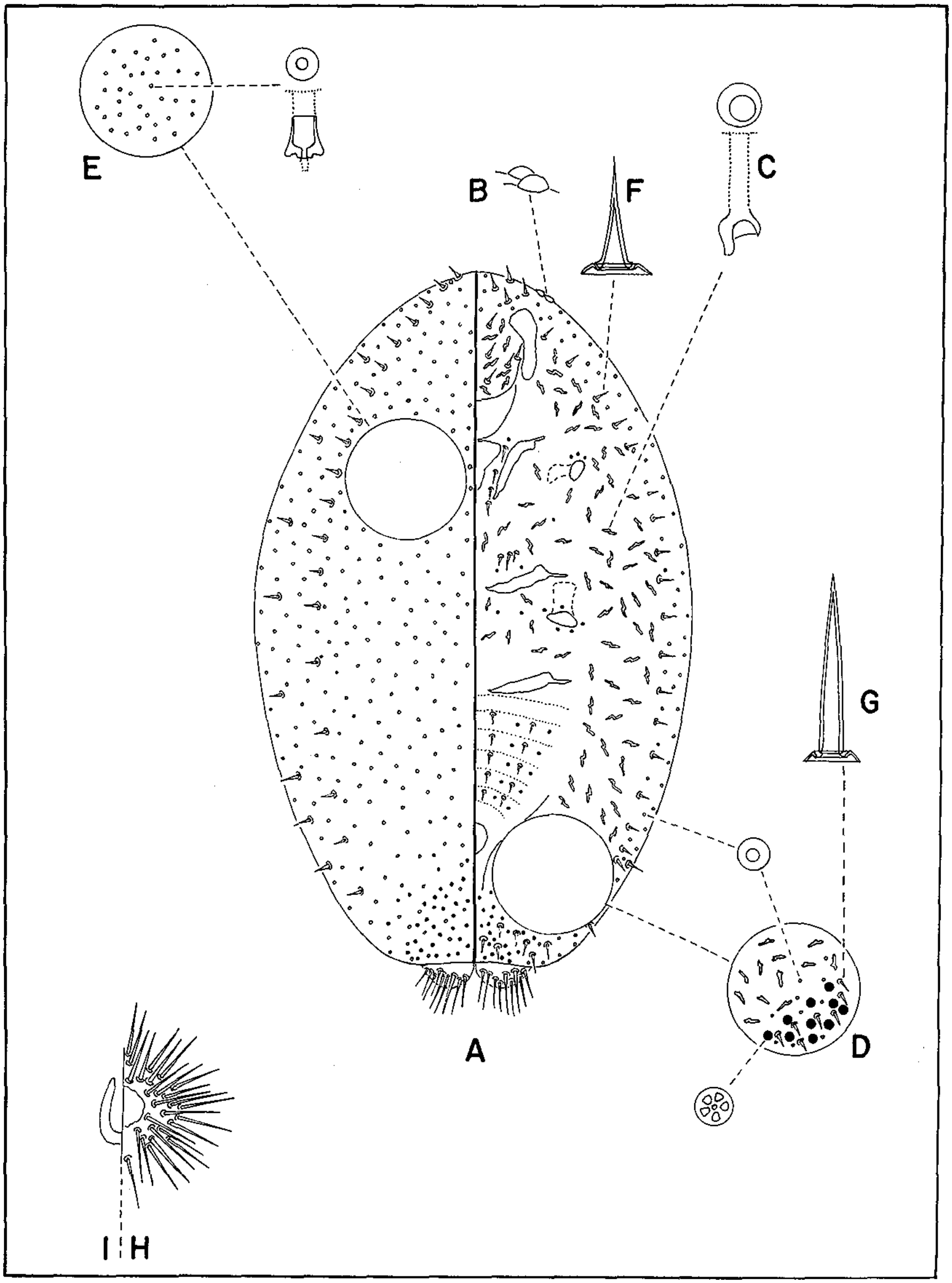


Plate 13.-*Allokermes galliformis* (Riley), third instar female

Labium. 309, 161 (99-309) long, 111, 103 (86-124) wide at base.

Spiracles. Anterior spiracles 62, 60 (54-62) long, atria 37, 39 (32-80) wide; posterior spiracles 62, 66 (49-79) long, atria 44, 40 (35-44) wide.

Legs. Prothoracic legs 136, 130 (123-165) long; mesothoracic legs 136, 136 (124-148) long; metathoracic legs 136, 148 (111-297) long.

Questionable identifications in literature. *Quercus alba,* **IN**, Brown Co. and Marion Co., near Indianapolis, summer 1911 (Dietz and Morrison, 1916:235,236); Tippecanoe Co. (Amos, 1933:206); **MA**, Lawrence, Methuen, Andover, Haverhill, and Dracot (King, 1899:139); **PA**, (Sleesman, 1945:44,45; Wilson, 1917:32,33). *Q. borealis,* **MA**, Lawrence, Methuen, Andover, Haverhill, and Dracot (King, 1899:139); **PA**, (Sleesman, 1945:44, 45); **CANADA**, Ontario, Toronto (Jarvis, 1908:52) Niagara District and SW corner of the province (Jarvis and Guelph, 1911:68,76). *Q. emoryi,* **NM**, Silver City, coll. H. H. Rusby (King, 1900b:78; Essig, 1915:117). *Q. garryana,* **NM**, Organ Mts., Dripping Spring (Cockerell, 1895a:244). *Q. ilicifolia,* **MA**, Lawrence, Methuen, Andover, Haverhill, and Dracot (King, 1899:139); **NY**, Middletown, Dec., coll. W. R. Walton (Lintner, 1896:60). *Q. kelloggii,* **CA**, Yolo Co., near Yolo, Cache Cr., May 16, 1910, coll. EJB (King, 1913b:206; Essig, 1915:116). *Q. nigra,* **LA**, (Newell and Rosenfeld, 1908:154). *Q. palustris,* **CT**, Wallingford (Britton, 1930:497). *Q. stellata,* **TX**, Navarro Co., near Corsicana, early Jan., 1918 (Hollinger and Parks, 1919:95). *Q. undulata,* **CO**, Manitou (Gillette and Baker, 1895:126). *Q. velutina,* **MA**, Lawrence, Methuen, Andover, Haverhill, and Dracot (King, 1899:139; Hollinger and Parks, 1919:92); **NY**, Ithaca, Cornell University, Karner, Middletown, and Brooklyn (Felt and Morrison, 1928:194). *Q. virginiana,* **FL**, Bradenton, Gainesville, Tampa, and West Palm Beach (Wilson, 1917:32,33); **LA**, New Orleans, Audubon Park (Barber, 1911:449,450); *Q. "wrightii,"* **NM**, Pinos Altos, coll. T.D.A. Cockerell (Cockerell, 1896b:226); *Quercus* sp., **AL** (Fernald 1903:62); **CA**, Los Angeles Co. (Howard, 1919:257); San Diego Co., Escondido (Essig, 1915:117); (Fernald, 1903:62; Carnes, 1906:17); **CO** (King, 1899:139, 1900b:78); **CT** (King, 1900b:78; Fernald, 1903:62; Britton, 1923:350,351); **DC**, (Fernald, 1903:62); **FL**, (King, 1900b:78; Fernald, 1903:62); Bradenton, Gainesville, Tampa, and West Palm Beach (Merrill and Chaffin, 1923:284); **IA**, Ames (Osborn, 1898:226); **KS**, Lawrence (Lawson, 1917:185; Hollinger and Parks, 1919:92); eastern portion, coll. GAD (Dean, 1909:265; Lawson, 1917:185); **LA** (Fernald, 1903:62); **MA** (King, 1900b:78; Fernald, 1903:62; Britton, 1923:350); coll. C. V. Riley (Balduf, 1939:21); **MO**, Boone, Jefferson, and St. Francis Co. (Hollinger, 1923:43); **NJ** (Fernald, 1903:62; Smith, 1909:122; Britton, 1923:350); **NM**, Las Vegas, Mar., 1900 (King, 1900b:78); Organ Mts., Pinos Altos (Cockerell, 1898a:65); (King, 1899:139; Fernald, 1903:62); **NY**, Middletown and Brooklyn (Felt, 1901:356; King, 1903a:22); Karner and Middletown (Hartman, 1916:94); (Lintner, 1896:60; King, 1899:139; Fernald, 1903:62; Britton, 1923:350); **OH**, Wooster, Sep. 29, 1899, coll. W. Newall (Webster and Burgess, 1902:110; Sanders, 1904:35); (King, 1899:139); **OK** (King, 1899:139); **SC**, Bluffton (Cockerell,1900:44); (King, 1900b:78); **UT**, Murray (Timberlake, 1916:396; Howard, 1919:256; Essig, 1926:833); North America E of Rocky Mts. (MacGillivray, 1921:196); nearly all parts of the United States (Doane, *et al.*, 1936:382, 383); eastern United States (Baker, 1972:97); **CANADA**, southern portion (Hoy, 1963:144).

Other literature citations. Balachowsky, 1950a:344; Bogue, 1898:172; Borchsenius, 1960:13; Carnes, 1906:18; Cockerell, 1894:31, 1895b:101, 1897b:95, 1898d:431, 1905:192; Comstock, 1881:337, 1883:132; Ehrhorn, 1898:186, 1899a:104; Ferris, 1955b:204; Hoy, 1963:144, 164; King, 1900b:78, 79, 81, 84, 1903a:21, 22, 1913b:206, 1914b:100; 1914c:133; Lindinger, 1910:324; MacGillivray, 1921:197; Maskell, 1894: 93; Newstead, 1902:138; Riley, 1894:70; Ruhl, 1917:50, 1923:4.

Remarks. This species, recorded from California to Virginia, has been verified as being found on at least 20 species of oaks. It is probably found throughout the southern temperate zone in North America.

Although the type specimens of *Kermes waldeni* King are easily separable from the type specimens of *A. galliformis* by structural and size differences between their spinescent pores, they appear identical in other respects. In addition, specimens from localities other than of the two types have spinescent pores intermediate in structure between the two. *K. waldeni* should perhaps be regarded as a subspecies of *A. galliformis* with a more northern distribution.

Some of the specimens listed here as *A. galliformis,* associated with first instars that are being described as a new species by Dr. R. G. Baer, do not differ from the topotypes of *A. galliformis.*

A. galliformis can apparently be distinguished from all other *Allokermes* by the following combination of characters: 1) pre-anal row of multilocular disc pores with a few pores extending medially onto median lobe of false venter, and also with pores extending dorsally to area adjacent to anal lobes but not above them; 2) lateral multilocular disc pores sparsely distributed in wide row; 3) spinescent 8-shaped pores longer than broad, with teeth and pits; and 4) anal lobe setae 54µ to 91µ long.

It is possible that *A. galliformis* contains a complex of several undescribed species or subspecies. A thorough study of the adult males undoubtedly will clarify this question.

Etymology. Riley named this species for its gall-like appearance.

ALLOKERMES GILLETTEI (COCKERELL)

Suggested common name: Gillette's Kermes.

Synonymy: *Kermes gillettei* Cockerell, 1895b:100, 101.
Coccus gillettei, Cockerell, 1929:150.
Talla gillettei, Lindinger, 1933:143.

Post-reproductive female. Cockerell (1895b) described the post- reproductive female as

> . . . 8 mm. long, 7 1/2 broad, 7 high. Distinctly segmented; dorsum with rounded tuberosities, not very shiny. Scale covered with minute dark brown specks. General colour ivory-white and dark brown mottled, the extent of the white or the brown variable, but usually a distinct white dorsal band, and more or less broken-up subdorsal ones.

YOUNG ADULT FEMALE

Plate 14

Type material studied. Topotypes from *Quercus* sp., **CO**, Manitou, Mar. 19, 1933, 2(2) UCD, 2(2) VPI.

The illustration and measurements were made from the following lot: *Quercus hypoleucoides*, AZ, 1/2 mi. up near Portal, Jun. 19, 1976, colls. MK, D. Hanna and I. Storks, 5(10), VPI.

Tergum

Description. Body (fig. A) ovoid or circular, 2480, 3330 (2480-5260) long, 2100, 3090 (2100-3710) wide.

Tubular ducts (fig. B). Head 11, 11 (8-12) wide.

Quinquelocular disc pores. Laterally distributed densely in narrow row (fig. C); pre-anal row with pores extending on each side of body from posterior end of lateral row of tubular ducts to area adjacent to anal lobes, ending abruptly; median lobe of false venter with several pores.

Pre-anal enlargement (fig. D). With ca. 26 quinquelocular disc pores and 4 setae.

Mid-dorsal enlargement (fig. E). With ca. 18 simple disc pores.

Spinescent 8-shaped pore (fig. F). 10, 14 (8-25) long, without teeth, pits unequal in length, divergent at tips; distributed in several transverse bands across mid-dorsum.

Setae. Marginals (fig. G) 18, 18 (17-22) long; pre-anals (fig. H) 20, 20 (15-37) long; anals 40, 44, (20-59) long.

Anal lobes (fig. I). Each with 23, 24 (20-26) setae.

Anal ring (fig. J). 74, 77 (68-93) long, 111, 115 (104- 124) wide.

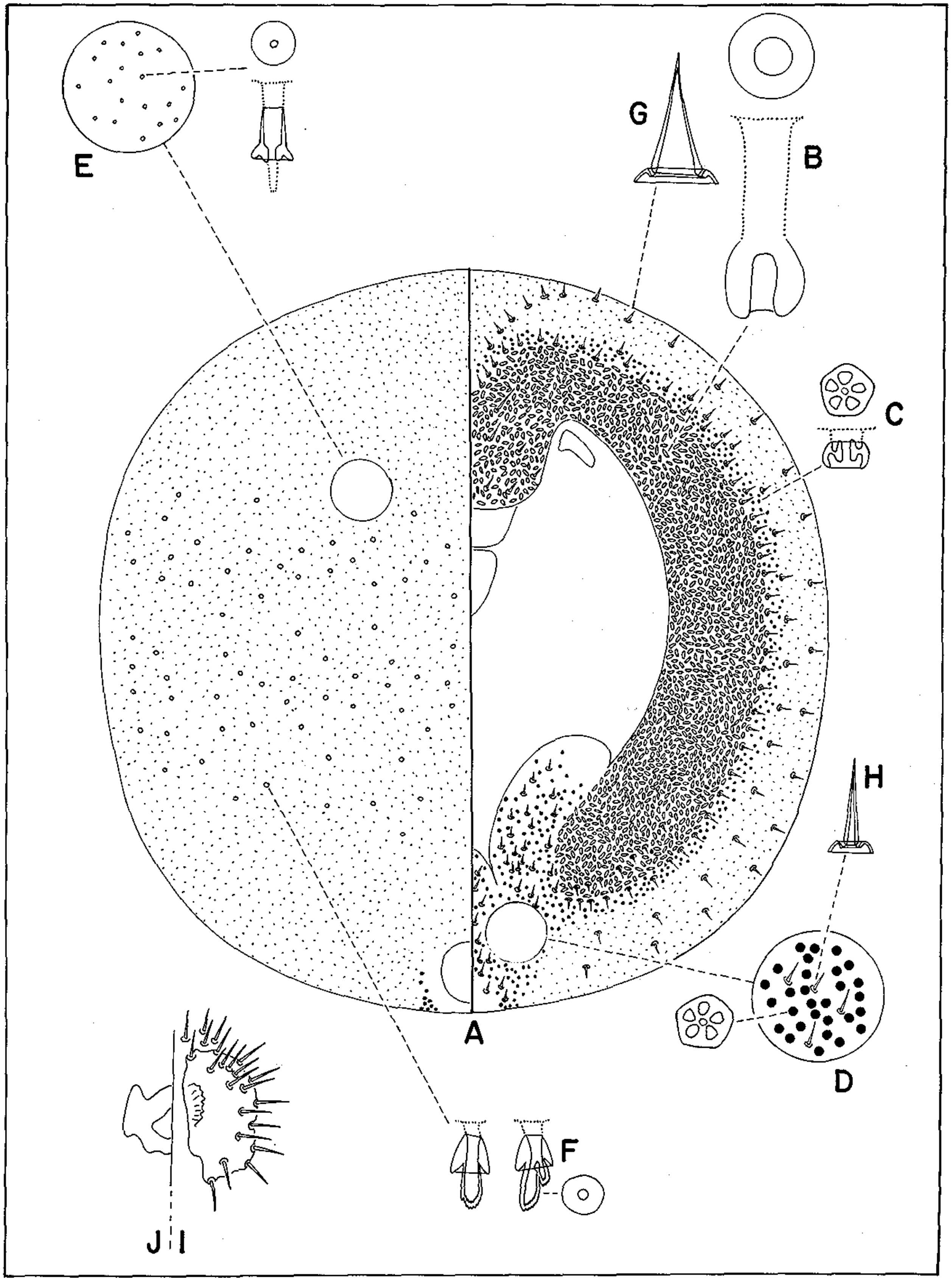


Plate 14.-*Allokermes gillettei* (Ckll.), adult female

Sternum

Antennae. Reduced, segmentation obscure, 111, 105 (62-167) long.

Labium. 148, 173 (148-217) long, 136, 134 (124-155) wide at base.

Spiracles. Anterior spiracles 99, 113 (99-124) long, atria 79, 84 (74-93) wide at base; posterior spiracles 99, 133 (99-167) long, atria 111, 113 (93-124) wide.

Legs. Prothoracic legs 130, 138 (130-179) long; mesothoracic legs 111, 137 (74-186) long; metathoracic legs 173, 147 (93-186) long.

Additional material studied. *Quercus emoryi*, **AZ,** near Portal on W slope of Silver Peak, Jun. 23, 1976, colls. MK and WAI, 3(3) VPI. *Quercus* sp., **AZ,** Greenlee Co., Rt. 666, Jul. 29, 1969, coll. MK, 7(14) VPI; Prescott, Indian Cr., Jul. 17, 1944, coll. LPW, 1(1) UCD; **CO,** 1(1), UCD; Colorado Springs, Sep. 3, 1919, coll. J. H. Pollock, 1(1) UCD; Douglas Co., Pike Natl. Forest, 20 mi. NW of Sedalia, Aug. 12, 1977, coll. WAI, 1(1) SWRS.

Questionable identifications in literature. *Quercus undulata*, NM (Fernald, 1903:62; MacGillivray, 1921:196). *Quercus* sp., **CO,** (Cockerell, 1905:191, 192); Trinidad (Lindinger, 1914: 116); Ouray, coll. E. Buthel (Cockerell, 1906:35); **NM,** Beulah, evel. 8000 feet, coll. T.D.A. Cockerell (King 1900b:79, 1914b:101); Las Cruces (Lindinger, 1914:116); (King, 1900b:79); northern part of state (Cockerell, 1905:192); (Cockerell, 1900:44; Essig, 1926:127; Doane *et al.*, 1936:382, 383); **TX** (Essig, 1926:276; Doane *et al*, 1936:382, 383).

Other literature citations. Balachowsky, 1950a:344; Cockerell, 1896a:327, 1897b:95; Ehrhorn, 1898:186; Ferris, 1955b:101; Gillette and Baker, 1895:126; Himebraugh, 1904:188; Hoy, 1963:145; King, 1913a:206.

Remarks. This species is found on *Quercus emoryi* and *Q. hypoleucoides* in Arizona and Colorado.

A. gillettei can apparently be distinguished from all other *Allokermes* by the following combination of characters: 1) pre-anal row of multilocular disc pores with a few pores extending medially onto median lobe of false venter, also these pores extending dorsally to area adjacent to anal lobes but not above them; 2) lateral multilocular disc pores in narrow, dense row; and 3) spinescent 8-shaped pores without teeth, longer than broad, resembling double pits, with pits unequal in depth.

The post-reproductive female is distinctive because of the paired dorsal tuberosities.

Etymology. Cockerell named this species in honor of C. P. Gillette.

ALLOKERMES GRANDIS (COCKERELL)

Suggested common name: The Giant Kermes.

Synonymy: *Kermes grandis* Cockerell, 1898d:431.
Lecanium tubuliferum Cockerell, 1898b:132. New synonym.
Talla grandis, Lindinger, 1933:143.

Post-reproductive female. Cockerell (1898d) described the post-reproductive female as:

> Globular, 10 millim. diam., not visibly segmented, surface dull; peppered or marbled with black, grey, and white. With a lens the white areas are seen to be thickly sprinkled with minute brown spots. The black and brown marbling is quite irregular.

YOUNG ADULT FEMALE

Plate 15

Type material studied. Paratypes from *Quercus engelmanni*, **MEXICO**, Amecameca, May 25, 1897, coll. Koebele, 2(2) UCD. One of these specimens has been marked as the lectotype, the other as a paralectotype.

Tergum

Description. Body (fig. A) circular, ca. 804 long, ca. 804 wide.

Tubular ducts. (fig. B). Head 12, 11 (10-12) wide.

Multilocular disc pores. Lateral row (fig. C) with quinquelocular pores distributed very densely anteriolaterally to rostrum and restricted to narrow band paralleling lateral row of tubular ducts; pre-anal row composed of quinquelocular and 7-locular pores, wide basally, tapering on each side of body from posterior end of lateral row of tubular ducts to point 1 or 2 pores wide adjacent to anal lobes; median lobe of false venter with ca. 38 pores.

Pre-anal enlargement (fig. D). With ca. 18 quinquelocular disc pores, 2, 7-locular disc pores, and 4 setae.

Mid-dorsal enlargement (fig. E). With ca. 14 simple disc pores.

Spinescent 8-shaped pores (fig. F). 13, 19 (13-25) long, teeth well developed, pits absent; distributed in several transverse bands on mid-dorsum.

Amorphous pores (fig. G). Present on mid-dorsum.

Setae Marginals (fig. H) 10, 18 (10-25) long; pre-anals (fig. I) 43, 37 (30-43) long; anals 74, 64 (54-74) long.

Anal lobes (fig. J). Each with 22, 19 (16-22) setae.

Anal ring (fig. K). 111, 99 (86-111) long, 148, 142 (136-148) wide.

Sternum

Antennae. Elongate, segmentation obscure, 136, 124 (111-136) long.

Labium. 74, 158 (74-241) long, 54, 107 (54-160) wide at base.

Spiracles. Anterior spiracles 136, 143 (136-149) long, atria 142, 118 (93-142) wide; posterior spiracles 111, 133 (111-155) long, atria 173, 195 (173-217) wide.

Legs. Prothoracic legs 155, 186 (155-216) long; mesothoracic legs 111, 74 (37-111) long; metathoracic legs 173, 186 (173-198) long.

Other literature citations. Balachowsky, 1950a:344; Cockerell, 1898b:132, 1899a:10, 1899b:393, 1900:44; Fernald, 1903:62; Ferris, 1955b:199; Hoy, 1963:146; King, 1900b:80; MacGillivray, 1921:196.

Remarks. This species, found on *Quercus engelmanni* in Mexico, appears to be rare. *A. grandis* can apparently be distinguished from all other *Allokermes* by the following combination of characters: 1) pre-anal row of multilocular disc pores with ca. 25 to 40 pores extending medially onto median lobe of false venter, also with pores extending dorsally to area adjacent to anal lobes but not above them; 2) spinescent 8-shaped pores without pits.

Etymology. Cockerell named this species for its large size and striking coloration.

ALLOKERMES KINGI (COCKERELL)

Color figs. 10, 11, 12. Plate 2 C, D

Suggested common name: Northern Red-oak Kermes

Synonymy: *Kermes kingi* Cockerell, 1898c:330.
Talla kingi, Lindinger, 1933:143.

Post-reproductive female. Cockerell (1898c) described the postreproductive female as:

> Very convex, but the sides hardly bulging; length 5, breadth 4 1/3, height about 3 1/2 millim. Colour light ochreous, of quite a bright tint, marbled with a slightly darker redder tint; the marbling is absent in the mid-dorsal line, leaving a more or less distinct longitudinal pallid band;

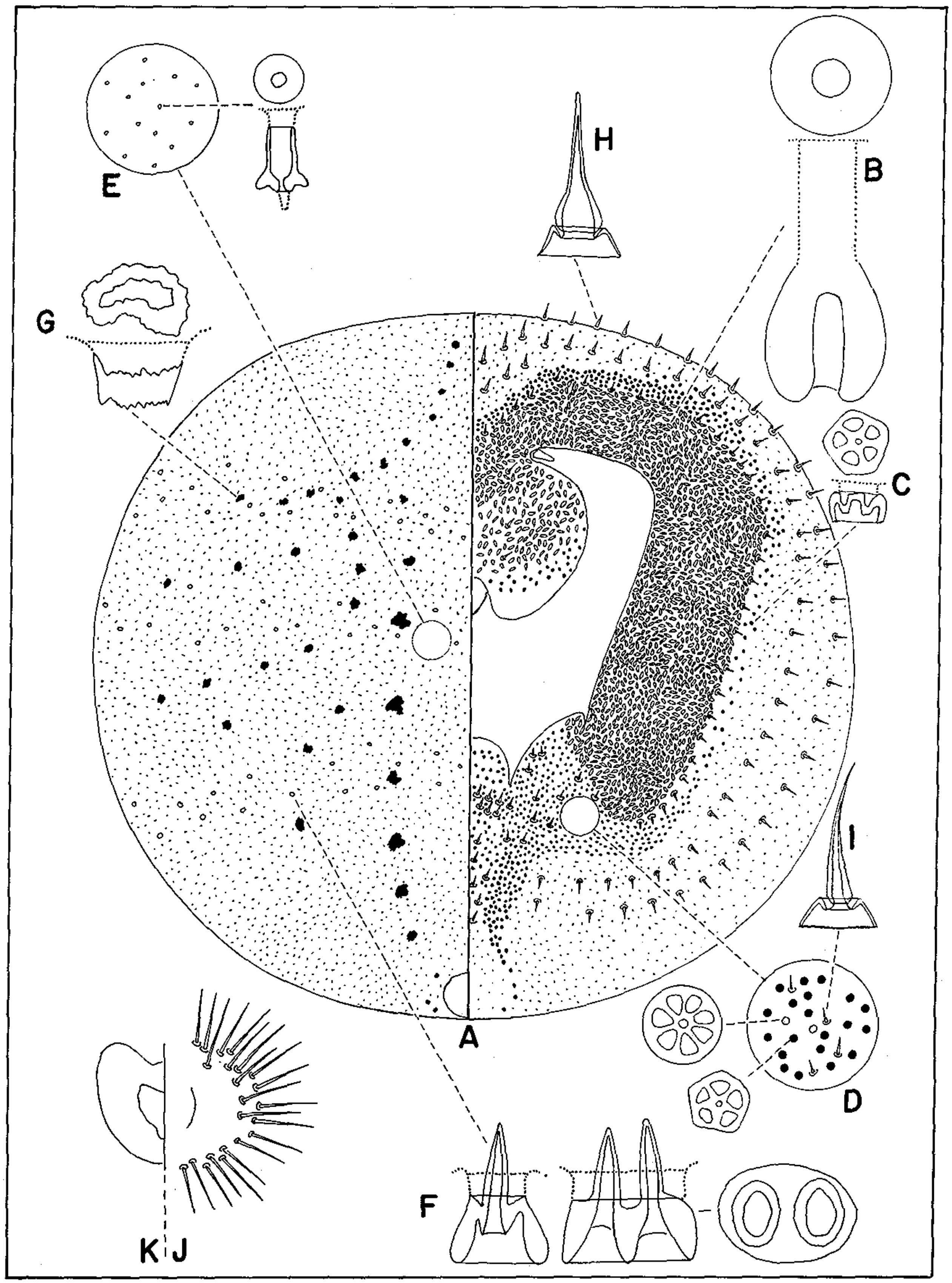


Plate 15.- *Allokermes grandis* (Ckll.), adult female

segmentation vaguely indicated by transverse rows of small black spots; entire surface very closely beset with minute dark dots. The scale is evenly rounded dorsally, without any prominences or depressions.

YOUNG ADULT FEMALE

Plate 16

Type material studied. Paratype, in poor condition, from *Quercus borealis*, MA, Lawrence, Jul. 28, 1898, coll. GBK, 1(1) AMNH; *Q. velutina*, MA, Lawrence, off State Rt. 114, Jun. 17, 1976, coll. SWB, 1(1) VPI.

The illustration was made from the following lot: *Quercus borealis*, PA, Norristown, let. of Jun. 29, 1937, fr. M. C. Van Horn, 1(3) USNM.

Tergum

Description. Body (fig. A) somewhat pentagonal or circular, 2400, 2440 (1860-3220) long, 3520, 2680 (1860-3590) wide.

Tubular ducts (fig. B). Head 9, 10 (9-11) wide.

Quinquelocular disc pores. Lateral row (fig. C) with sparsely distributed pores extending onto and covering mid-dorsum; pre-anal row with densely distributed pores extending on each side of body from posterior end of lateral row of tubular ducts to above anal lobes and then becoming less densely distributed, grading into pores on mid-dorsum; absent on median lobe of false venter.

Pre-anal enlargement (fig. D). With ca. 89 quinquelocular disc pores and 6 setae.

Mid-dorsal enlargement (fig. E). With ca. 3 quinquelocular disc pores and 38 simple disc pores.

Spinescent 8-shaped pores (fig. F). 19, 19 (14-27) long, teeth converging at tips, subequal to pits, distributed in several transverse bands on mid-dorsum.

Setae. Marginals (fig. G) 18, 19 (17-21) long; pre-anals (fig. H) 18, 18 (17-22) long; anals 59, 51 (37-59) long.

Anal lobes (fig. I). Each with 15, 18 (15-23) setae.

Anal ring (fig. J). 88, 93 (84-106) long, 98, 108 (98-116) wide.

Sternum

Antennae. Reduced, segmentation obscure, 123, 101 (74-123) long.

Labium. 148, 163 (99-203) long, 128, 128 (104-156) wide at base.

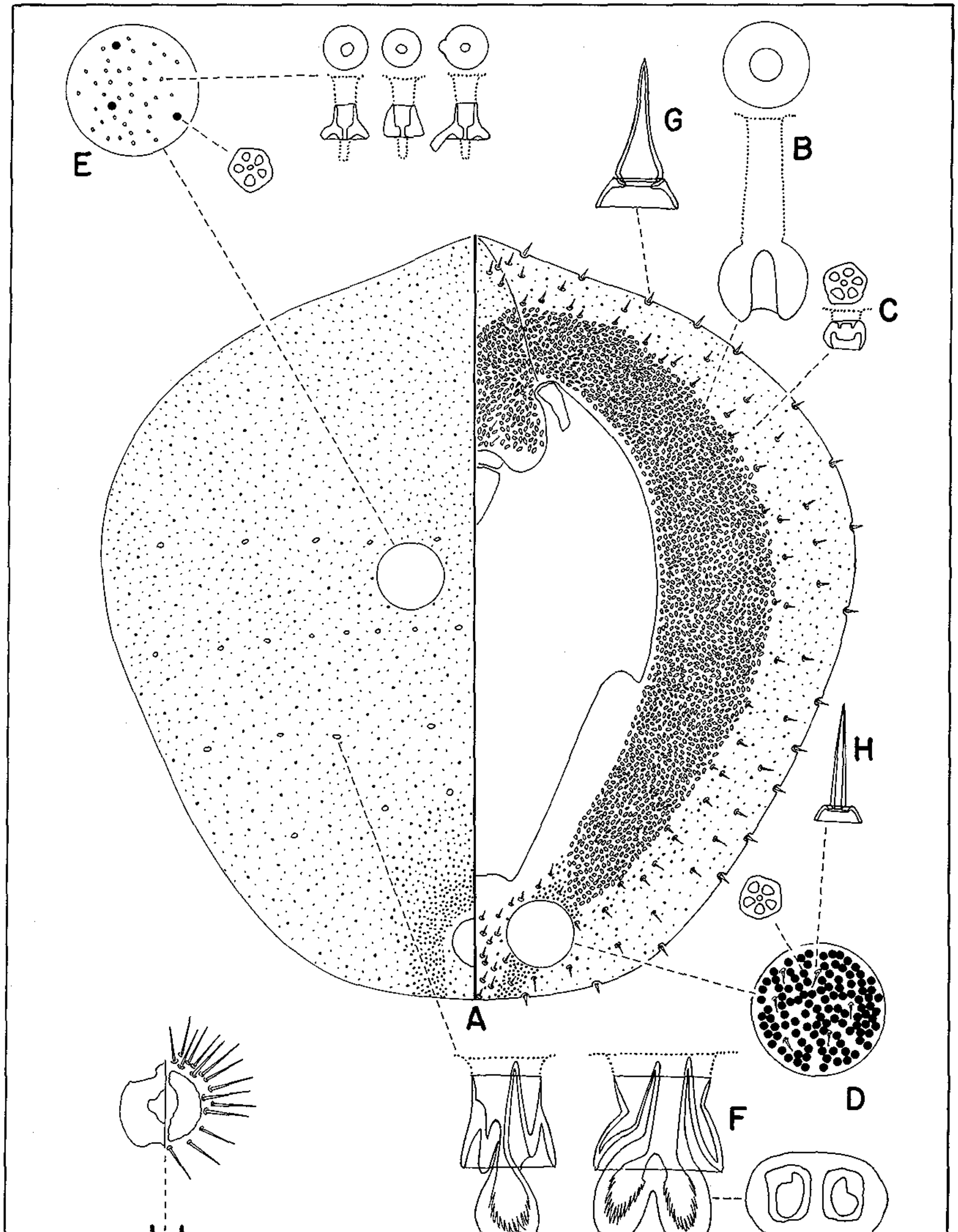


Plate 16.-*Allokermes kingi* (Ckll.), adult female

Spiracles. Anterior spiracles 119, 127 (104-138) long, atrium 74, 92 (74-111) wide; posterior spiracles 143, 139 (105-173) long, atria 99, 132 (99-160) wide.

Legs. Prothoracic legs 124, 123 (109-136) long; mesothoracic legs 86, 92 (80-105) long; metathoracic legs 74, 128 (74-186) long.

Additional material studied. *Quercus borealis,* **IN,** Orange Co., coll. J. M. Amos, 3(3) VPI; **NY,** Staten Island, Sep. 4, 1917, coll. RWD, 2(2) UCD; **OH,** Columbus, Ohio State University, Jul. 19, 1976, colls. MMK, 22(163) VPI; **OH,** rest area on Rt. 33 E of St. Mary's Jul. 18, 1976, colls. MMK, 14(37) VPI; **VA,** Montgomery Co., Blacksburg, May 19, 1969, colls. G. W. Dekle, MLW, and J. O. Howell, 2(2) FDA; Montgomery Co., Blacksburg, VPI, Jun. 12, 1974, coll. ABH, 1(2) VPI; Jul. 1 & 9, 1974, coll. ABH, 25(25) VPI; Jul. 18, 1974, coll. ABH, 3(4) VPI; Jul. 23, 1974, coll. ABH, 3(3) VPI; Jul. 24, 1974, coll. ABH, 16(16) VPI; Jul. 30, 1974, coll. ABH, 23(23) VPI; *Q. coccinea,* **OH,** Cincinnati, Jul. 31, 1915, colls. J. M. McCulloch and Sons, 3(3) OHSU, 3(3) VPI. *Q. ilicifolia,* **VA,** Montgomery Co., Blacksburg, VPI, Aug. 16, 1968, coll. MLW, 1(1) VPI; Oct. 18, 1968, coll. MK, 1(1), VPI. *Q. imbricaria,* **OH,** Ohio State University, Jul. 16, 1960, coll. MK, 8(8) VPI. *Q. laurifolia,* **FL,** Gainesville, Jul. 30, 1971, coll. G. W. Dekle, 4(4) FDA; **IN,** W. Lafayette, Oct. 21, 1931, coll. J. M. Amos, 3(3) VPI. *Q. phellos,* **AL,** Leesburg, Sep. 1, 1974, coll. CHR, 6(6) AU. *Q. velutina,* **IN,** Purdue University, Jul. 8, 1974, coll. D. L. Schuder, 1(1) VPI; **PA,** W Chester, Nov. 5, 1908, coll. F. Windle, 2(2) USNM, 1(1) UCD, 2(2) VPI; **VA,** Craig Co., Broad Run, Jul. 22, 1967, colls. MLW and CGW, 1(1) VPI. Montgomery Co., Blacksburg, VPI, Jun. 5, 1975, coll. ABH, 1(5) VPI; Jun. 19, 1975, coll. ABH, 2(8) VPI; Jul. 2, 1975, coll. ABH, 16 (43) VPI; Jul. 24, 1974, coll. ABH, 3(3) VPI; Sep. 18, 1974, coll. RGB, 6(6) VPI; Nov. 4, 1974, coll. ABH, 8(8) VPI; Dec. 30, 1974, coll. ABH, 8(8) VPI; Aug. 7, 1974, coll. ABH, 4(4) VPI. *Quercus* sp., **DC,** Washington, Jun. 18, 1970, colls. DRM and S. Nakahara, 3(6) USNM; **FL,** Indian River Co., 10 mi. W of Vero Beach, May 8, 1975, colls. DRM, R. F. Denno, and J. A. Davidson, 4(8) VPI; Shady, Rt. 475A, Sep. 17, 1976, colls. CHR and L. R. Ray, 2(2) VPI; **GA,** Henry Co., Jun. 8, 1976, coll. R. Beshear, 1(1) VPI; **OH,** Cincinnati, Aug. 3, 1916, colls. J. M. McCulloch and Sons, 1(1) OHSU; **TN,** roadside park 6.5 mi. E of Maryville on Rt. 73, Jun. 6, 1976, colls. MMK, 3(6) VPI; **VA,** Skyline Drive, Hazel Overlook, Jul. 29, 1958, coll. MK, 15(15) VPI; Montgomery Co., Blacksburg, VPI, Jun. 16, 1975, coll. ABH, 3(6) VPI.

Questionable identifications in literature. *Q. borealis,* **DE** (Fernald, 1903:63; MacGillivary, 1921:197); **IN,** Tippecanoe Co. (Amos, 1933:206); **MA,** Lawrence, Jul. 28, 1898, coll. GBK (King, 1900b:80); **NJ,** (Smith, 1909:122); **NY,** Long Island, Masbeth, Maurice Woods, coll. C. E. Olsen (Olsen, 1919:141; Balduf, 1939:20, 21); Middletown (Felt and Morrison, 1928:194); **OH,** Pomeroy, Aug. 28, 1903, coll. JGS (Sanders, 1904:36); Salem, coll. JGS (Sanders, 1904:36); **PA,** (Trimble, 1928:43); **VA,** Jun.-Sep., 1974, 1975, coll. ABH (Hamon *et al.*, 1976:62); eastern United States of America (Hoy, 1963:148); United States of America (Hamon *et al.*, 1975); *Q. imbricaria,* **IN,** Covington (Dietz and Morrison, 1916:235); Tippecanoe Co., (Amos, 1933:206); eastern United States of America (Hoy, 1963:148); **OH,** Lisbon, coll. JGS (Sanders, 1904:36); **VA,**

Jun.-Sep., 1974, 1975, coll. ABH (Hamon *et al.*, 1976); **CT**, New Haven, Nov. 11, 1913, coll. BHW (King, 1914d:151); *Quercus* sp., **CT**, New Haven, Aug. 20, 1908, coll. H. L. Vierek, Aug. 26, 1913, coll. QSL (King, 1914d:151); (Britton, 1920:63); New Haven, Jan. 24, 1911, Nov. 11, 1915, coll. BHW, Aug. 26, 1913, coll. QSL (Britton, 1923:351); **DE**, (Cockerell, 1900:44); coll. C.P. Gillette (King, 1900b:80); (Merrill and Chaffin, 1923:284); **FL**, Cutler, Ft. Pierce, Gainesville, Oneco, Orlando, Tampa, West Palm Beach (Merrill and Chaffin, 1923:284); **IN**, Indianapolis (Dietz and Morrison, 1916:235); Merrill and Chaffin, 1923:284); **MA**, Springfield (King, 1900c:117); (Merrill and Chaffin, 1923:284); E coast of United States of America (Doane *et al.*, 1936:382, 383); eastern United States of America (Baker, 1972:97).

Other literature citations. Balachowsky, 1950a:344; Britton, 1923:350; Cockerell, 1899c:276; Ferris, 1921:61; 1955b:200; Fulmek, 1943:38; Lindinger, 1908:96.

Remarks. This species has been recorded from eight species of oaks, but principally from *Quercus borealis* and *Q. velutina.* All records are from the northeastern United States, the mountains of Virginia, or Alabama and Florida. The southern records on *Q. phellos* and *Q. laurifolia* may represent another undescribed species, but appear to be indistinguishable from *A. kingi* morphologically.

A. kingi can apparently be separated from all other *Allokermes* by the following combination of characters: 1) pre-anal row of quinquelocular disc pores not extending medially onto median lobe of false venter, also with pores extending dorsally to above anal lobes, encircling them; 2) lateral row of quinquelocular disc pores present, extending dorsally into sparsely distributed quinquelocular disc pores on mid-dorsum; and 3) spinescent 8-shaped pores with small teeth that are subequal to length of pits.

Etymology. Cockerell named this species in honor of G.B. King.

ALLOKERMES KOSZTARABI (BAER)

Common name: Kosztarab's Gall-like Coccoid.

Synonymy: *Kermes kosztarabi* Baer, 1980:20-25. Baer and Kosztarab, 1985.

Post-reproductive female. This stage was never described, because we could not separate this species through the adult females from *A. galliformis* (Riley). The original description of the species was based on first instar nymphs.

For more records on this species, the reader should see the studies by Baer (1980) and by Baer and Kosztarab (1985).

ALLOKERMES NIVALIS (KING AND COCKERELL)

Suggested common name: The White Kermes

Synonymy: *Kermes nivalis* King and Cockerell, Cockerell, 1898c:330.
Coccus nivalis, Cockerell, 1929:150.
Talla nivalis, Lindinger, 1933:143.

Post-reproductive female. King and Cockerell (1898c) described the post-reproductive female as

> Length 4 1/2, breadth 4 1/2, height about 3 millim. Dark sepia-brown, irregularly marbled with blackish and pale ochreous, the latter colour inclined to be arranged in transverse bands, and beset with numerous minute dark dots. All of the scale except the middle of the back is powdered with snow-white secretion, which becomes very abundant at the sides. Microscopical characters ordinary; skin fairly closely beset with small round glands, and showing some larger glands at irregular intervals, on brown patches.

YOUNG ADULT FEMALE

Plate 17

Type material studied. Topotypes from *Quercus borealis*, MA, Lawrence, off State Rt. 114, Jun. 18, 1976, coll. SWB, 1(3) VPI.

Tergum

Description. Body (fig. A) somewhat pentagonal or circular, 2330, 2230 (2040-2410) long, 1920, 2043 (1920-2170) wide.

Tubular ducts (fig. B). Head 10 long, ca. 10 wide.

Multilocular disc pores. Lateral row (fig. C) with densely distributed quinquelocular and 7-locular pores extending onto and covering mid-dorsum; pre-anal row with densely distributed pores extending on each side of body from posterior end of lateral row of tubular ducts to above anal lobes and then becoming slightly less densely distributed, grading into pores on mid-dorsum; absent on median lobe of false venter.

Pre-anal enlargement (fig.D). With ca. 22 quinquelocular disc pores, 8, 7-locular disc pores, and 4 setae.

Mid-dorsal enlargement (fig. E). With ca. 19 quinquelocular disc pores, 1, 7-locular disc pore, and 25 simple disc pores.

Spinescent 8-shaped pores (fig. F). 9, 11 (9-12) long, teeth sunken within rim, pits absent; distributed in several transverse bands on mid-dorsum.

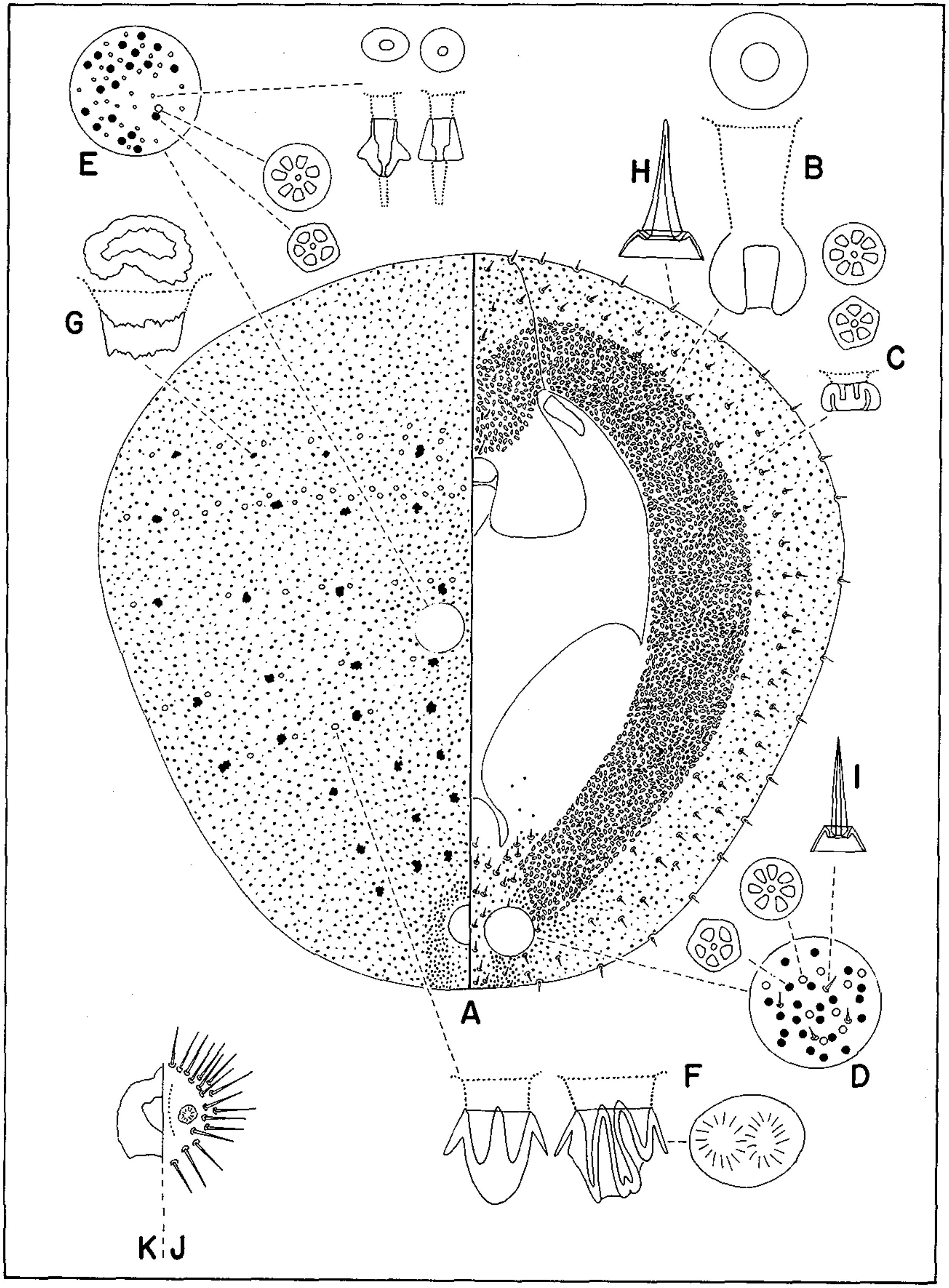


Plate 17.-*Allokermes nivalis* (King and Ckll.), adult female

Amorphous pores (fig. G). Present on mid-dorsum in several transverse bands.

Setae. Marginals (fig. H) 22, 20 (17-22) long; pre-anals (fig. I) 17, 20 (17-25) long; anals 37, 35 (31-39) long.

Anal lobes (fig. J). Each with 17, 14 (13-17) setae.

Anal ring (fig. K). 109, 86 (74-109) long, 104, 117 (104-124) wide.

Sternum

Antennae. Elongate, segmentation obscure, 124, 130 (111-155) long.

Labium. 161, 173 (161-203) long, 136, 138 (136-143) wide at base.

Spiracles. Anterior spiracles 136, 128 (124-136) long, atria 59, 57 (49-62) wide; posterior spiracles 136, 136 (123-148) long, atria 86, 94 (86-99) wide.

Legs. Prothoracic legs 136, 131 (123-136) long; mesothoracic legs 161, 169 (149-197) long; metathoracic legs 179, 142 (111-179) long.

Questionable identifications in literature. *Quercus alba,* KS, Lawrence, coll. S. J. Hunter (Dean, 1909:266). *Quercus* sp., E coast (Doane, *et al.*, 1936;382, 383).

Other literature citations. Balachowsky, 1950a:344; Britton, 1923:350; Cockerell, 1899b:393, 1900:44; Fernald, 1903:64; Ferris, 1955b:201; Hoy, 1963:151; King, 1900b:80; Lawson, 1917:183; MacGillivray, 1921:195; Newstead, 1902:138.

Remarks. This species is found on *Quercus borealis* and *Q. alba* in Massachusetts. A post-reproductive female paratype, collected on *Q. alba* (as was the holotype) was available for study. It is covered with a white mealy wax, which, in the authors' opinion, could have been secreted only by the multilocular disc pores present on the dorsum of the slide-mounted *Q. borealis* specimens. For this reason the two lots from the two hosts are considered as belonging to the same species.

A. nivalis can apparently be distinguished from all other *Allokermes* by either of the following: 1) the presence of a gland on each anal lobe; and 2) the presence of quinquelocular and 7-locular disc pores densely distributed on the mid-dorsum. Both characters are exclusive to *A. nivalis*. *A. nivalis* is an uncommon species.

Etymology. King and Cockerell named this species for the snow-white secretion that covers its dorsum.

ALLOKERMES RATTANI (EHRHORN)

Suggested common name: Rattan's Kermes.

Synonymy: *Kermes rattani* Ehrhorn, 1906:329.
Talla rattani, Lindinger, 1933:143.

Post-reproductive female. Ehrhorn (1906) described the post-reproductive female as

> . . . globose, from 5 to 6 mm. in diameter, varying a little according to position on twig. Surface smooth, not shiny, nor hardly pubescent, sometimes waxy. Colour light brown, generally with four white stripes running parallel with segmentation. When seen through lens these stripes have numerous brown dots at intervals.

YOUNG ADULT FEMALE

Plate 18

Type material studied. None.

The illustration and measurements were made from the following lot, which was identified as *Kermes rattani* by G. F. Ferris: *Chrysolepis chrysophylla*, **CA,** San Jose, Loma Prieta Mt., Jul. 16, 1922, coll. GFF, 12(14) UCD, 7(7) VPI.

Tergum

Description. Body (fig. A) somewhat pentagonal or ovoid, 1730, 2610 (1730-3590) long, 1610, 2925 (1610-4330) wide.

Tubular ducts (fig. B). Head 10, 10 (8-12) wide.

Quinquelocular disc pores. Lateral row absent; pre-anal row with pores extending on each side of body from posterior end of lateral row of tubular ducts to above anal lobes; several pores on median lobe of false venter.

Pre-anal enlargement (fig. C). With ca. 43 quinquelocular disc pores and 5 setae.

Mid-dorsal enlargement (fig. D). With ca. 28 simple disc pores.

Spinescent 8-shaped pores (fig. E). 22, 17 (12-22) long, teeth absent, pits enlarged, saclike; distributed in several transverse bands on mid-dorsum.

Setae. Marginals (fig. F) 20, 23 (13-74) long; pre-anals (fig. G) 24, 28 (17-44) long; anals 47, 67 (47-74) long.

Anal lobes (fig. H). Each with 15, 22 (11-32) setae.

Anal ring (fig. I). 124, 103 (86-167) long, 74, 113 (74-148) wide.

Sternum

Antennae. Reduced to elongate, segmentation obscure, 136, 111 (74-136) long.

Labium. 203, 184 (155-217) long, 148, 154 (128-222) wide at base.

Spiracles. Anterior spiracles 111, 143 (104-204) long, atria 86, 89 (67-111) wide; posterior spiracles 128, 163 (124-216) long, atria 99, 100 (49-124) wide.

Legs. Prothoracic legs 148, 147 (68-173) long; mesothoracic legs 111, 140 (99-186) long; metathoracic legs 178, 126 (80-186) long.

Additional material studied. *Chrysolepis sempervirens*, **CA**, Mammoth Lakes, 0.2 mi. before entrance to Earthquake Fault Picnic Area, Jun. 29, 1976, coll. MK, 9(9) VPI; *Quercus douglasii*, **CA**, Putah Cr., Monticello Dam, Dec. 6, 1967, coll. JWB, 1(1) JWB, 1(1) VPI.

Questionable identifications in literature. *Chrysolepis* sp., **CA**, Santa Catalina, Mountain View (Hoy, 1963:156, 157). *Quercus chrysolepis*, Santa Catalina, Mountain View (Hoy, 1963:156, 157); Santa Catalina, Pebbly Beach (Cockerell, 1940:288); Santa Cruz Peninsula (Ferris, 1920:28).

Other literature citations. Balachowsky, 1950a:344; MacGillivray, 1921:197.

Remarks. This species, found on *Chrysolepis* species and *Quercus douglasii* in California, is the only *Allokermes* recorded from *Chrysolepis* species. The specimens from *C. sempervirens*, with a narrow lateral row of quinquelocular disc pores that the specimens on *C. chrysophylla* do not have, probably deserve subspecific status.

A. rattani can apparently be distinguished from all other *Allokermes* by the following combination of characters: 1) spinescent 8-shaped pores without teeth, with pits saclike; and 2) pre-anal row of multilocular disc pores with a few quinquelocular disc pores extending medially onto median lobe of false venter, also with pores extending dorsally to above anal lobes, encircling them.

Etymology. Ehrhorn named this species in honor of V. Rattan.

DESCRIPTION OF KERMES BOITARD

Type: *Kermes roboris* (Fourcroy)

Adult female [**plate 22,** *Kermes sylvestris* (Ckll. and King)]. With 1 tubular duct type (fig. B); dorsum without heavily sclerotized pores; spiracular furrow absent; multilocular disc pores always present laterally, and if not covering

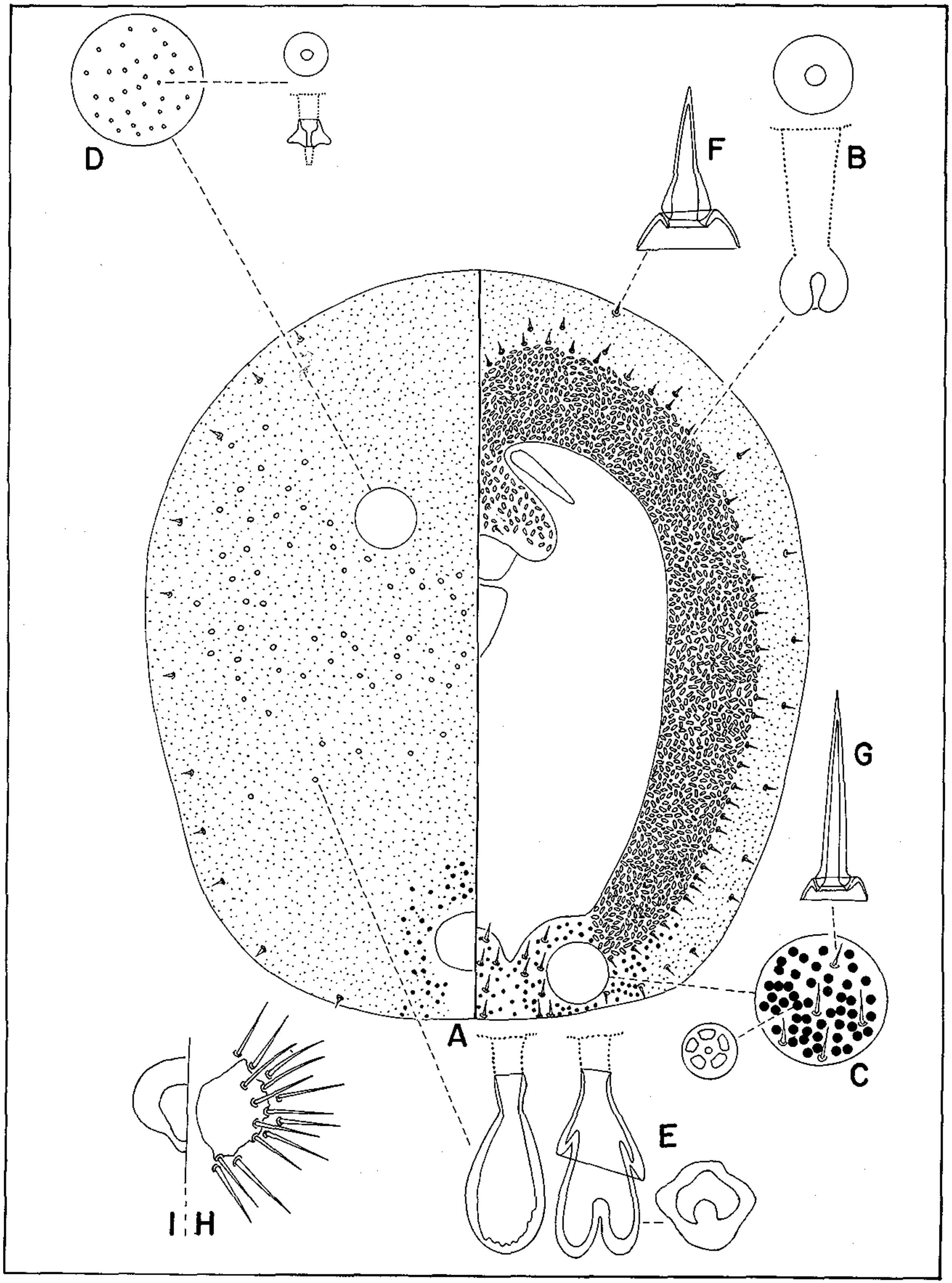


Plate 18.-*Allokermes rattani* (Ehrhorn), adult female

entire dorsum, clustered about marginal setae (fig. C); anal lobes membranous, ventral to anal opening, without definite margins, and each bearing 2 slender setae (fig. H, with arrows) dorsally, and from 11 to 24 long, slender setae ventrally (fig. H); anal ring narrow, cordlike, with margins not distinct from surrounding derm, and not enclosing third instar anal ring (fig. I).

Third instar female [plate 24, *Kermes sylvestris* (Ckll. and King)]. With 1 tubular duct type (fig. B); dorsum without heavily sclerotized pores; spiracular furrow absent; multilocular disc pores always present laterally, and if not covering entire dorsum, clustered about marginal setae (fig. C); anal lobes membranous, ventral to anal opening, without definite margins, and each bearing 2 slender setae dorsally (fig. I, with arrows), and from 11 to 24 long, slender setae ventrally (fig. I); anal ring narrow, cordlike, with margins not distinct from the surrounding derm (fig. J).

Remarks. The genus is represented in both the Nearctic and Palearctic Regions. In our opinion, based on Borchenius' (1960) illustrated descriptions of the Palearctic *Kermes roboris*, it appears that *K. roboris* belongs together in the genus *Kermes* with the four Nearctic species studied here. Many other Palearctic species also belong in *Kermes*. Specimens are restricted to *Quercus* spp. and *Chrysolepis* spp. and are found in wounds, on bark, in forks between twigs, or on branches.

Etymology. Boitard named this genus for the crimson dye produced from *Kermes roboris*.

KEY TO THE ADULT FEMALES OF *KERMES*

1. Mid-dorsum without multilocular disc pores 2

   Mid-dorsum with many multilocular disc pores distributed evenly and densely (pl. 21 A). . . . . *shastensis* Ehrhorn, p. 77

2. Pre-anal row of multilocular disc pores without prolongations posteriolaterally; false venter without median lobe posteriorly 3

   Pre-anal row of multilocular disc pores with 3 prolongations posteriolaterally, each prolongation apically with ca. 20 multilocular disc pores surrounding 2 or 3 setae; false venter with small median lobe posteriorly (pl. 20 A) . . . *rimarum* Ferris, p. 74

3. Multilocular disc pores not dispersed among anal setae (pl.19 I); eyes present; multilocular disc pores in pre-anal band similar in size to multilocular disc pores surrounding marginal setae; marginal setae 0.6 as long as pre-anal

setae (pl.19 G, H); on *Chrysolepis* spp.
in California . . . . *nudus*, new species, p. 71

Multilocular disc pores dispersed among anal setae (pl.22 H); eyes absent; multilocular disc pores in pre-anal row 0.75 size of multilocular disc pores surrounding marginal setae (pl.22 C,D); marginal setae similar in size to the pre-anal setae (pl.22 F, G); on *Quercus* spp. in eastern deciduous
forest . . . . *sylvestris* (Ckll. and King), p. 80

DESCRIPTIONS OF SPECIES OF *KERMES*

KERMES NUDUS, NEW SPECIES

Suggested common name: The Chinquapin Kermes.

Post-reproductive female. Unknown.

YOUNG ADULT FEMALE

Plate 19

Type material. *Chrysolepis chrysophylla*, **CA**, Yosemite Natl. Park, State Rt. 120, Jun. 30, 1976, colls. MMK, holotype 1(1) USNM, paratypes 8(14) VPI, 1(1) UCD. *C. sempervirens*, Mono Co., Mammoth Lake, Jun. 29, 1976, colls. MMK, 2(4) VPI; Mono Co., Mammoth Lake, 0.2 mi. before entrance to Earthquake Fault Picnic Area, Jun. 29, 1976, coll. MK, 3(3) VPI; Mono Co., Mammoth, Earthquake Fault, Jul. 4, 1976, colls. RJG and R. F. Gill, 5(5) CDA, 1(1) USNM, 1(1) UCD. *Chrysolepis* sp., **CA**, El Dorado Co., S. Fork, Shingle Mill Creek at Cat Creek Road, June 12, 1979, coll. RJG 4(4) VPI. One of the *C. chrysophylla* specimens has been marked as the holotype; all others, as paratypes.

Tergum

Description. Body (fig. A) circular, 1980, 2482 (1980-2930) long, 1920, 2415 (1850-2790) wide.

Eyes (fig. B). Present, each with 1 ocellus.

Tubular ducts (fig. C). Head 8, 9 (8-10) wide.

Multilocular disc pores. Lateral row (fig. D) with quinquelocular and 7-locular pores clustered around submedial and marginal setae; pre-anal row with densely distributed 5-, 6-, 7-, 8-, and 9-locular pores extending on each side of body from posterior end of lateral row of tubular ducts to area just ventral to anal lobe setae, ending abruptly.

Pre-anal enlargement (fig. E). With ca. 12 quinquelocular disc pores, 2, 6-locular disc pores, 11, 7-locular disc pores, 7, 8-locular disc pores, 2, 9-locular disc pores, and 11 setae.

Mid-dorsal enlargement (fig. F). With ca. 29 simple disc pores.

Setae. Marginals (fig. G) 10, 12 (7-16) long; pre-anals (fig. H) 17, 20 (12-37) long; anals 33, 29 (12-37) long.

Anal lobes (fig. I). Each with 15, 17 (13-23) setae.

Anal ring (fig. J). 74, 63 (28-111) long, 87, 80 (29-111) wide.

Sternum

Antennae. Long, segmentation indistinct, 214, 183 (153-272) long.

Labium. 217, 213 (185-248) long, 185, 203 (185-296) wide at base.

Spiracles Anterior spiracles 83, 98 (78-136) long, atria 92, 103 (82-124) wide; posterior spiracles 122, 126 (63-178) long, atria 156, 170 (148-195) wide.

Legs. Prothoracic legs 259, 253 (146-322) long; mesothoracic legs 279, 282 (249-390) long; metathoracic legs 278, 252 (195-298) long.

Remarks. This species is found on *Chrysolepis* species in California. *K. nudus* can apparently be distinguished from all other North American *Kermes* by the following combination of characters: 1) pre-anal row of multilocular disc pores without prolongations posteriorly, not dispersed among anal setae, and with pores that are similar in size to multilocular disc pores around lateral setae; 2) mid-dorsum without multilocular disc pores; 3) false venter without small median lobe posteriorly; 4) eyes present; and 5) marginal setae 0.6 as long as pre-anal setae.

Etymology. This species is named for its naked mid-dorsum, which, except for the presence of simple disc pores, lacks all other types of pores, pits, or sclerotizations.

KERMES PRINUS BAER AND KOSZTARAB

Suggested common name: Chestnut oak Kermes

Synonymy: *Kermes prinus* Baer and Kosztarab, 1981:230. Baer and Kosztarab, 1985.

Remarks. This species has been described by utilizing the distinct morphology of the first instars. It was assigned to the *K. concinnulus* Cockerell group, where *K. cockerelli* Ehrhorn, *K. rimarum* Ferris and *K. shastensis*

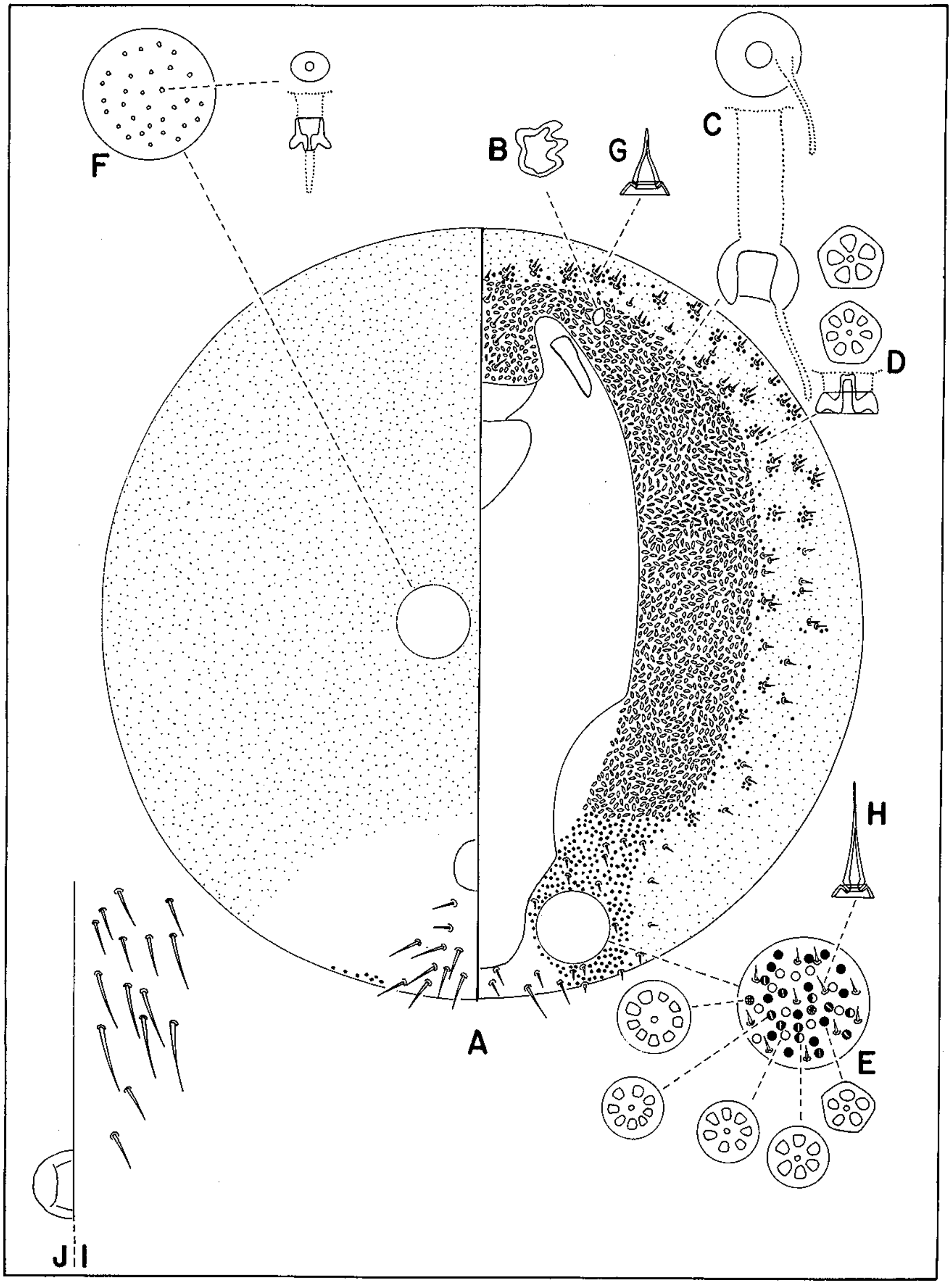


Plate 19.- *Kermes nudus*, new species, adult female

Ehrhorn belong. The description was based on specimens collected from *Quercus prinus* L., chestnut oak, found in Pipestem State Park, West Virginia. For more records on this species, see Baer and Kosztarab (1985).

KERMES RIMARUM FERRIS

Color fig. 13. Plate 2E

Suggested common name: Bark-crevice Kermes.

Synonymy: *Kermes rimarum* Ferris, 1955b:202.

Post-reproductive female. Ferris (1955b) described this species from slide-mounted specimens. His scant characterization of the post-reproductive female is as

> A small, dark species, its diameter not exceeding 2-5 mm. in any plane, variously shaped in conformity with the irregularities of its surroundings. Dark brown and displaying a small amount of secretion.

YOUNG ADULT FEMALE

Plate 20

Type material studied. Paratypes from *Quercus gambelii* (= *Q. utahensis*), NM, Beulah, near Las Vegas, Jul. 15, 1947, coll. GFF, 2(2) UCD. One of these has been marked as the lectotype; all others, as paralectotypes.

Tergum

Description. Body (fig. H) circular, 2410, 2340 (2270- 2410) long, 2410, 2090 (1760-2410) wide.

Eyes (fig.B). Present, each with 1 ocellus.

Tubular ducts (fig. C). Head 10, 10 (9-10) wide.

Multilocular disc pores. Lateral row (fig. D) with trilocular, quinquelocular, and 7-locular pores clustered around submedial setae; pre-anal row with densely distributed 3-, 5-, 6-, and 7-locular pores and 3 prolongations posteriolaterally, each prolongation apically with ca. 20 pores surrounding 2 or 3 setae; false venter with ca. 14 pores on small median lobe.

Pre-anal enlargement (fig. E). With ca. 1 quadrilocular disc pore, 20 quinquelocular disc pores, 2, 6-locular disc 7, 7-locular disc pores, and 8 setae.

Mid-dorsal enlargement (fig. F). With ca. 7 simple disc pores.

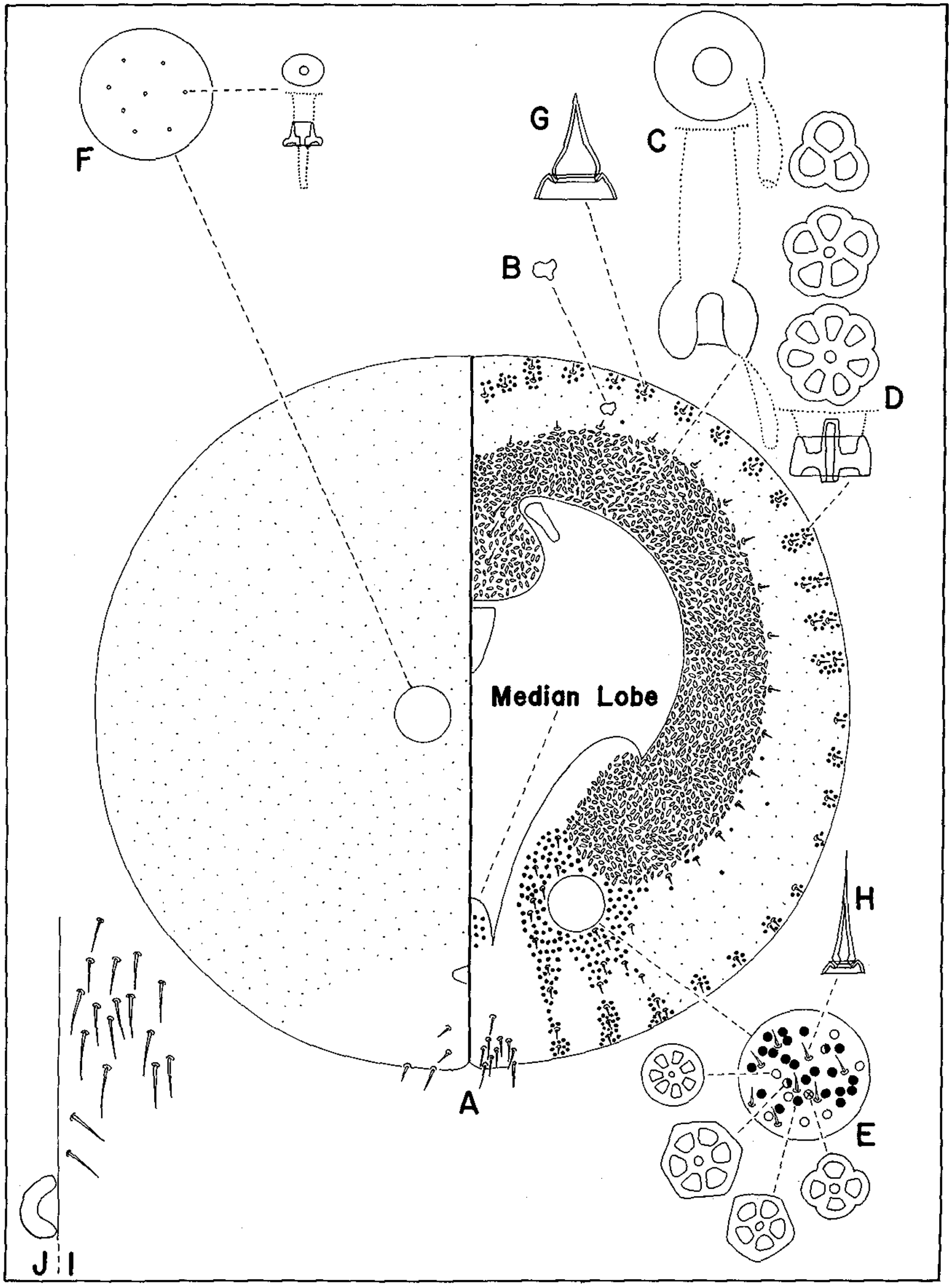


Plate 20.-*Kermes rimarum* Ferris, adult female

Setae. Marginals (fig. G) 17, 15 (13-17) long; pre-anals (fig. H) 17, 14 (10-17) long; and anals 47, 51 (47-54) long.

Anal lobes (fig. I). Each with 15, 16 (15-16) setae.

Anal ring (fig. J). Ca. 155 long, 86, 80 (74-86) wide.

Sternum

Antennae. Elongate, segmentation obscure, 136, 146 (136-155) long.

Labium. Ca. 260 long, ca. 136 wide at base.

Spiracles. Anterior spiracles ca. 136 long, atria 68, 78 (68-87) wide; posterior spiracles 155, 109 (62-155) long, atria 99, 115 (99-130) wide.

Legs. Prothoracic legs 297, 226 (155-297) long; mesothoracic legs 247, 217 (186-247) long; metathoracic legs 259, 229 (198-259) long.

Additional material studied. *Quercus douglasii*, **CA**, 2 mi. below Monticello Dam on Putah Cr., April 5, 1968, coll. JWB, 5(5) JWB. *Q. durata*, **CA**, Mt. St. Helena, 10 mi. N of Calistoga, May 17, 1968, coll. JWB, 2(3) JWB. *Q. gambelii*, **AZ**, near Portal, 9.9 mi. W on rd. from SW Research Station, Jun. 20, 1976, colls. MMK, 2(4) VPI. *Q. garryana*, **OR**, Jackson Co., 9.2 mi. NE of Ashland, Apr. 26, 1977, coll. RLP, 15(35) UCD; Jackson Co., 1 mi. E of Central Point, Apr. 26, 1977, coll. RLP, 4(8) UCD; *Q. lobata*, **CA**, Davis, University of California, Shield's Grove Arboretum, Jul. 5, 1976, colls. MMK, 3(4) VPI; Fresno Co., Sanger, Mar. 30, 1946, coll. J. W. Dixon, 1(1) CDA; Lafayette, Sep. 28, 1938, coll. N.W. Stanger, 2(4) UCD; L.S.J.U., May 11, 1911, coll. LC, 1(1) ORSU; San Joaquin Co., Stockton, 9230 Morada, May 6, 1976, coll. J. B. Gianelli, 1(1) CDA; Tulare Co., Visalia, Apr. 18, 1974, colls. Thomas and Akana, 3(3) CDA; Walnut Cr., Aug. 20, 1911, coll. J.C.B., 1(1) UCD. *Quercus* sp., **CA**, Danville, Mar. 28, 1958, colls. Seely and Danielson, 1(2) CDA; Sacramento Co., Galt, Apr. 21, 1964, coll. K.E. Miller, 1(1) CDA; San Mateo, 1(1), UCD; Tulare Co., E Orange Cove, Sandcreek Road, Apr. 17, 1964, coll. A. Morrison, 1(1), CDA; Ventura Co., Quatal Cyn., May 25, 1977, colls. RJG and R. Hobza, 2(2) CDA; **OR**, Jackson Co., 9.2 mi. NE of Ashland, Apr. 26, 1977, coll. RLP, 10(10) VPI; Jun. 1-5, 1977, coll. RLP 4(4), VPI; Jackson Co., 1 mi. from Central Point, Apr. 26, 1977, coll. RLP, 4(4) VPI.

Other literature citation. Hoy, 1963:57.

Remarks. This species has been recorded on five species of oaks in the western United States. Some of these records associated with first instars that have been identified by Dr. R. G. Baer as *K. cockerelli* Ehrhorn, do not differ from the two type specimens of *K. rimarum*.

K. rimarum can apparently be distinguished from all other North American *Kermes* by the following combination of characters: 1) pre-anal row of multilocular disc pores with 3 prolongations posteriolaterally, each prolongation apically with ca. 20 multilocular disc pores surrounding 2 or 3 setae; 2) false venter with small median lobe posteriorly; and 3) mid-dorsum without multilocular disc pores.

Etymology. Ferris named this species for its crevice-dwelling habits.

KERMES SHASTENSIS EHRHORN

Color figs. 14, 15, 16. Plate 2 F

Suggested common name: The Cottony Kermes.

Synonymy: *Kermes shastensis* Ehrhorn, 1911:275, 276.
Talla shastensis, Lindinger, 1933:143.
Kermes branigani, Ferris, 1955b:195 (misidentification).

Post-reproductive female. Ehrhorn (1911) described the post-reproductive female as

> . . .enveloped in a thick white, brittle, waxy secretion, making the scale very striking and easily detected on the twigs of the trees. Scales round about 5 mm. in diameter. After removing waxy secretion, colour of scale is mahogany brown, very shiny, with usually three distinct dark brown lines across the dorsum.

YOUNG ADULT FEMALE

Plate 21

Type material studied. Topotypes from *Quercus chrysolepis*, CA, Siskiyou Co., May 19, 1976, coll. RJG, 4(4) CDA, 1(1) USNM, 1(1) VPI.

Tergum

Description. Body (fig. A) ovoid or circular, 4520, 3120 (2630-4520) long, 3740, 2790 (2290-3740) wide.

Eyes (fig. B). Present, each with 2 ocelli.

Tubular ducts (fig. C). Head 8, 9 (8-10) wide.

Multilocular disc pores. Lateral row (fig. D) with densely distributed 4-, 6-, 7-, 8-, and 9-locular pores extending on to and covering mid-dorsum; pre-anal row with densely distributed quadrilocular, 6-locular, and 7-locular pores extending on each side of body from posterior end of lateral row of tubular ducts to area just ventral to anal lobe setae, grading into pores on mid-dorsum.

Pre-anal enlargement (fig. E). With ca. 9 quinquelocular disc pores, 5, 6-locular disc pores, 13, 7-locular disc pores, and 6 setae.

Mid-dorsal enlargement (fig. F). With ca. 1 quinquelocular disc pore, 1, 6-locular disc pore, 7, 7-locular disc pores, 1, 8-locular disc pore, 1, 9-locular disc pore, and 6 simple disc pores.

Setae. Marginals (fig. G) 13, 15 (10-19) long; pre-anals (fig. H) 25, 25 (20-32) long; anals 44, 29 (23-44) long.

Anal lobes (fig. I). Each with 22, 22 (21-24) setae; sclerotized dorsally.

Anal ring (fig. J). 67, 75 (51-91) long, 119, 113 (90-128) wide.

Sternum

Antennae. Long, segmentation indistinct, 175, 184, (161-230) long.

Labium. 247, 246 (241-248) long, 282, 229 (193-282) wide at base.

Spiracles. Anterior spiracles 136, 116 (83-161) long, atria 119, 127 (118-146) wide; posterior spiracles 161, 147 (107-161) long, atria 200, 189 (161-207) wide.

Legs. Prothoracic legs 302, 272 (184-302) long; mesothoracic legs 322, 281 (218-329) long; metathoracic legs 293, 268 (197-295) long.

Additional material studied. *Chrysolepis* sp., **CA**, Tuolumne Co., Dardanelle, Jun. 20, 1949, coll. H.H. Keifer, 1(1) UCD; *Quercus turbinella*, **CA**, Humbolt Co., Hoopa, Jun. 9, 1959, coll. A.G. Forbes, 4(4) CDA, 1(1) VPI.

Questionable identifications in literature. *Quercus chrysolepis*, **CA**, Sierra and Siskyou Mts. (Ferris, 1955b:204); *Q. chrysolepis* var. *shastensis*, **CA**, Mt. Shasta, Lake Tahoe (Hoy, 1963:161); *Q. vaccinifolia*, **CA**, Volcano Canyon (Hoy, 1963:161).

Other literature citations. Balachowsky, 1950a:344; Doane *et al.*, 1936:383; Essig, 1915:118, 1926:276, 1931:614; MacGillivray, 1921:196.

Remarks. This species is found on *Quercus chrysolepis*, *Q. turbinella*, and *Chrysolepis* species in California.

K. shastensis can apparently be distinguished from all other North American *Kermes* by its possession of many multilocular disc pores distributed evenly and densely on the mid-dorsum.

The post-reproductive adult female is noted for its covering of white wax, which in younger specimens is fluffy and cottony, and in older specimens, hard and brittle.

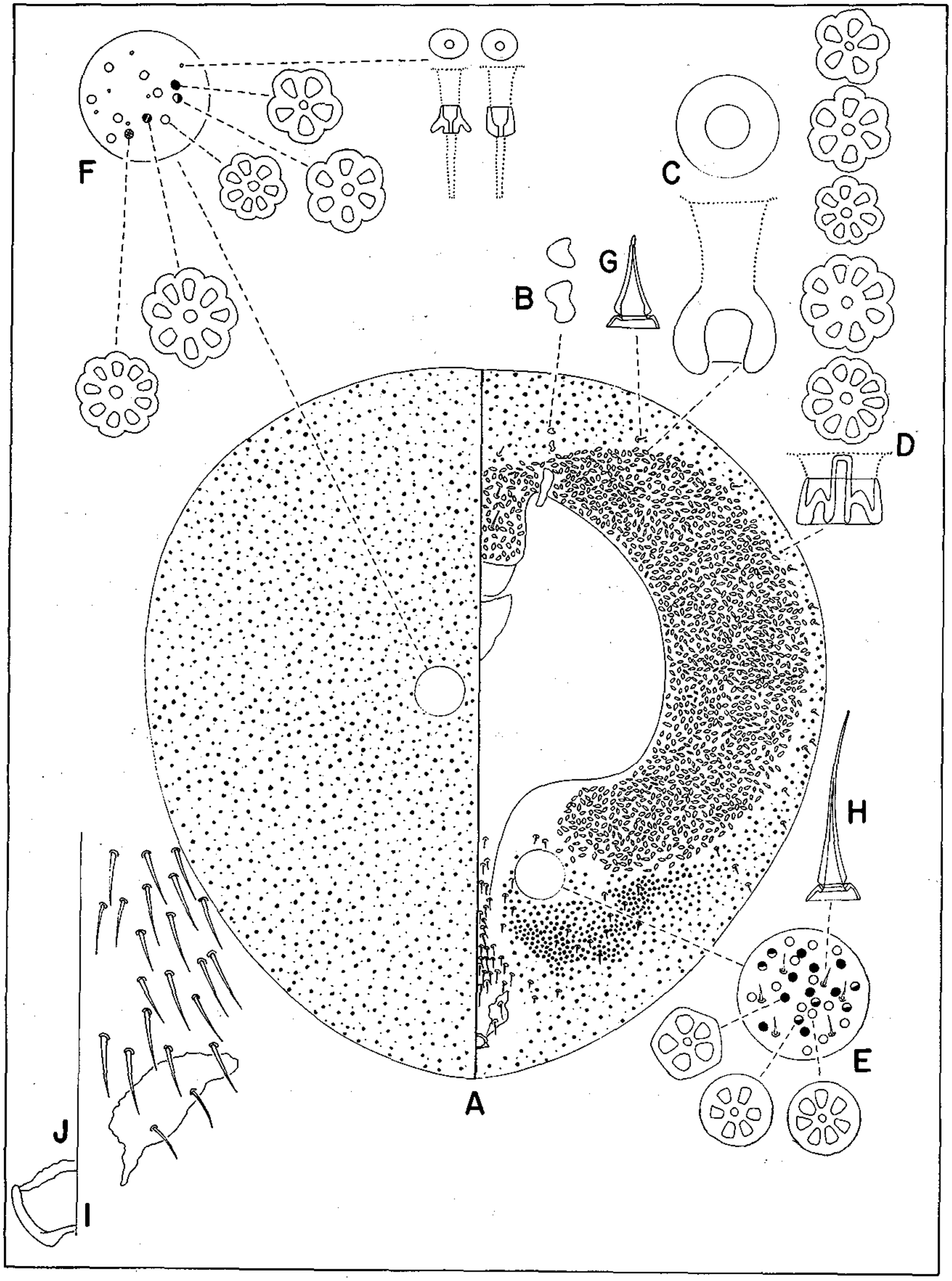


Plate 21.-*Kermes shastensis* Ehrhorn, adult female

Etymology. Ehrhorn named this species for its type locality, Shasta Springs, California.

KERMES SYLVESTRIS (COCKERELL AND KING)

Color fig. 17

Suggested common name: The Forest Kermes.

Synonymy: *Sphaerococcus sylvestris* Cockerell and King, 1898:326.
Kermes andrei King, 1900a:22. New synonym.
Talla andrei, Lindinger, 1933:143.

Post-reproductive female. King (1900a) described the post- reproductive female as

> . . . pyriform in shape, very convex, 5 mm. high and 5 mm. in diameter at its base, variable in some individuals which are nearly hemispherical. Surface shiny. Colour, light brown, with three and sometimes four, very dark brown bands, these variable in length and breadth. There are also several suffused dark brown blotchy spots and round dots, more numerous around the posterior cleft. Segmentation obsure; a median posterior keel-like prominence, which is very much wrinkled above near the region of the posterior cleft.

YOUNG ADULT FEMALE

Type material studied. Topotypes from *Quercus alba*, **MA**, Lawrence, off State Rt. 114, Jun. 18, 1976, coll. SWB, 1(1) VPI; Lawrence, Sep. 9, 1899, coll. GBK 1(1) AMNH; Lawrence, Sullivan Brothers Square, Jun 17, 1976, coll. SWB, 3(3) VPI; North Andover, Jun. 15, 1976, coll. SWB, 2(2) VPI.

The illustrations were made from the following lot: *Quercus alba*, **AL**, Madison Co., Huntsville, May 9, 1976, coll. CHR, 2(2) AU.

Tergum

Plate 22

Description. Body (fig. A) somewhat pentagonal or circular, 1830, 4130 (1830-4960) long, 1710, 3753 (1710-5320) wide.

Antennae. Reduced to elongate, segmentation obscure, 87, 99 (60-131) long.

Eyes. Absent.

Tubular ducts (fig. B). Head 10, 10 (9-12) wide.

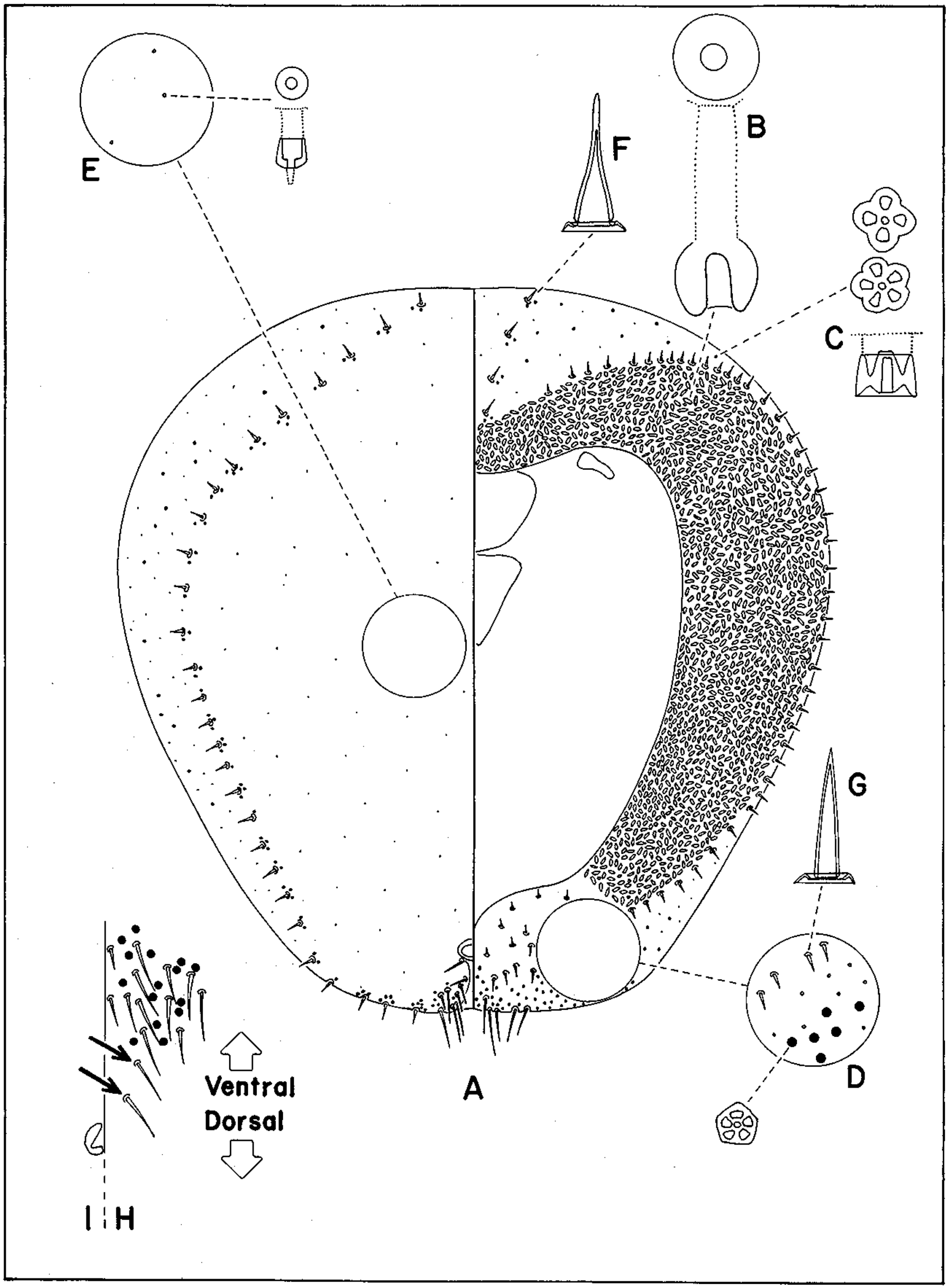


Plate 22.-*Kermes sylvestris* (Ckll. and King), adult tergum

Multilocular disc pores. Lateral row (fig. C) with some quadrilocular and quinquelocular pores distributed sparsely between setal rows and with others clustered around submedial setae; pre-anal row with sparsely distributed quinquelocular pores extending on each side of body from posterior end of lateral row of tubular ducts to anal lobe setae, ending abruptly.

Pre-anal enlargement (fig. D). With ca. 5 quinquelocular disc pores, 8 simple disc pores, and 4 setae.

Mid-dorsal enlargement (fig. E). With ca. 3 simple disc pores.

Setae. Marginals (fig. F) 15, 18 (15-25) long; pre-anals (fig. G) 17, 19 (12-31) long; anals 27, 31 (24-46) long.

Anal lobes (fig. H). Each with 14, 13 (11-17) setae.

Anal ring (fig. I). 32, 64 (32-105) long, 49, 67 (49-87) wide.

Sternum

Plate 23

Antennae. Reduced to elongate, segmentation obscure, 87, 99 (60-131) long.

Labium. 155, 212 (155-248) long, 136, 159 (111-202) wide at base; 4 indistinct segments, anterior surface (fig. B) with 7 setae, posterior surface (fig. A) with 1.

Spiracles. Anterior spiracles (fig. C) 87, 116 (87-124) long, atria 74, 86 (74-105) wide; posterior spiracles (fig. D) 99, 135 (99-173) long, atria 121, 123 (99-149) wide.

Legs. The specimen studied was teneral. Therefore, legs were somewhat soft and pliable. Prothoracic legs 227, 193 (161-285) long; mesothoracic legs 212, 212 (183-299) long; metathoracic legs 235, 185 (121-235) long.

Multilocular disc pores. Quinquelocular pores (fig. H) distributed in vicinity of spiracular atria on thorax, in vicinity of submedial row of setae on abdominal segments II-V; 10-locular pores (fig. I) distributed sparsely on each thoracic segment, also within intersegmental folds on all abdominal segments. As one progresses posteriorly, 10-locular pores become less randomly distributed and more concentrated into invaginations or pouches.

Abdominal setae (fig. J). Long and slender.

Abdominal derm (fig. K). Thickly beset with minute teeth, these only visible if specimen stained well.

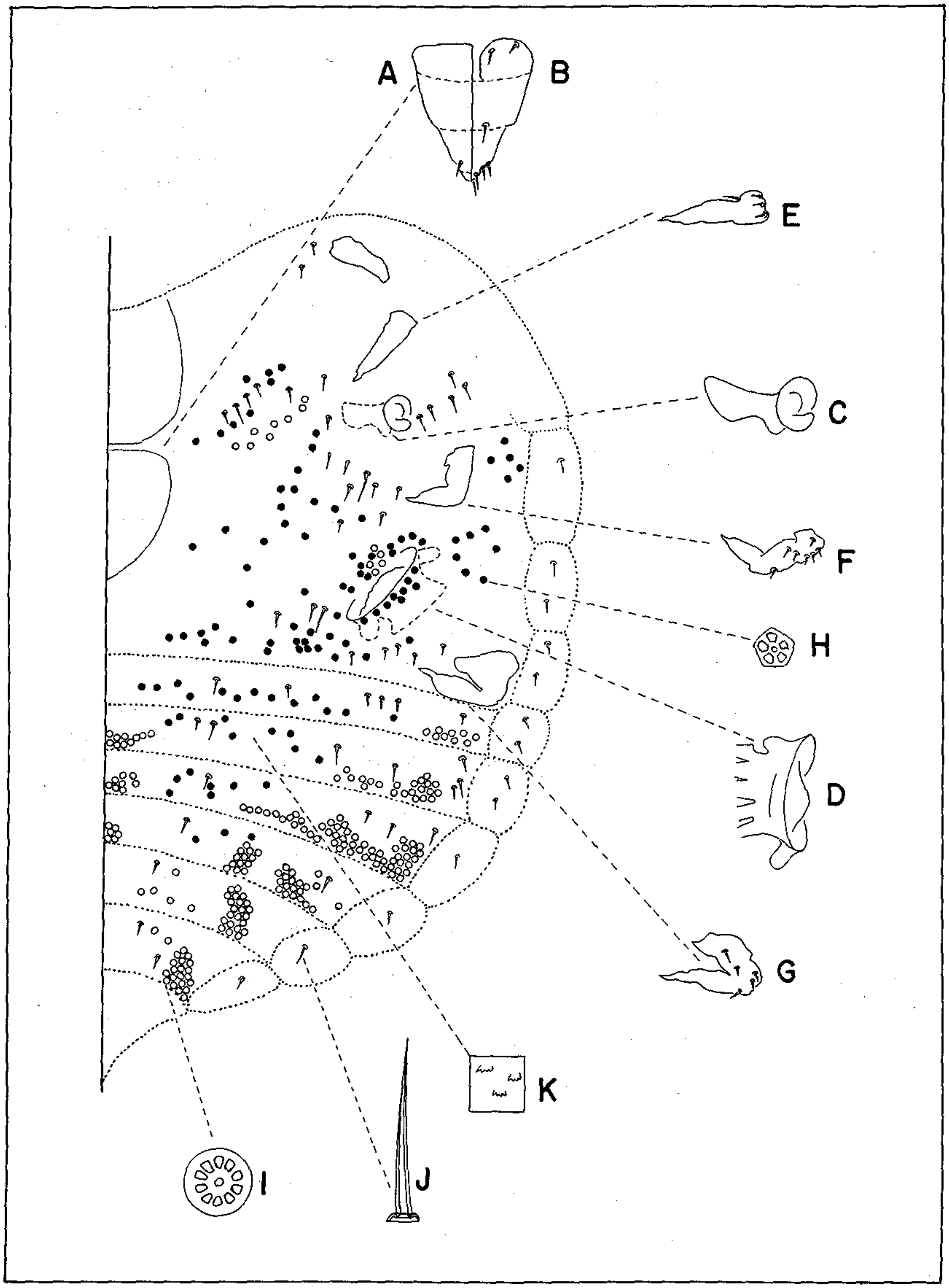


Plate 23.-*Kermes sylvestris* (Ckll. and King), adult sternum

Additional material studied. *Quercus alba*, **MD**, Hagerstown, Greenhill Gardens, Jun. 7, 1972, coll. MLW, 2(2) AU, 1(2) VPI; **VA**, Montgomery Co., Brush Mt., May 12, 1968, colls. MLW and CGW, 1(2) VPI; Montgomery Co., Rebecca Thompson's Riding Academy, May 15, 1969, coll. MK, 3(4) VPI; Jun. 20, 1975, colls. RGB and ABH, 1(1) VPI. *Q. ilicifolia*, **VA**, Albemarle Co., May 8, 1969, coll. MK, 3(4) VPI. Montgomery Co., Brush Mt., Old Firetower, May 12, 1968, colls. MLW and CGW, 4(4) VPI. *Q. stellata*, **AL**, Auburn, S Gay Street, Jun. 8, 1976, 1(1) VPI; TX, Bryan, Apr. 6, 1918, coll. AHH, 1(1) UCD; May 3, 1919, coll. AHH, 1(1) UCD; *Quercus* sp., **DC**, Washington, Mt. Hamilton, Apr. 27, 1922, coll. J.E. Walter, 2(2) USNM, 1(1) VPI; **GA**, Atlanta, coll. W. M. Scott, 1(1) VPI; **SC**, Litchfield Beach, Jul. 7, 1968, coll. MK 4(4) VPI.

THIRD INSTAR FEMALE

Plate 24

Type material studied. Lectotype on *Quercus alba*, **MA**, Methuen, Jun. 15, 1895, coll. GBK, 1(1) USNM.

Description. Body (fig. A) ovoid, ca. 2100 long, ca. 1760 wide.

Tergum

Eyes. Absent.

Tubular ducts (fig. B). Head ca. 8 wide.

Multilocular disc pores. Lateral row (fig. C) with some quinquelocular pores distributed sparsely between setal rows and with others clustered around submedial setae; pre-anal row with sparsely distributed quinquelocular and 7-locular pores extending on each side of body from posterior end of lateral row of tubular ducts to among anal lobe setae, ending abruptly.

Pre-anal enlargement (fig. D). With ca. 7 quinquelocular disc pores, 1, 7-locular disc pore, and 4 setae.

Mid-dorsal enlargement (fig. E). With ca. 3 simple disc pores.

Setae Anterior dorsum with a large, stout seta (fig. G) on each side. Marginals (fig. F) ca. 14 long, pre-anals (fig. H) ca. 14 long, anals ca. 34 long.

Anal lobes (fig. I). Each with ca. 11 setae.

Anal ring (fig. J). Ca. 22 long, 49 wide.

Sternum

Antennae. Reduced, segmentation obscure, ca. 99 long.

Labium. Ca. 173 long, ca. 143 wide at base.

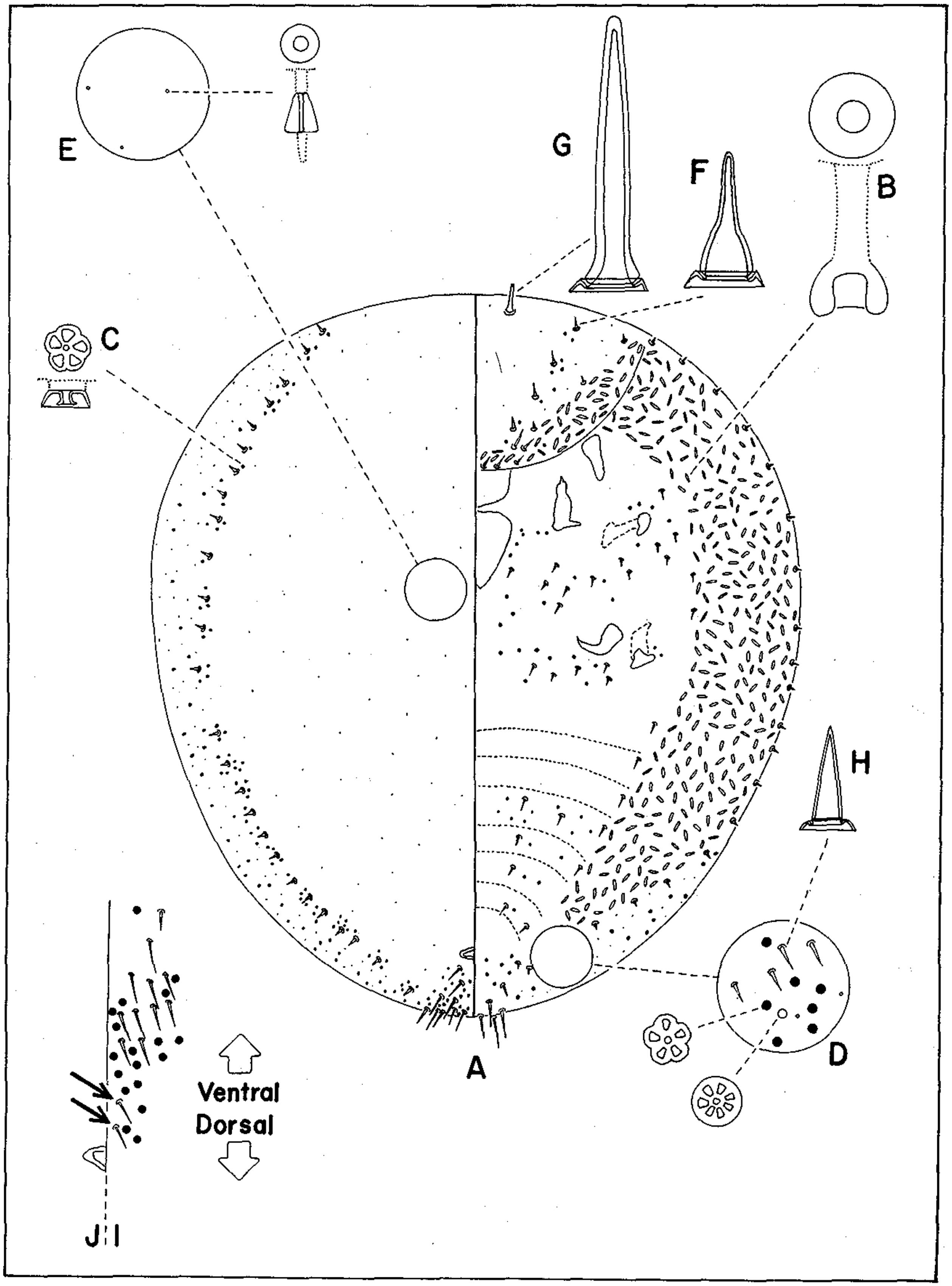


Plate 24.-*Kermes sylvestris* (Ckll. and King), third instar female

Spiracles. Anterior spiracles ca. 82 long, atria ca. 32 wide; posterior spiracles ca. 86 long, atria ca. 37 wide.

Legs. Prothoracic legs ca. 124 long; mesothoracic legs ca. 160 long; metathoracic legs absent on specimen studied.

Questionable identifications in literature. *Quercus alba,* **GA,** (Hoy, 1963:139); **IN,** Tippecanoe Co. (Amos, 1933:206); **MD,** Boone Co. and Ripley Co. (Hollinger, 1923:43); **MS,** (Hoy, 1963:139); **OH,** Columbus, coll. JGS (Sanders, 1904:35; Hoy, 1963:139); **PA,** (Trimble, 1928:43). *Q. borealis,* **GA ,MA, OH** (Hoy, 1963:139). *Q. macrocarpa,* **OH,** Columbus, coll. JGS (Sanders, 1904:35). *Q. muehlenbergii,* **OH,** Columbus, JGS (Sanders, 1904:35). *Q. palustris,* **PA,** (Sleesman, 1945:44, 45). *Q. prinus,* **OH,** Columbus, coll. JGS (King, 1903a:22; Webster and Burgess, 1902:113). *Q. stellata,* **GA,** Atlanta, coll. Scott (King, 1903a:22). *Quercus* sp., **GA** (King, 1902a:60; Fernald, 1903:60; MacGillivray, 1921: 196); **IN,** near Noblesville, near Indianapolis, and at Vincennes (Dietz and Morrison, 1916:234); **IN, MA,** (MacGillivray, 1921:196); **OH** (Fernald, 1903:60; MacGillivray, 1921:196); **OH,** 8 mi. N of Columbus, Minerva Park, coll. JGS (Sanders, 1904:35); **WI** (Severin and Severin, 1909:297); **MA to GA** (Smith, 1909:122); E coast to MS valley states (Doane *et al.*, 1936:382, 383).

Other literature citations. Balachowsky, 1950a: 344; Britton, 1923:382; Cockerell, 1900:44; Ferris, 1955b:194; King, 1900b:81, 1903a:22.

Remarks. This species has been recorded from Massachusetts to Texas and has been verified as being found on 4 species of oaks. It appears to be most common on *Quercus alba.*

K. sylvestris can apparently be distinguished from all other North American *Kermes* by the following combination of characters: 1) pre-anal row of multilocular disc pores without prolongations posteriolaterally, dispersed among anal setae, and with pores that are 3/4 size of quinquelocular disc pores around lateral setae; 2) mid-dorsum without multilocular disc pores; 3) false venter without median lobe posteriorly; 4) eyes absent; and 5) marginal setae similar in size to pre-anal setae.

K. sylvestris is a species that completes its development rapidly: post-reproductive females can be collected in late May. It is a rare species. Of the adult material the authors examined, only one female was young enough to be in a stage comparable to the young females illustrated for the other *Kermes* species.

The one newly-molted adult female *K. sylvestris* is also more similar to the type third instar than to the many available older adults that were still membranous enough to be slide-mounted.

It is therefore possible that *K. sylvestris* contains a complex of one or more undescribed species or subspecies. The adults from Alabama, Mississippi, and Texas may belong to an undescribed species.

The mature adults of *K. sylvestris* cannot be distinguished from the mature adults of *K. rimarum* or *K. nudus*. They also cannot be distinguished from some mature adults collected on *Q. castaneifolia* in Iran, suggesting that the species may be cosmopolitan in its distribution. Future studies will be needed to clarify the taxonomy of this species.

Etymology. Cockerell and King, believing this species to be a *Sphaerococcus*, named it for its unusual habit of occurring on trees in forests. Other *Sphaerococcus* occur on grasses.

DESCRIPTION OF NANOKERMES, NEW GENUS

Type: *Kermes pubescens* Bogue

Adult female (Plate 29). With 2 tubular duct types (fig. C, D); posterior dorsum with paired bullet-shaped pores, these heavily sclerotized, ca. 4 u long (fig. H), sparsely distributed in several transverse bands dorsal to anal ring; spiracular furrow occasionally present, extending onto dorsum, and lined with multilocular disc pores (fig. E); multilocular disc pores otherwise not present along lateral margin; anal lobes sclerotized, surrounding anal opening, roughly triangular, and each bearing 1 stout, medially projectng seta (fig. K); anal ring cordlike, with margins not distinct from surrounding derm, occasionally enclosing within it areolate anal ring of third instar female [*Nanokermes iselini* (Baer and Kosztarab), plate 28M].

Third instar female (Plate 27, *Nanokermes folium*, new species). With 2 tubular duct types (figs. D, E); spiracular furrow always present, extending onto dorsum, and lined with multilocular disc pores (fig. F); multilocular disc pores otherwise not present along lateral margin; anal lobes prominent, conelike, each bearing at its apex 1 long seta and several shorter, lanceolate ones (fig. K); anal ring areolate and bearing 3 long setae on each half (fig. M).

Remarks. This genus is restricted to the Nearctic Region. Adults are found on the upper surfaces of leaves or petioles of *Quercus* species.

Etymology. *Nanokermes* literally means "very small Kermes."

KEY TO THE ADULT FEMALES OF *NANOKERMES*

1. Mid-dorsum with ca. 1000 tubular ducts distributed evenly and densely 2

   Mid-dorsum with ca. 30 tubular ducts distributed in 3 bands (pl. 25 A). . . . . *folium*, new species, p. 88

2. Anterior spiracular furrow absent; 4 setae in each dorsal submedial row; anal plate small, narrow, and indistinct (pl. 28) . . . . *iselini* (Baer and Kosztarab), p. 94

Anterior spiracular furrow present; 11 setae in each dorsal submedial row; anal plate large, wide and distinct (pl. 29) . . . . *pubescens* (Bogue), p. 97

DESCRIPTIONS OF SPECIES OF *NANOKERMES*

NANOKERMES FOLIUM, NEW SPECIES

Plate 2 G

Suggested common name: Leaf Kermes.

Synonymy: *Kermes pubescens,* McConnell and Davidson, 1959:463 (misidentification).

Post-reproductive female. Description from following lot: VA, Fairfax, Jun. 5, 1975, coll. B. Zirilli.

Spheroid, ca. 3 mm long, 2 high, 2 1/2 broad; basal fourth covered with short, clear strands of wax. Color yellowish brown, with 3 to 5 transverse, suffused bands of brown intersecting with 2 longitudinal stripes of darker brown. If wax is rubbed off, surface of dorsum is shiny, somewhat translucent, and covered with minute dark brown specks.

YOUNG ADULT FEMALE

Type material. *Quercus alba,* **MA,** Lawrence, off State Rt. 114, Jun. 18, 1976, coll. SWB, 1(1) VPI; North Andover, Merrimack College Campus, Jun. 15, 1976, coll. SWB, 27(105) VPI 5(20) USNM, 3(12) UCD, 3(12) CDA. **MD,** College Park, Jun. 12, 1926, coll. F. W. Berley, 1(2), VPI; **TN,** Smoky Mt. Natl. Park, Jun. 6, 1976, colls. MMK, 4(8) VPI; **VA,** Cherrydale, Jun. 11, 1917, coll. F. E. Rich, 1(1) USNM; Fairfax, Estate of R. Kennedy, May 28, 1975, coll. B. Zirilli, 10(10) VPI; Fairfax, Jun. 5, 1975, coll. B. Zirilli, 15(15) VPI; Falls Church, Apr. 25, 1916, coll. W. Middleton, 1(3) VPI; 1(2) USNM; Montgomery Co., Rebecca Thompson's Riding Academy, Jun. 20, 1975, colls. RGB and ABH, 9(9) VPI; Jun. 29, 1976, colls. SWB and RGB, 12(22) VPI. *Q. borealis,* **PA,** Norristown, let. of Jun. 29, 1937, fr. M. C. Van Horn, 12(12) USNM, 7(7) VPI, 6(6) UCD. *Quercus* sp., **DC,** Hillcrest, ref. slip of May 28, 1942, fr. Mrs. L. M. Davis, 1(3) VPI; National Capital Reg., May, 1965, coll. E. Binder, 1(3), VPI; Washington, May, 1950, 1(1) USNM; **MD,** College Park, University of Maryland, May 22, 1974, coll. S. Nakahara, 4(10) VPI; North Chevy Chase, May 22, 1942, coll. H B. Leming, 1(4) VPI; NY, New York, Botanical Gardens, Jun. 3, 1937, coll. G. Raw, 3(9) UCD; **VA,** Portsmouth, 209 Fellon Rd., Pine Crest Baptist Church, Jun. 26, 1967, coll. W. F. Tate, 15(37) VPI; Springfield, Aug.

1963, coll: E. B. Fogleman, 9(33) VPI; Vesuvius, Nature Camp, Jun. 19, 1968, colls. MLW and MK, 4(7) VPI. One of the Falls Church, VA specimens has been marked as the holotype; all others as paratypes.

Tergum

Plate 25

Description. Body (fig. A) oblong or circular, 1580, 1620 (1490-1760) long, 1210, 1350 (1210-1490) wide.

Eyes (fig. C). Present, each with 2 ocelli.

Tubular ducts. Type I (fig. D) with head 8, 8 (7-9) wide; type II (fig. E) with head 11, 11 (10-12) wide, distributed in wide row paralleling lateral row of type I ducts, extending dorsally to encircle spiracular band of multilocular disc pores, and with ca. 30 ducts on mid-dorsum in 3 transverse bands.

Multilocular disc pores. Spiracular band (fig. F) present, composed of 3-, 4-, 5-, and 8-locular pores; pre-anal band with 9 or 10 trilocular, quadrilocular, and quinquelocular pores between posterior end of lateral row of type I tubular ducts and anal lobes.

Pre-anal enlargement (fig. G). With ca. 4 trilocular disc pores, 1 quadrilocular disc pore, 3 quinquelocular disc pores, 10 simple disc pores, 1 small tubular duct, and 6 setae.

Mid-dorsal enlargement (fig. H). With ca. 27 simple disc pores.

Spinescent 8-shaped pores (fig. I). 8, 7 (6-8) long, teeth stout, heavily sclerotized, pits absent; distributed in 5 transverse bands of ca. 5 pores each on posterior dorsum.

Setae. Marginals (fig. J) 12, 13 (12-15) long; pre-anals (fig. K) 11, 14 (12-17) long; anals (fig. L, shaded), 29, 30 (25-35) long.

Anal lobes (fig. L). Each with 1 stout, medially projecting seta.

Anal ring (fig. M). 20, 32 (20-44) long, 31, 33 (25-49) wide; occasionally enclosing areolate anal ring of third instar.

Sternum

Plate 26

Antennae. (fig. B). Elongate, segmentation obscure, retaining exuviae of first, second, and third instars.

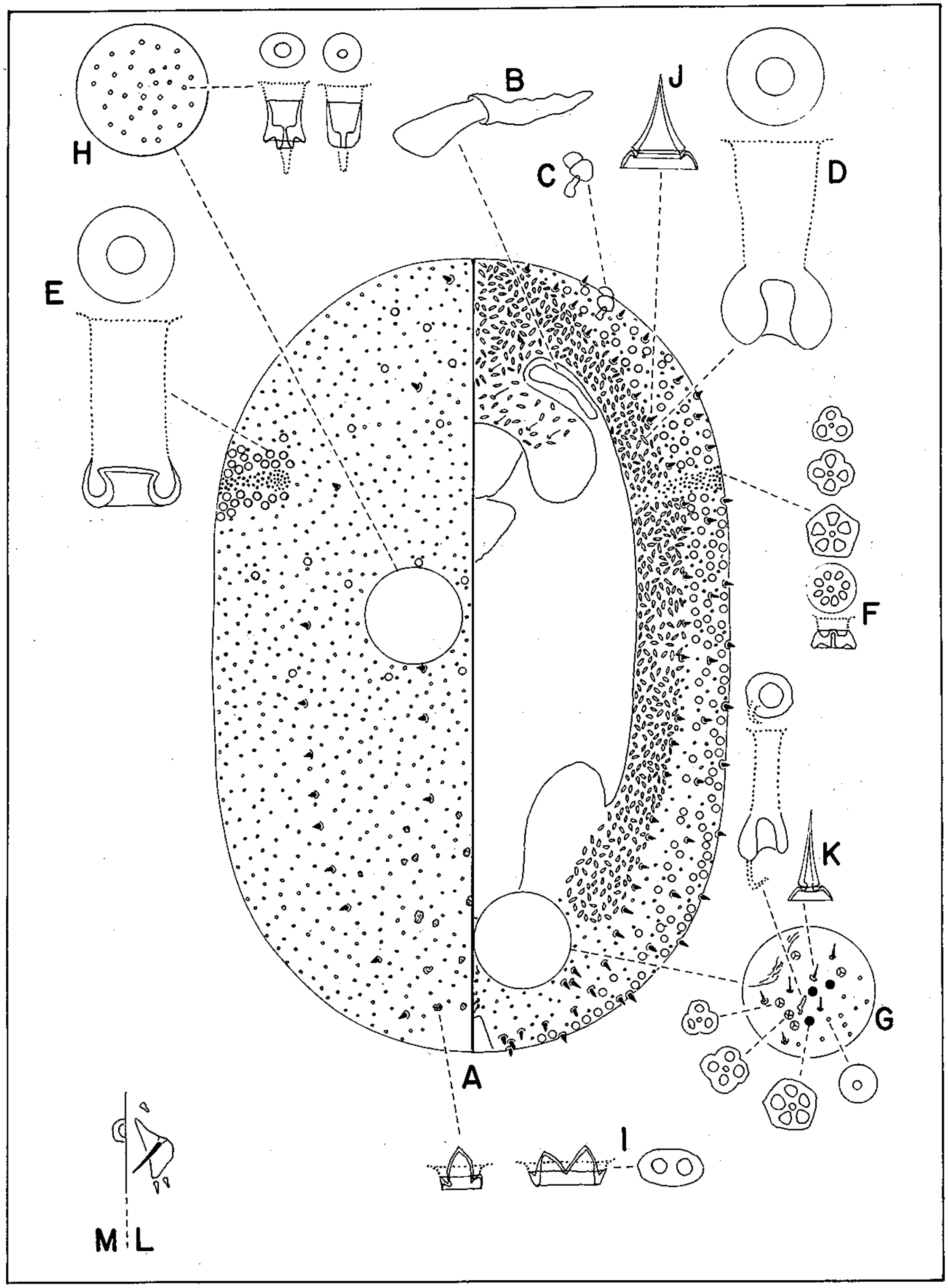


Plate 25.-*Nanokermes folium*, new species, adult tergum

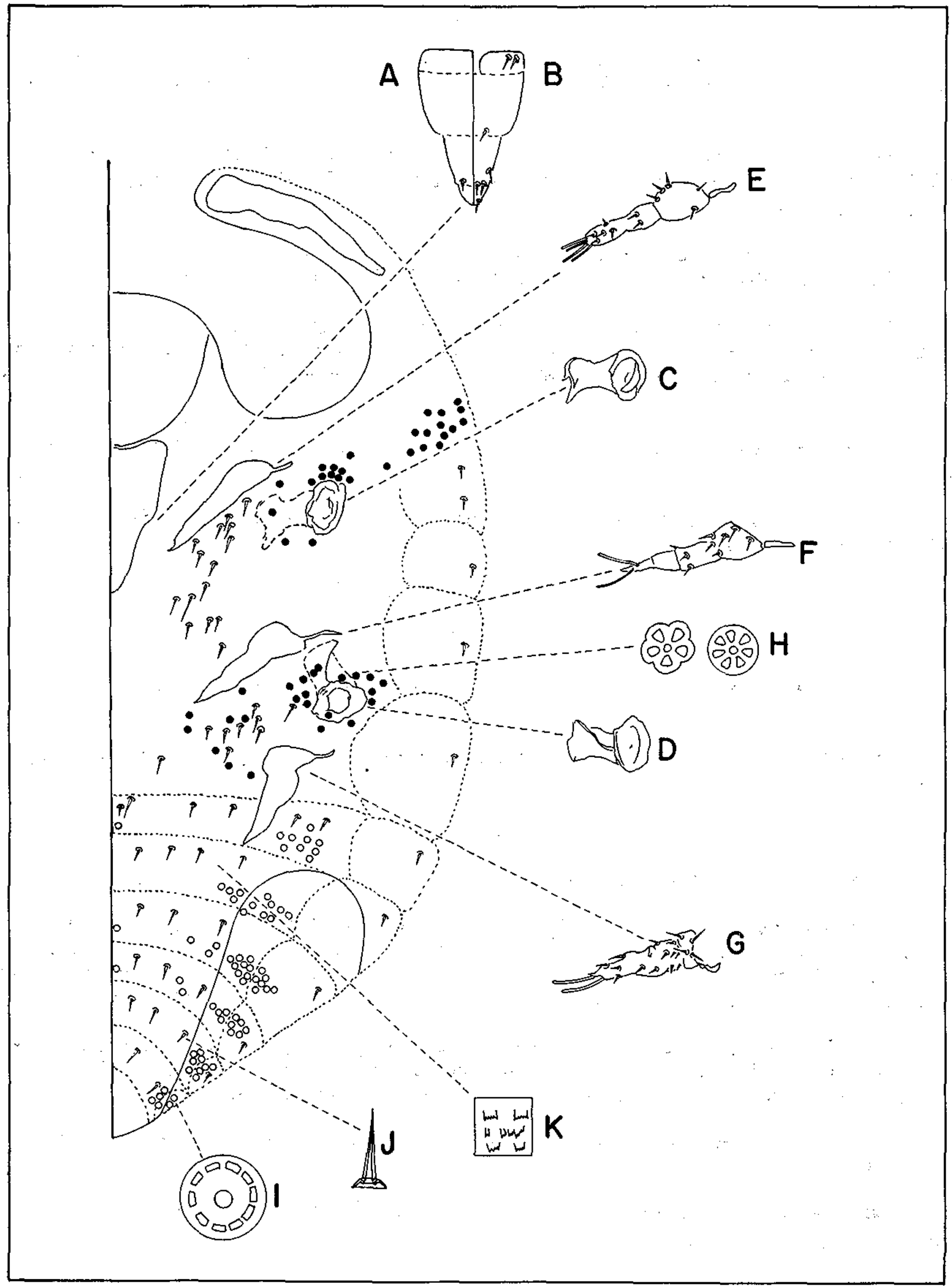


Plate 26.-*Nanokermes folium*, new species, adult sternum

Labium. 161, 159 (136-186) long, 99, 137 (99-155) wide at base; 4 indistinct segments; anterior surface (fig. B) with 7 setae, posterior surface (fig. A) with 1.

Spiracles. Anterior spiracles (fig. C) 192, 119 (99-192) long, atria 49, 49 (42-62) wide; posterior spiracles (fig. D) 94, 105 (94-116) long, atria 62, 64 (57-74) wide.

Legs. Prothoracic legs (fig. E) 178, 161 (136-178) long; mesothoracic legs 173, 160 (155-228) long; metathoracic legs 111, 168 (111-216) long.

Multilocular disc pores. Quinquelocular and 7-locular pores (fig. H) distributed in vicinity of spiracular atria, lacking elsewhere; 10-locular pores (fig. I) absent on thorax, distributed within the intersegmental folds on all abdominal segments.

Abdominal setae (fig. J). Long and slender medially, shorter and stouter laterally.

Abdominal derm (fig. K). Thickly beset with minute teeth, these only visible if specimen stained well.

THIRD INSTAR FEMALE

Plate 27

Paratype material. *Quercus* sp., DC, Washington, May 1950, 2(5) USNM, 1(2) VPI.

Description. Body (fig. A) 1110, 1154 (984-1420) long, 897, 907 (774-1050) wide.

Tergum

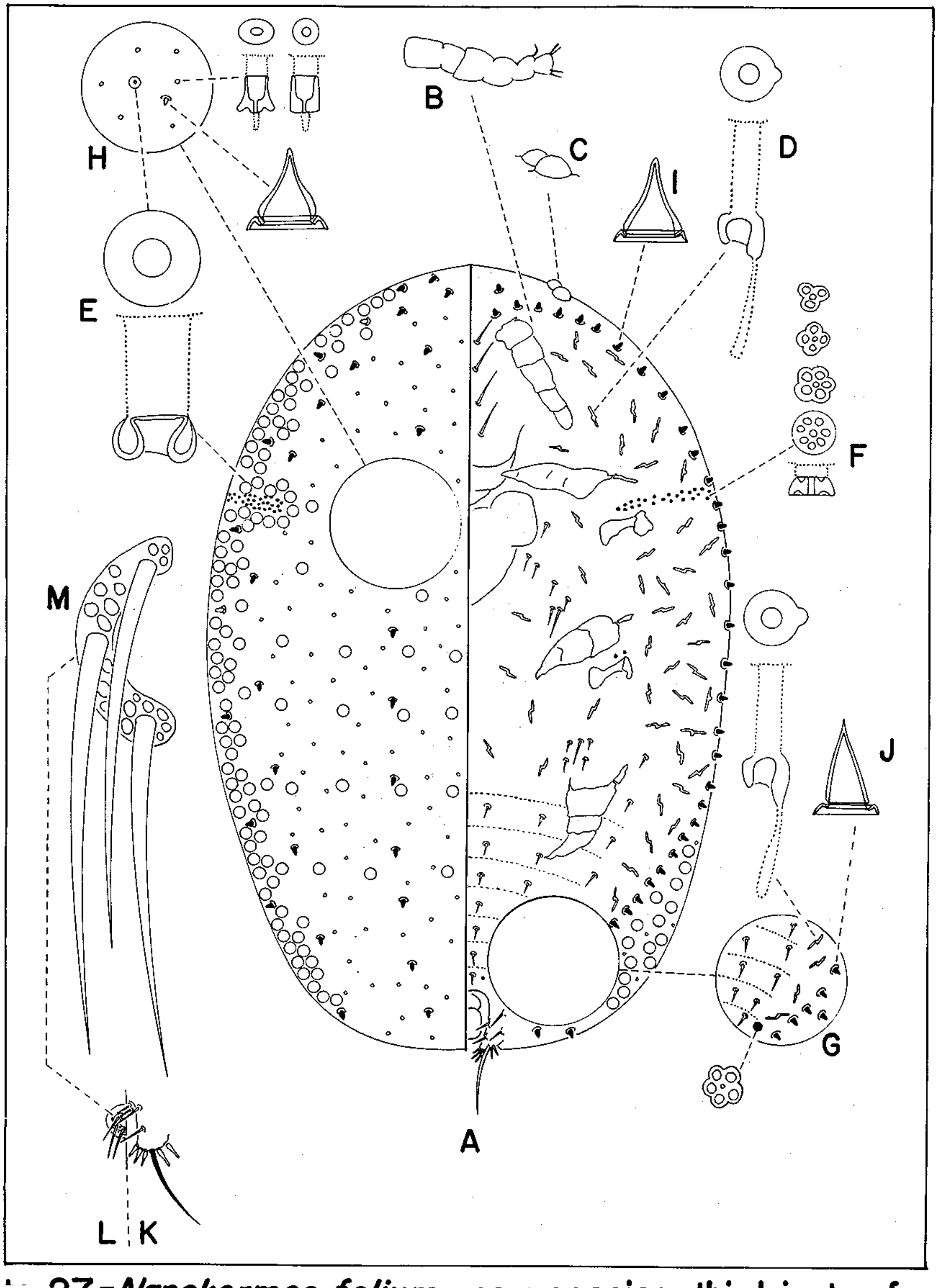
Eyes (fig. C). Present, each with 2 ocelli.

Tubular ducts. Type I (fig. D) with head 7, 6 (5-7) wide; type II (fig. E) with head 11, 10 (10-11) wide, distributed in wide row paralleling lateral row of type I ducts, extending dorsally to encircle spiracular band of multilocular disc pores, and with ca. 20 ducts on mid-dorsum in 5 transverse bands.

Multilocular disc pores. Spiracular band (fig. F) present, composed of 3-, 4-, 5-, and 7-locular pores; pre-anal band with 1 or 2 quinquelocular pores between posterior end of lateral row of type I tubular ducts and anal lobes.

Pre-anal enlargement (fig. G). With ca. 1 quinquelocular disc pore, 4 type I tubular ducts, and 6 setae.

Mid-dorsal enlargement (fig. H). With ca. 1 type II tubular duct, 6 simple disc pores, and 1 seta.



late 27.-*Nanokermes folium* , new species, third instar female

Setae. Marginals (fig. I) 10, 10 (10-11) long; pre-anals (fig. J) 12, 13 (10-15) long; anals (fig. K, shaded) 42, 36 (22-47) long.

Anal lobes (fig. K). Each with 6 setae apically, one long and slender, the remainder shorter and stouter.

Circumanal sclerotization (fig. L). 20, 30 (20-37) long, 32, 28 (11-32) wide, always enclosing areolate anal ring (fig. M), with 3 long, slender setae per side.

Sternum

Antennae (fig. B). Elongate, segmentation obscure, 156, 146 (99-168) long.

Labium. 116, 113 (104-124) long, 86, 118 (62-124) wide at base.

Spiracles. Anterior spiracles 57, 58 (47-67) long, atria 27, 23 (17-27) wide; posterior spiracles 69, 61 (49-69) long, atria 32, 28 (25-32) wide.

Legs. Prothoracic legs 165, 139 (124-165) long; mesothoracic legs 148, 141 (124-158) long; metathoracic legs 148, 137 (116-148) long.

Remarks. This species, found on *Quercus alba* from Massachusetts to the mountains of Tennessee, has been recorded once from *Q. borealis.*

It has been confused with *N. pubescens* (Bogue), and much of the literature referring to *N. pubescens* may actually refer to it.

N. folium can apparently be distinguished from all other *Nanokermes,* including *N. pubescens,* by its having only ca. 30 type II tubular ducts distributed in 3 bands. Specimens from northern localities have several times the number of these ducts than other specimens from southern localities, but their number never approaches the thousands found in *N. pubescens* and *N. iselini* (Baer and Kosztarab). Perhaps these northern and southern forms should be regarded as subspecies of *N. folium.*

Etymology. This species is named for its habit of positioning itself on leaf mid-ribs and petioles. The name *folium* is used as a noun in opposition.

NANOKERMES ISELINI (BAER AND KOSZTARAB)

Suggested common name: Iselin's Kermes.

Synonymy: *Kermes iselini* Baer and Kosztarab (1981).

Post-reproductive female (description from paratype female).

Spheroidal, ca. 3 mm long, 2 high, 2 1/2 broad, completely covered with short, clear strands of wax. Color uniform dark yellowish brown.

If wax is rubbed off, surface of dorsum is shiny, somewhat translucent, and covered with minute dark brown specks.

YOUNG ADULT FEMALE

Plate 28

Type material studied. Paratypes from *Quercus mohriana*, NM, Otero Co., 15 mi. N of El Paso gap, Jun. 15, 1976, coll. WAI, 13 (26) VPI, 4(7) USNM, 2(4) UCD, 1(2) CDA.

Tergum

Description. Body (fig. A) circular, 1360, 2212 (1360- 3160) long, 1300, 2190 (1300-3590) wide.

Eyes (fig. C). Present, each with 1 ocellus.

Tubular ducts. Type I (fig. D) with head 8, 9 (8-10) wide; type II (fig. E) with head 12, 12 (12-13) wide, distributed evenly and densely over entire dorsum.

Multilocular disc pores. Spiracular band absent; pre-anal band with ca. 17 trilocular, quadrilocular, and quinquelocular pores between posterior end of lateral row of type I tubular ducts and anal lobes.

Pre-anal enlargement (fig. F). With ca. 2 simple disc pores, 5 trilocular disc pores, 1 quadrilocular disc pore, 6 quinquelocular disc pores, and 2 setae.

Mid-dorsal enlargement (fig. G). With ca. 25 type II tubular ducts and 13 simple disc pores.

Spinescent 8-shaped pores (fig. H). 6, 7 (5-9) long, teeth stout, heavily sclerotized, pits absent; distributed in a single transverse band of ca. 6 pores on posterior dorsum.

Setae. Marginals (fig. I) 20, 16 (12-20) long; pre-anals (fig. J) 15, 16 (12-20) long; anals (fig. K, shaded) 44, 37 (27-44) long.

Anal lobes (fig. K). Each with 1 stout, medially projecting seta.

Anal ring (fig. L). 26, 36 (20-44) long, 29, 35 (29-38) wide; always enclosing areolate anal ring of third instar (fig. M).

Sternum

Antennae (fig. B). Elongate, segmentation obscure, 186, 182 (148-247) long, retaining exuviae of first, second, and third instars.

Labium. 136, 161 (136-186) long, 161, 161 (143-185) wide at base.

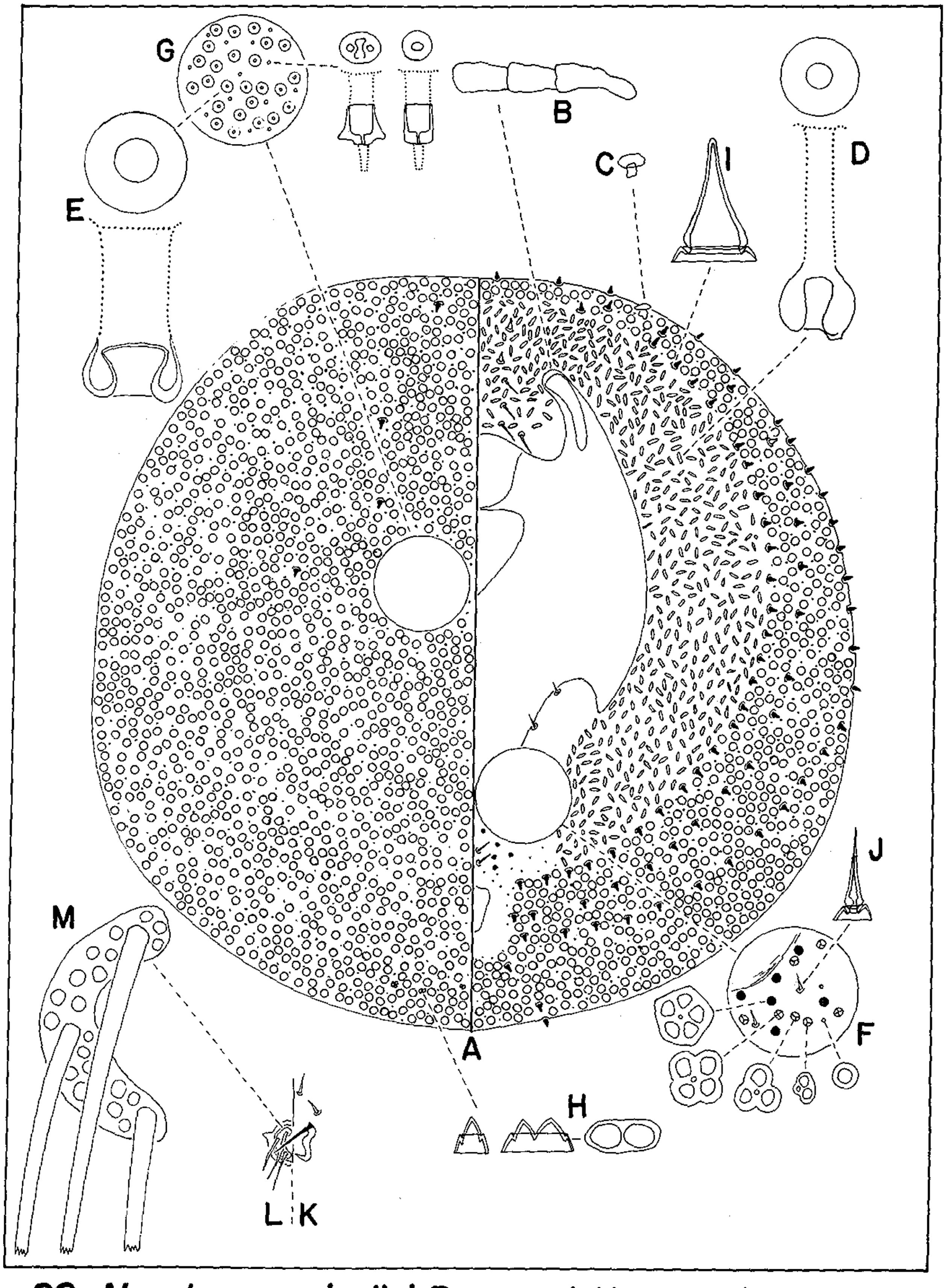


Plate 28.-*Nanokermes iselini* Baer and Kosztarab, adult femc

Spiracles. Anterior spiracles 99, 92 (74-99) long, atria 30, 60 (30-74) wide; posterior spiracles 124, 107 (74-155) long, atria 54, 69 (50-81) wide.

Legs. Prothoracic legs 173, 201 (170-247) long; mesothoracic legs 198, 194 (161-229) long; metathoracic legs 155, 172 (136-217) long.

Additional material studied. *Quercus arizonica*, AZ, Portal, ca. 1 1/2 mi. up on S Fork Rd., Jun. 19, 1976, colls. MK, P. Hanna, and I. Storks, 4(7) VPI.

Remarks. This species is found on *Quercus arizonica* and *Q. mohriana* in Arizona and New Mexico.

N. iselini can apparently be distinguished from all other *Nanokermes* by the following combination of characters: 1) mid-dorsum with ca. 1000 type II tubular ducts distributed evenly and densely on it; 2) anterior spiracular furrow absent; 3) 4 setae in each dorsal submedial row; and 4) anal plate small, narrow and indistinct.

Etymology. Baer and Kosztarab (1981) named this species in honor of its first collector, W. A. Iselin.

NANOKERMES PUBESCENS (BOGUE)

Color fig. 18

Suggested common name: Pubescent Leaf Kermes.

Synonymy: *Kermes pubescens* Bogue, 1898:172.
Coccus pubescens, Cockerell, 1929:150.
Talla pubescens, Lindinger, 1933:143.

Post-reproductive female. Bogue (1898) described the post-reproductive female as

> . . . spheroidal, 3 1/2 mm. in diameter, 3 high; pointed and grooved beneath; covered all over with short straggling whitish pubescence. Color rather light brown, with more or less obscure and suffused dark brown bands marking the obsolete segments. Surface shining, with minute concolorous specks, but no dark spots or pits.

YOUNG ADULT FEMALE

Plate 29

Type material studied. Topotypes from *Quercus* sp., KS, Manhattan, Apr. 15, 1899, 1(1) USNM; Apr. 23, 1906, coll. GAD 1(1) USNM.

Although mounted on slides, most of the type and identified material was too sclerotized to illustrate. Only the one specimen in the following lot was suitable: *Q. marilandica,* OK, Oklahoma City, let. of Jun. 2, 1952, fr. A. E. Thomas, 1(1) USNM.

Tergum

Description. Body (fig. A) circular, ca. 1420 long, 1360 wide.

Eyes. Absent.

Tubular ducts. Type I (fig. C) with head ca. 7 wide; type II (fig. D) with head ca. 11 wide, distributed evenly and densely over entire dorsum.

Multilocular disc pores. Spiracular band (fig. E) present, composed of trilocular, quadrilocular, and quinquelocular pores; pre-anal band with ca. 9 or 10 trilocular, quadrilocular, and quinquelocular pores between posterior end of lateral row of type I tubular ducts and anal lobes.

Pre-anal enlargement (fig. F). With ca. 4 trilocular disc pores, 2 quadrilocular disc pores, 4 quinquelocular disc pores, 6 simple disc pores, 5 pre-anal setae, and 2 lateral setae.

Mid-dorsal enlargement (fig. G). With ca. 30 type II tubular ducts and 16 simple disc pores.

Spinescent 8-shaped pores (fig. H). Ca. 5 long, teeth stout, heavily sclerotized, pits absent; distributed in 2 transverse bands on posterior dorsum, the dorsal band with ca. 14 pores, the ventral band with ca. 4 pores.

Setae. Marginals (fig. I) ca. 12 long; pre-anals (fig. J) ca. 12 long; anals (fig. K, shaded) ca. 22 long.

Anal lobes (fig. K). Each with 1 stout, medially projecting seta.

Anal ring (fig. L). Ca. 29 long, ca. 24 wide, occasionally enclosing areolate anal ring of third instar.

Sternum

Antennae (fig.B). Elongate, segmentation obscure, ca. 155 long.

Labium. Ca. 114 long, ca. 124 wide at base.

Spiracles. Anteior spiracles ca. 74 long, atria ca. 44 wide; posterior spiracles ca. 106 long, atria ca. 57 wide.

Legs. Prothoracic legs ca. 161 long; mesothoracic legs ca. 161 long; metathoracic legs ca. 148 long.

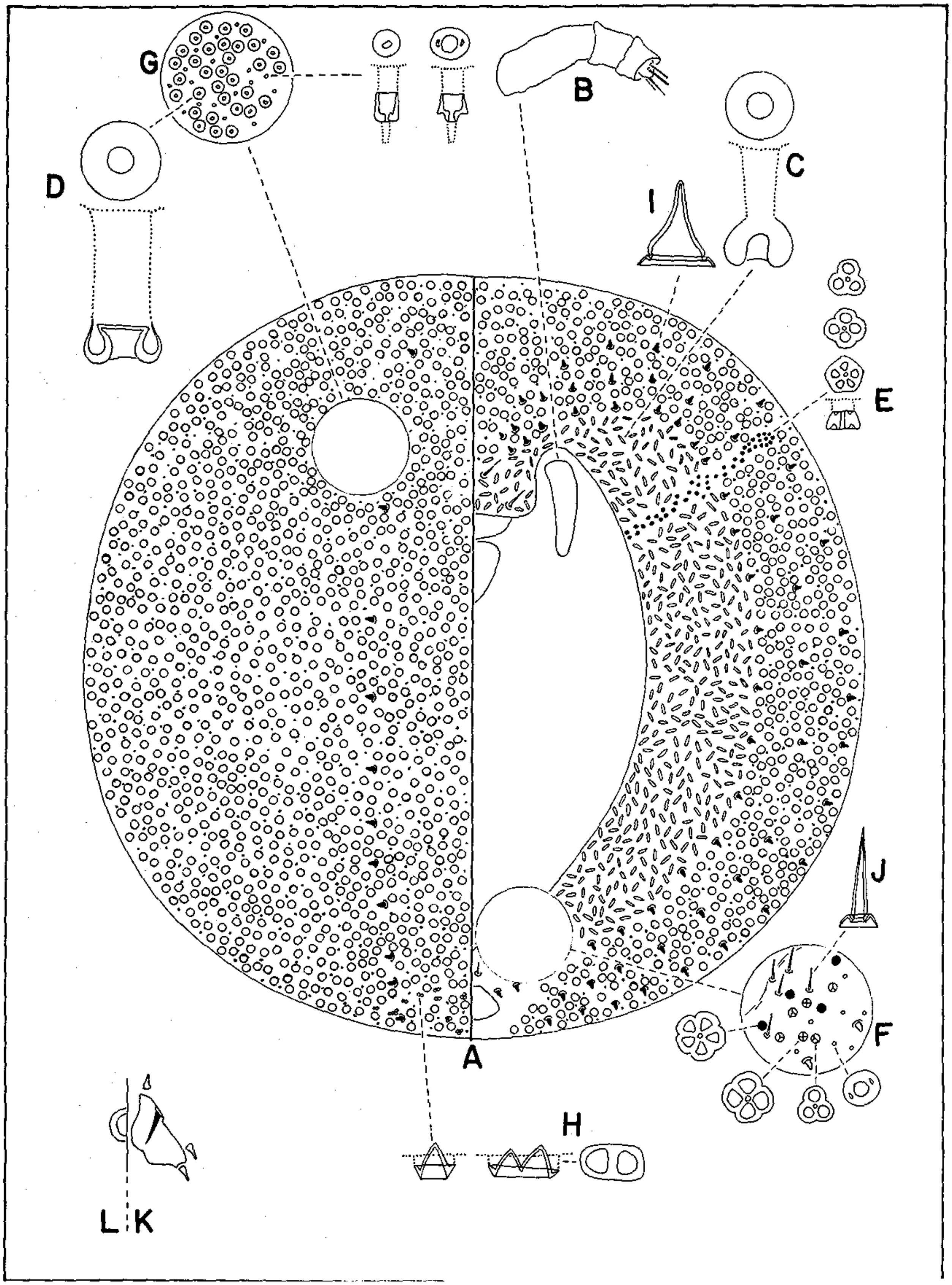


Plate 29.-*Nanokermes pubescens* (Bogue), adult female

Additional material studied. *Quercus alba*, **AR**, Mena, May 28, 1959, coll. G. C. Dowell, 1(3) USNM; **IN**, Marion Co., Jul. 1, 1913, coll. H. Dietz, 2(2) UCD, 1(1) VPI; **KS**, Lawrence, Mar. 1898, 4(7) CDA. *Q. X deamii (Q. macrocarpa X Q. muehlenbergii)*, **IL**, Lisle, Jun. 11, 1976, coll. J. E. Appleby, 7(23) VPI. *Q. macrocarpa*, **KS**, K. A. C. campus, Jul. 9, 1906, 1(1) KSU. *Q. "obtusiloba,"* **TX**, Dallas, May 18, 1882, 1(1) USNM. *Q. stellata*, **AL**, Baldwin Co., Summerdale, May 2, 1975, coll. B. R. Hammond, 5(5) AU. *Quercus* sp., **AL**, Birmingham, let. of Apr. 28, 1925, fr. N. F. Howard, 1(1) USNM; **AZ**, Prescott, Indian Cr., Jul. 17, 1941, coll. LPW, 3(3) UCD, 3(3) VPI; **MS**, Jones Co., May 7, 1930, 2(2) UCD; **MO**, Kirkwood, Sep. 9, 1892, coll. M. Murtfelt, 1(2), USNM; **VA**, Virgilina, May 29, 1975, ABH, 4(4) VPI; coll. GBK, 1(1) AMNH.

Questionable identifications in literature. *Quercus alba*, **DC**, Washington (Kotinsky, 1921:79; Felt and Rankin, 1932: 351); **IL** (Flint and Farrar, 1940:41); **KS**, Douglas Co., Lawrence (Hunter, 1902:107; Lawson, 1917: 184); **MA**, Lawrence, coll. GBK (Cockerell, 1898c:322; King, 1899:139, 1900b:80; Hartman, 1916:94); Andover and Methuen (King, 1899:139, 1900b:80; Garman, 1905:53; Baerg, 1955:147); **MD**, University of Maryland campus (McConnell and Davidson, 1959:463); **PA**, (Sleesman, 1945:44, 45); **RI**, Roger Williams Park, Prior Rd., coll. C. A. Davis (King, 1903b:192); eastern United States of America (Hoy, 1963:153); northern United States of America (Herrick, 1935:237); **CANADA**, (Hunter, 1902:120, 145; Gibson, 1913:18, 19; Houser, 1918:306; McDaniel, 1930:13; Flint and Farrar, 1940:41; Baerg, 1955:148); Ontario, Perth, Toronto, Guelph, and Brantford (Fletcher and Gibson, 1908:130; Hoy, 1963:153). *Q. alba* group, **IL**, Urbana, University of Illinois, coll. A. A. Girault (Girault, 1911:168, 169). *Q. bicolor* X *Q. macrocarpa* (Dodge and Rickett, 1943:509). *Q. borealis*, **MA**, Lawrence, Andover, and Methuen, coll. GBK (King, 1899: 139, 1900b:80; Garman, 1905:53; Houser, 1918:306; Howard, 1919:257; Kotinsky, 1921:79; McDaniel, 1930:13; Herrick, 1935:237; Flint and Farrar, 1940:41; Baerg, 1955:147, 148). *Q. lyrata*, **LA** (Newell and Rosenfeld, 1908;155). *Q. macrocarpa*, **IL** (Flint and Farrar, 1940:41; Baerg, 1955:148); **IN**, Indianapolis (Dietz and Morrison, 1916:235; Kotinsky, 1921:79; MacGillivray, 1921:195); Tippecanoe Co. (Amos, 1933:206); Lafayette, mid-Jul. (Osmun, 1962:134); **KS**, Manhattan, coll. GAD (Dean, 1909:266; Lawson, 1917:184; MacGillivray, 1921:195; Baerg, 1955:147); **KY**, Jun. 29, 1892, coll. H. Garman (Garman, 1905: 53; Baerg, 1955:147); **MA**, (MacGillivray, 1921:195); **MI** (McDaniel, 1930:13; Baerg, 1955:148); **OH**, Columbus, Minerva Park, coll. JGS (Webster and Burgess, 1902:113; Fernald, 1903:64; King, 1903a:22; Sanders, 1904: 37; Garman, 1905:51; Houser 1918:306; Baerg, 1955:147); Cincinnati (Houser, 1918:306; Baerg, 1955:147); 1921:195); **PA**, southwest portion (Trimble, 1928:43); eastern United States of America (Hoy, 1963:153); northern United States, May (Herrick, 1935:237); **CANADA**, Ontario, Guelph, Perth, and Toronto, Jun. 12 (Jarvis, 1908:50, 67; Jarvis, 1911:64; Baerg, 1955: 147); Ontario, Guelph, coll. A. Eastham (Treherne, 1916: 178; Howard, 1919:256); **CANADA**, (Hoy, 1963: 153); (Dodge and Rickett, 1943:510; Pirone, 1972:439). *Q. muehlenbergii*, **KS**, Lawrence (Lawson, 1917:184; Baerg, 1955:147); **KY** (Garman, 1905:51; Baerg, 1955:147); eastern United States of America (Hoy, 1963:153); northern United States of America (Herrick, 1935:237); **CANADA**, (Hoy, 1963:153); (Houser, 1918:306; Kotinsky, 1921:79; McDaniel, 1930:13;

Baerg, 1955: 148). *Q. prinoides*, **KS**, Manhattan, coll. GAD (Dean, 1909:266; Lawson, 1917:184; Baerg, 1955:147); eastern United States of America (Hoy, 1963:153); **CANADA**, (Hoy, 1963:153); (McDaniel, 1930:13). *Q. prinus*, **IN**, Tippecanoe Co. (Amos, 1933:206); eastern United States of America (Hoy, 1963:153); **CANADA**, (Hoy, 1963:153); (Kotinsky, 1921:79). *Q. stellata*, **AR**, May 1953, coll. W. J. Baerg (Baerg, 1955:148); **MO**, 1954, coll. G.W. Thomas (Baerg, 1955:148); eastern United States of America (Hoy, 1963:153); **CANADA** (Hoy, 1963:153). *Quercus* sp., **CT**, New Haven, Aug. 20, 1908, coll. H. L. Viereck; New Haven, Jun. 27, 1913, coll. W. E. Britton (King, 1914d:151; Britton, 1923:351); New Haven, Jun. 24-Jul. 21, 1915, coll. BHW (Britton, 1923:351); (Britton, 1920:63, 1926:175; Britton and Zappe, 1926:182); **IL**, Urbana, coll. A. A. Girault (Girault, 1911:168-178; Timberlake, 1916:585; Howard, 1919:256, 257); **KS**, (Hunter, 1902:120, 145; Smith, 1943:200); **MA** (Cockerell, 1900: 44; Fernald, 1903:64); **MS** (Baerg, 1955:148); **NJ**, Lakehurst, coll. W. T. Davis (Smith, 1910:122); Orange (Headlee, 1928:127); **OK** (Baerg, 1955:148); **NY**, Scarsdale (Felt and Morrison, 1928:194); **WI** (Severin and Severin, 1909:297); E coast to MS valley states (Doane *et al.* 1936:382,383); eastern half of the United States, Jun.-Jul. (Baker,1972:97); (Pirone, 1972:440).

Other literature citations. Balachowsky, 1950a:344, 4; Barber, 1911:449; Britton, 1923:350; Cockerell, 1899b:393, 1900:44; Felt and Morrison, 1928:194; Ferris, 1955b:202; Fulmek, 1943:38; Hamon *et al.*, 1976:2; Koteja, 1974a:49, 154, 1976:273; Koteja and Zak-Ogaza, 1972:194; Koteja and Liniowska, 1976:668; Kuwana, 1931:16; Lindinger, 1910:324, 1958:369; Peck, 1963:935; Ruhl, 1913: 79, 80, 1914:25, 1917:50, 1919:44; Schmidt, 1939:140.

Remarks. This species has been recorded from 5 species of oaks in the midwestern United States. If the number of citations in the literature is an indication of abundance, then it is very common. Most of the references, however, probably refer to *N. folium*, new species.

N. pubescens can apparently be distinguished from all other *Nanokermes* by the following combination of characters: 1) mid-dorsum with ca. 1000 type II tubular ducts distributed evenly and densely over it; 2) anterior spiracular furrow present; 3) 11 setae in each dorsal submedial row; and 4) anal plate large, wide, and distinct.

The post-reproductive female is noted for its dorsum, which is covered with short strands of wax that *en masse* resemble pubescence. This "pubescence" is so remarkably similar in color and texture to the pubescence on the buds of *Quercus macrocarpa*, and the scale so similar in size to these buds, that the first author has had problems distinguishing scales from buds even when using a dissecting microscope.

Etymology. Bogue named this species for its waxy pubescence.

OLLIFFIELLA COCKERELL

Type: *Olliffiella cristicola* Cockerell

Adult Female (Plate 30) With 1 tubular duct type (fig.C); middle dorsum with 8-shaped pores (fig.G), these consisting of 2 joined cuplike pits, each heavily sclerotized, ca. 4µ long, and with its twin distributed in units randomly but densely on derm; spiracular furrow absent; multilocular disc pores present laterally and evenly distribtued in marginal strip (fig.D); anal lobes membranous, ventral to anal opening, without definite margins, and each bearing 29 to 38 long, slender setae, mostly on the ventral surface (fig. J); anal ring narrow, cordlike, with margins not distinct from surrounding derm, and not enclosing third instar anal ring (fig. K).

Third Instar Female (Plate 32) With 1 tubular duct type (fig.B); spiracular furrow absent; multilocular disc pores present laterally and evenly distributed in marginal strip (fig. D); anal lobes membranous, somewhat ventral to anal opening, without definite margins, and each bearing 31 long, slender setae ventrally (fig. I); anal ring narrow, cordlike, with margins not distinct from surrounding derm (fig. J).

Remarks. This genus is restricted to the Nearctic Region. Adults are found in galls on leaves of *Quercus* spp.

Etymology. Cockerell named this genus in honor of S. Olliff.

OLLIFFIELLA CRISTICOLA COCKERELL

Color figs. 1, 4. Plate 2 H, I, J

Suggested common name: The Gall Kermes.

Synonymy: *Olliffiella cristicola* Cockerell, 1896c:299, 300; Ferris, 1955b:206; Kosztarab 1982:159.

Post-reproductive female. Cockerell (1896c) described the postreproductive female as:

> . . . having very small but perfectly distinct and well formed legs and antennae; the antennae resembling those of *Coccus*, six-jointed, the joints after the third successively shorter; the femora very stout, semi-circular in outline, the tarsi distinctly two-jointed, the four digitules all filiform, with small round knobs; the skin of the dorsal surface is thickly beset with glands, mostly double or figure-of-eight.

YOUNG ADULT FEMALE

Type material studied. Lectotype from *Quercus "wrightii,"* NM, Pinos Altos, Aug. 3, 1896, 1(1) USNM.

The illustration and measurements were made from the following lot: *Quercus emoryi*, AZ, Cochise Co., Portal, SW Research Station, Jun. 21, 1968, coll. R. F. Wilkey, 1(1) RFW, 1(1) USNM.

Tergum

Plate 30

Description. Body (fig. A) ovoid or circular, 3960, 3550 (2480-4210) long, 3960, 3433 (2010-4330) wide.

Eyes (fig. B). Present, each with 2 ocelli.

Tubular ducts (fig. C). Head 4, 4 (4-5) wide.

Multilocular disc pores. Lateral row (fig. D) with 3-, 4-, 5-, and 7-locular pores distributed in wide band lateral to and paralleling marginal row of tubular ducts; pre-anal band with trilocular, quinquelocular, and 7-locular pores extending on each side of body from posterior end of lateral row of tubular ducts to just below anal lobes, ending abruptly.

Pre-anal enlargement (fig. E). With ca. 2 trilocular disc pores, 22 quinquelocular disc pores, 1, 7-locular disc pore, and 4 setae.

Mid-dorsal enlargement (fig. F). With ca. 10 simple disc pores and 17 8-shaped pores.

8-shaped pores (fig. G). 5, ca. 5 long, with 2 pits and no teeth; distributed evenly and densely over mid-dorsum.

Setae. Marginals (fig. H) in submedial row 30, 35 (30-40) long; pre-anals 67, 69 (49-91) long.

Anal lobes (fig. J). Each with 30, 32 (29-38) setae.

Anal ring (fig. K). 80, 85 (57-117) long, 136, 127 (96-148) wide.

Sternum

Plate 31

Antennae. Elongate, segmentation distinct, 173, 171 (155-185) long.

Labium. 216, 192 (173-216) long, 142, 133 (114-142) wide at base; 4 indistinct segments; anterior surface (fig. B) with 7 setae, posterior surface (fig. A) with 1.

Spiracles. Anterior spiracles (fig. C) 124, 115 (111-124) long, atria 80, 72 (62-80) wide; posterior spiracles 124, 126 (118-136) long, atria 32, 70 (32-111) wide.

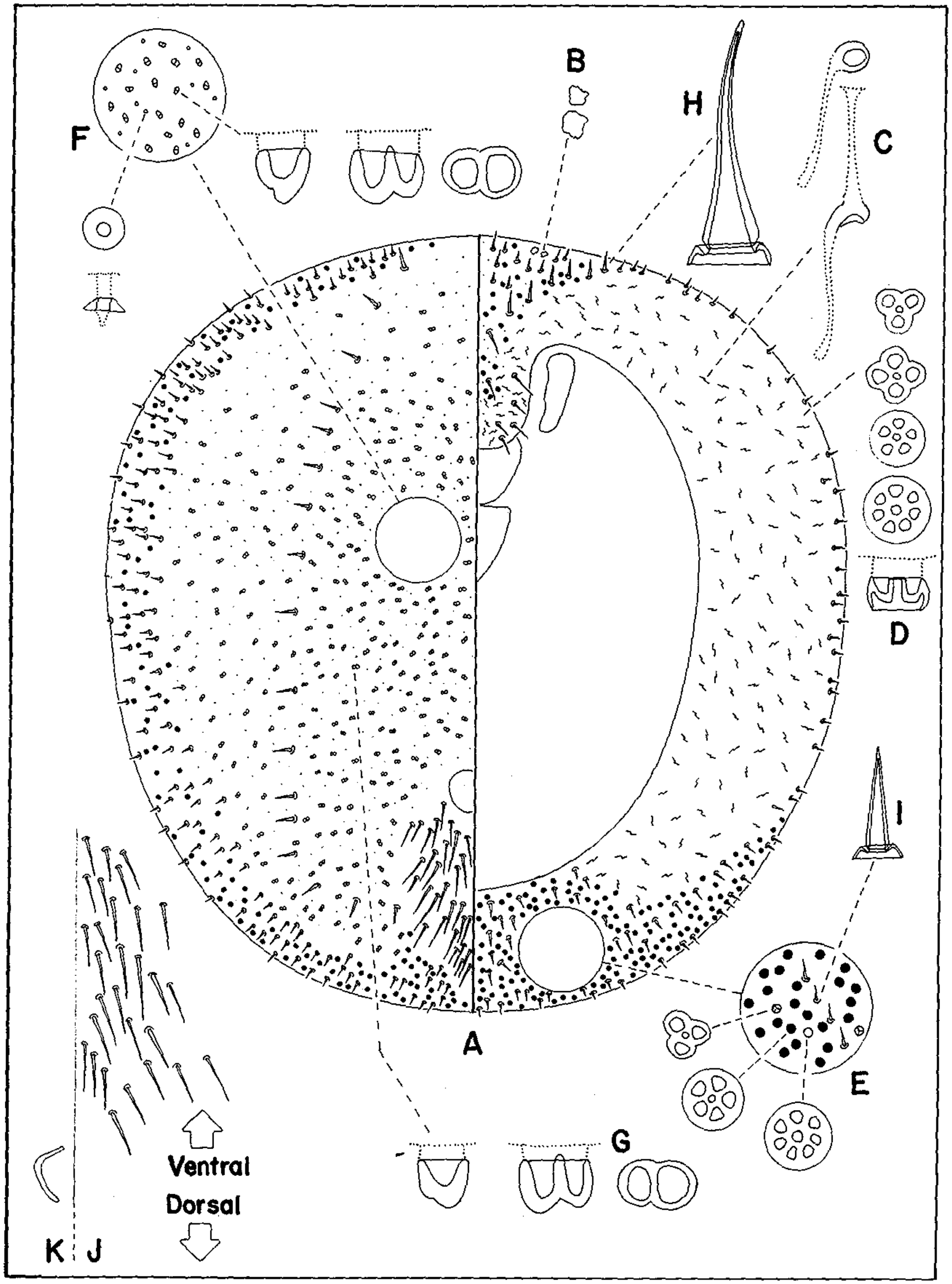


Plate 30.-*Olliffiella cristicola* Cockerell, adult tergum

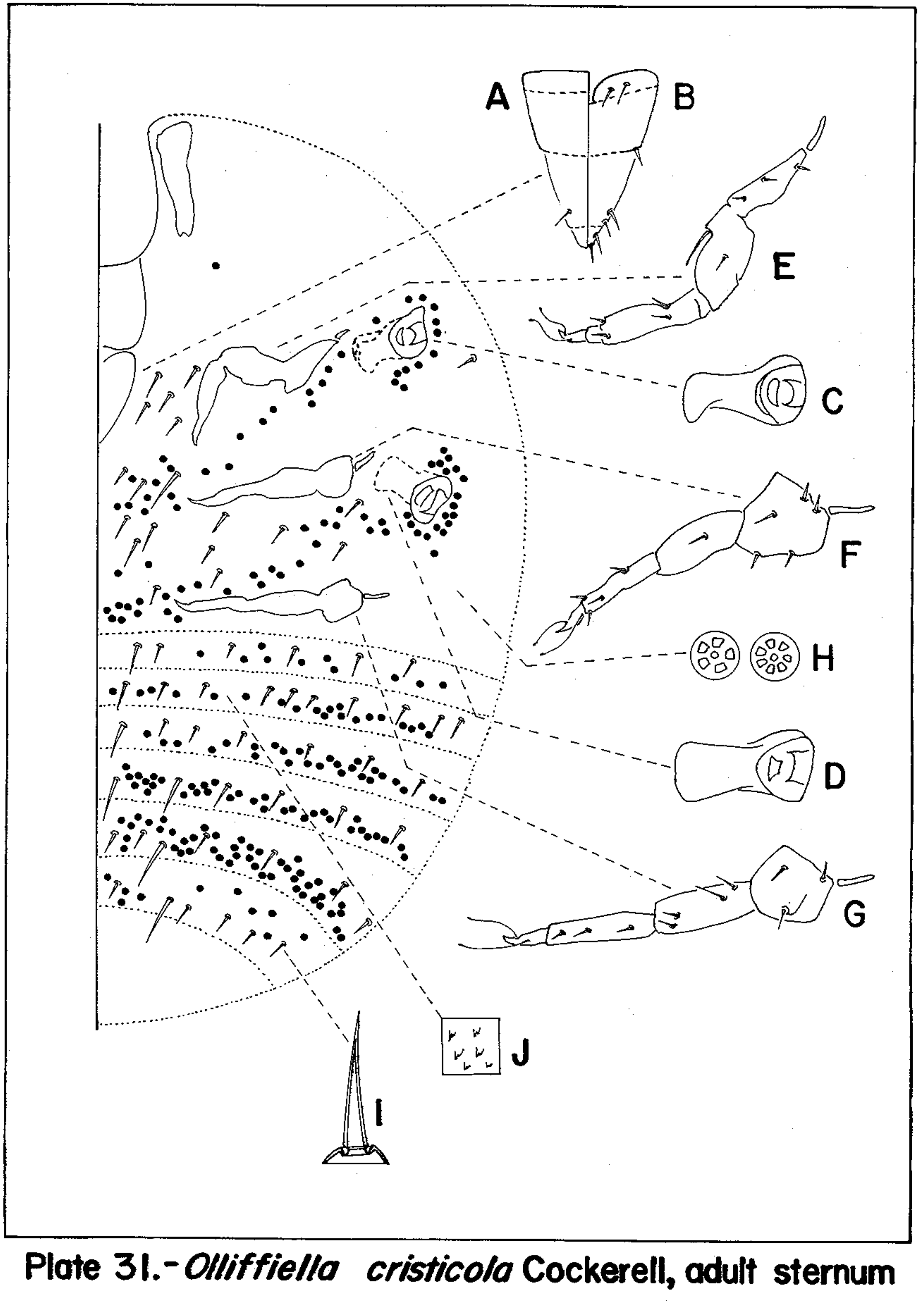


Plate 31.-*Olliffiella cristicola* Cockerell, adult sternum

Legs. Prothoracic legs (fig. E) 383, 344 (309-340) long; mesothoracic legs 371, 367 (340-389) long; metathoracic legs 309, 350 (309-371) long.

Multilocular disc pores. Quinquelocular and 7-locular pores (fig. H) distributed in vicinity of spiracular atria, in transverse band on each thoracic segment, and within intersegmental folds on all abdominal segments.

Abdominal setae (fig. I). Long and slender.

Abdominal derm (fig. J). Thickly beset with minute teeth, these only visible if specimen stained well.

Additional material studied. *Quercus emoryi*, AZ, Pine, Oct., 1939, coll. Mrs. N. W. Capron, 2(2) USNM; near Prescott, Jun. 28, 1935, through L. H. Weld, 1(3) USNM; Dragoon Pass, Jul. 6, 1949, coll. GFF, 1(1) UCD; Sycamore Flat, Nov. 21, 1918, coll. G. Hofer, 1(3) USNM; Wolf Cr., Sep. 26, 1945, coll. L. H. Weld, 1(2) USNM. *Quercus* sp., AZ, E of Vail, Jun. 1918, coll. GFF, 1(1) UCD.

THIRD INSTAR FEMALE

Plate 32

Type material studied. None. The illustration and measurements were made from the following lot: *Quercus emoryi*, AZ, Cochise Co., Portal, SW Research Station, Jun. 21, 1964, coll. R. F. Wilkey, 1(1) RFW.

Description. Body (fig.A) ca. 1240 long, ca. 1140 wide.

Eyes (fig.B). Present, each with 1 ocellus.

Tubular ducts (fig. C). Head ca. 5 wide.

Quinquelocular disc pores. Lateral row (fig. D) in wide band lateral to and paralleling marginal row of tubular ducts; pre-anal band extending on each side of body from posterior end of lateral row of tubular ducts to just below anal lobes, ending abruptly.

Pre-anal enlargement (fig. E). With ca. 8 quinquelocular disc pores and 2 setae.

Mid-dorsal enlargement (fig. F). With ca. 2 simple disc pores.

Setae. Marginals (fig. G) ca. 25 long; pre-anals (fig. H) ca. 18 long; anals ca. 42 long.

Anal lobes (fig. I). Each with ca. 23 setae.

Anal ring (fig. J). Ca. 44 long, ca. 44 wide.

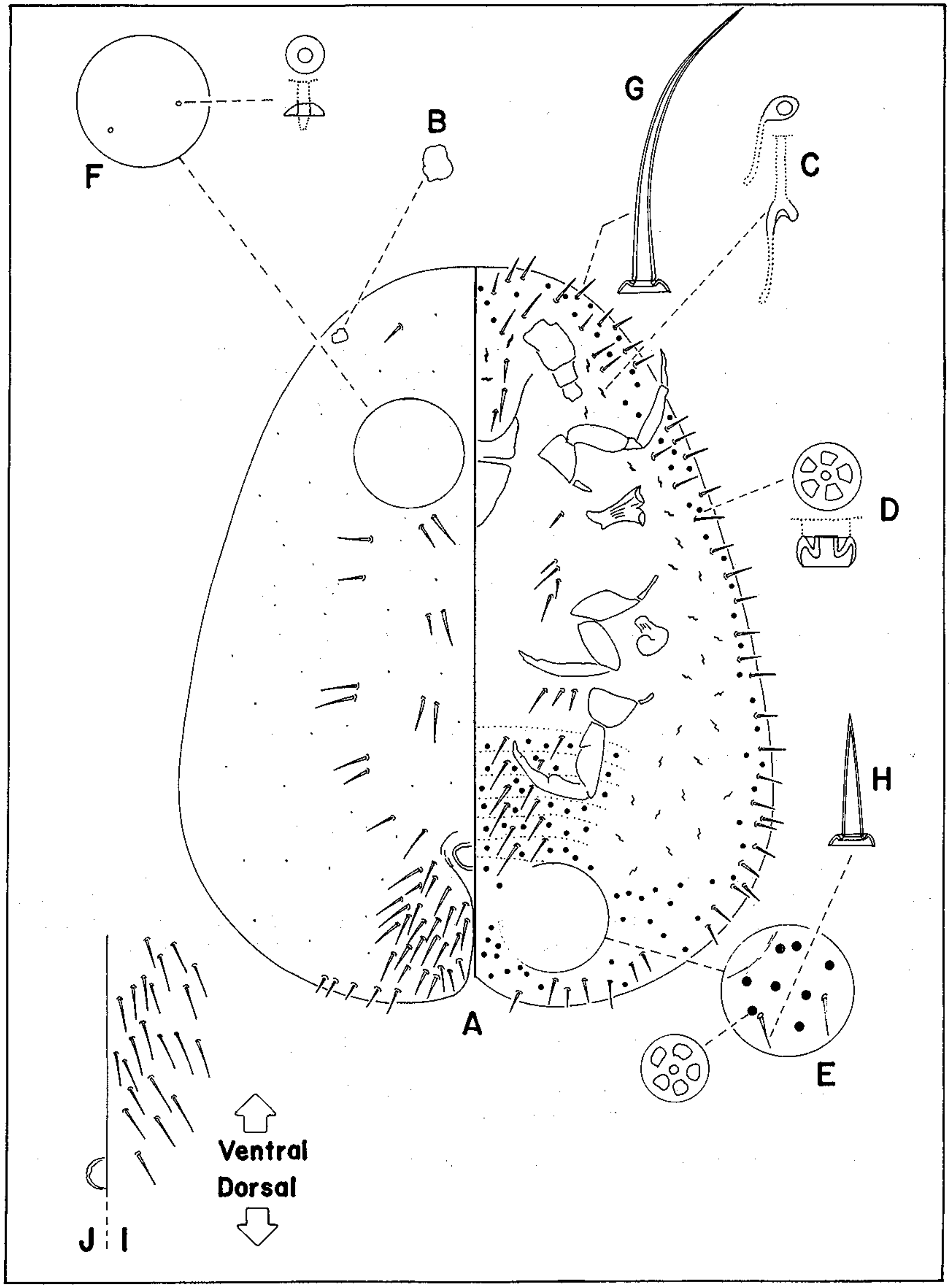


Plate 32.-*Olliffiella cristicola* Cockerell, third instar female

Sternum

Antennae. Elongate, segmentation distinct, ca. 149 long.

Labium. Ca. 136 long, ca. 111 wide at base.

Spiracles. Anterior spiracles ca. 49 long, atria ca. 30 wide; posterior spiracles ca. 37 long, atria ca. 32 wide.

Legs. Prothoracic legs. ca. 278 long; mesothoracic legs ca. 235 long; metathoracic legs ca. 278 long.

Questionable identifications in literature. *Quercus emoryi*, AZ, between Benson and Dragoon, coll. GFF (Ferris, 1919:15, 16, 1955b:205, 206); Prescott and Vail (Ferris, 1955b:205, 206); AZ, (Hoy, 1963:175; Sternlicht, 1974:195-197); NM (Hoy, 1963:175); southwestern United States of America (Ferris, 1950:7). *Q. undulata*, AZ, NM (Hoy, 1963:175). *Quercus* sp. (not *Q. "wrightii"*); NM, Pinos Altos (Cockerell, 1898a:65).

Other literature citations. Cockerell, 1896b:226, 1899c: 276, 1899b:392; Doane *et al.*, 1936:383; Essig, 1926:276; Ferris, 1921:60, 61, 1937:5, 1955a:23, 1957: 87, 88; Houard, 1940: 96, 294, 300; Lindinger, 1937:191; Lobdell, 1937:79, 80; MacGillivray, 1921:188, 190, Reyne; 1954:239; Schmidt, 1940:167.

Remarks. This species is found on *Quercus "wrightii,"* and *Q. emoryi* in New Mexico, Arizona and Mexico. It is the only North American Kermesidae to form a gall.

Etymology. The name "cristicola" literally means "crestdweller," referring to the prominent apical crest of the gall.

NOTES ON UNPLACED SPECIES

The following species either have not been seen by the authors or have been seen only as a post-reproductive female. Until further studies have been made on the microscopic characters of newly-molted adult females from the type localities of these species, one cannot be certain of their correct generic assignment and synonymy.

KERMES ARIZONENSIS KING

Synonymy: *Kermes arizonensis* King, 1903a:21, 22.
Talla arizonensis (King), Lindinger, 1933:143.

Post-reproductive female. King (1903a) described the post-reproductive female as

. . . variable in size, transverse diameter 3 and 5 mm. Color grayish white, distinctly marbled with a light yellow or reddish brown, and having four prominent linear transverse dark brown bands, somewhat wavy, due to quite large pits at intervals; surface not shiny; speckled with minute black dots. Dead dry half-grown individuals, dark red brown.

Type host and locality. *Quercus* sp., AZ, Prescott.

Questionable identifications in literature. *Quercus alba*, PA (Trimble, 1928:43); Philadelphia (Sleesman, 1945:44, 45); OH, Columbiana Co., Salem, Sep. 7, 1903, coll. JGS (Sanders, 1904:35). *Quercus* sp., AZ (King, 1913a:206); CO, NM (Cockerell, 1905:192).

Other literature citations. Balachowsky, 1950a:344; Doane *et al.*, 1936:383; Essig, 1926:275; Fernald, 1903:60; Ferris, 1955b:194, 197; Hoy, 1963:139; King, 1913b:207, 1914a:48; MacGillivray, 1921:197.

Remarks. This species was described from the type locality of *Kermes emoryi* Ferris, which, based on the newly-molted adult female, is a synonym of *Allokermes galliformis* (Riley).

Etymology. King named this species for the state with the type locality, Arizona.

KERMES AUSTINI EHRHORN

Synonymy: *Kermes austini* Ehrhorn, 1899a:104.
Kermes galliformis, Essig, 1915:117 (misidentification?)
Talla austini (Ehrhorn), Lindinger, 1933:143.

Post-reproductive female. Ehrhorn (1899a) described the post- reproductive female as

. . .spherical, about 4.5 mm. broad, 4 mm. long, 4 mm. high. . . Dorsum slightly covered with a waxy secretion. Scale not gibbous and segmentation indistinct, indicated by brown dots when seen through a lens. Colour light brown, with several irregular white stripes running parallel with the segments. There is a distinct groove on the caudal portion of the scale, which is distinctly marked with brown. Scale more or less pitted. Pits generally marked dark brown or black. Ventral scale is more or less flat and light brown. Keel not very prominent.

Type host and locality. *Quercus oblongifolia*, CA, San Diego Co., Guejito Mts., 8 mi. E of Escondido.

Other literature citations. Balachowsky, 1950a:344; Carnes, 1906:68; Cockerell, 1899b:393, 1900:44; Doane *et al.*, 1936:383; Essig, 1926:275, 1931:614; Fernald, 1903: 60; Ferris, 1955b:194; Hoy, 1963:139; King, 1900b:81; MacGillivray, 1921:197.

Etymology. Ehrhorn named this species in honor of its first collector, F. Austin.

KERMES BOGUEI COCKERELL

Synonymy: *Kermes boguei* Cockerell, 1897b:94, 95.
Coccus boguei (Cockerell), 1929:150.
Talla boguei (Cockerell), Lindinger, 1933:143.

Post-reproductive female. Cockerell (1897b) described the post-reproductive female as:

> Globose, slightly oval; length about 6 1/2, breadth 5 3/4, height 5 mm., varying a little in these proportions. Surface without gibosities, not very shiny; with a lens one sees that it presents innumerable dull rugosities with intervening shiny lines. The general color is dark; there are five suffused, more or less broken bands of dull scarlet; the areas between these are whitish, but largely occupied by broken black lines or stripes. There are also transverse blotchy bands of black, much interrupted. The general effect produced is an irregular blotching of scarlet, black, and dull white; the black may predominate and make a dark scale in which the scarlet and white are not so readily noticed.

Type host and locality. *Quercus alba*, OK, ca. 10 mi. from Stillwater.

Other literature citations. Balachowsky, 1950a:344; Cockerell, 1899b:393, 1900:44; Doane *et al.*, 1936:383; Fernald, 1903:61; Ferris, 1955b:194; Hoy, 1963:141; King, 1900b:79; MacGillivray, 1921:197.

Etymology. Cockerell named this species in honor of its collector, E. E. Bogue.

KERMES CERIFERUS EHRHORN

Synonymy: *Kermes ceriferus* Ehrhorn, 1899b:5,6.
Coccus ehrhorni n. n., Cockerell, 1929:150.
Talla cerifera (Ehrhorn), Lindinger, 1933:143.
Kermes ehrhorni, Balachowsky, 1950a:344.

Post-reproductive female. Ehrhorn (1899b) described the post-reproductive female as:

> . . . globular, about 4 to 4 1/2 mm. in diameter, ground color brown, shiny, dotted with black spots. Scale completely covered with dirty white wax. Segmentation obsolete, only indicated by black markings. Ventrum slightly pubescent.

Type host and locality. *Quercus* sp., AZ, Walnut Cr. Canyon, near Flagstaff.

Other literature citations. Balachowsky, 1950a:344; Cockerell, 1899b: 393, 1900:44; Doane *et al.*, 1936, 383; Essig, 1926:275; Fernald, 1903:61; Ferris, 1955b:195; Hoy, 1963: 141; King, 1900b:81, 82; MacGillivray, 1921:196.

Etymology. Ehrhorn named this species for the dirty white wax covering its dorsum.

KERMES COCKERELLI EHRHORN

Synonymy: *Kermes cockerelli* Ehrhorn, 1898:185.
Coccus cockerelli (Ehrhorn), Cockerell, 1929:150.
Talla cockerelli (Ehrhorn), Lindinger, 1933:143.

Post-reproductive female. Ehrhorn (1898) described the post-reproductive female as

> . . .5 mm. long, 4.5 mm. broad and 4 mm. high, deeply segmented, dorsum usually marked with black lines and spots along the sutures, some species not showing any. There is a broad, median, longitudinal groove, where the segmentation is obsolete; on each side of this the segments are strongly gibbous. Color light brown, without any conspicuous black specks. . . .

Type host and locality. *Quercus lobata*, CA, Mountain View.

Questionable identifications in literature. *Quercus chrysolepis*, **CA**, Placer Co., Colfax, elev. 2,500 feet (King, 1914b:101; Essig, 1914b:47, 1915:115); *Q. kelloggii*, **CA**, Yolo Co., near Yolo, Cache Cr., May 16, 1910, coll. EJB (King, 1913b:206; Essig, 1915:115, 1926:275, 276; Hartman, 1916:93; Compere, 1926:41; Hoy, 1963:141). *Q. lobata*, **CA** (Essig, 1915:115, 1926:275, 276). *Quercus* sp., **CA**, Hollister, col. EOE (Compere, 1926:41); Yolo Co., Woolands, coll. EJB (Compere, 1926:41, 1928:215).

Remarks. Dr. R. G. Baer has examined first instars from the type lot of this species and can distinguish these from first instars of *Kermes rimarum* Ferris.

Etymology. Ehrhorn named this species in honor of T. D. A. Cockerell.

KERMES CONCINNULUS COCKERELL

Synonymy: *Kermes concinnulus* Cockerell, Bogue, 1898:172.
Coccus concinnulus (Cockerell), 1929:150.
Talla concinnula (Cockerell), Lindinger, 1933:143.

Post-reproductive female. Cockerell (Bogue, 1898) described the post-reproductive female as:

> . . . 4 mm. long, 4 1/2 broad, 3 1/2 high; very convex, rounded in front, more or less flattened behind; flattened beneath, except a median anterior keel-like prominence. Color lively ochreous. Surface shining, not speckled with black; segmentation very distinct, the sutures marked by bands and spots of dark brown and black, on the hind part by numerous pits. A median longitudinal groove, where the segmentation is obsolete, also partly marked out in black. Sutures not deep, nor are the segments strongly gibbous on each side of the median groove.

Type host and locality. *Quercus macrocarpa*, KS, Manhattan.

Questionable identifications in literature. *Quercus macrocarpa*, KS, Manhattan, coll. GAD (Dean, 1909:265).

Other literature citations. Balachowsky, 1950a:344; Cockerell, 1899b:393, 1900:44; Doane *et al.*, 1936:383; Fernald, 1903: 61; Ferris, 1955b:197; Hoy, 1963:142; Hunter, 1902:145; King, 1900b:80; Lawson, 1917:185; MacGillivray, 1921:198.

Remarks. Judging from the type host and the description of the post-reproductive female, one would suspect that this species is identical to *K. sylvestris* (Ckll. and King).

Etymology. Unknown.

KERMES MIRABILIS KING

Synonymy: *Kermes mirabilis* King, 1914c:133.
Kermes rattani, Ferris, 1920:28, 1955b:200; Hoy, 1963:157 (misidentification?)
Talla mirabilis (King), Lindinger, 1933:143.

Post-reproductive female. King (1914c) described the post-reproductive female as

> Subglobular, color gray, surface dull, not shiny. Diameter 7 mm. Markings consist of five transverse black bands, composed of quite large round dots and fine lines. Between the lines and dots the surface is pebbled and marbled with black dots and specks. There are also some very faint reddish brown patches.

Type host and locality. *Quercus* sp., CA, Mountain View.

Other literature citations. Balachowsky, 1950a:344; MacGillivray, 1921:196.

Remarks. Judging from the type locality, one would suspect that this species is identical to *Allokermes rattani* (Ehrhorn).

Etymology. The name "mirabilis" incorporates the Latin combining form "mirab-," meaning wonderful.

KERMES NIGROPUNCTATUS EHRHORN AND COCKERELL

Synonymy: *Kermes nigropunctatus* Ehrhorn and Cockerell, Ehrhorn, 1898: 186.
Talla nigripunctata (Ehrhorn and Cockerell), Lindinger, 1933: 143.

Post-reproductive female. Ehrhorn and Cockerell (Ehrhorn, 1898) described the post-reproductive female as

> . . .4.5 mm. long, 5.5 broad, nearly 4 high, not very pale ochreous, speckled all over with black, the specks so small as to be readily overlooked without the use of a lens; segmentation obscure, but discernible, the sutures slightly impressed and marked by more or less pallid transverse bands; an obscure median longitudinal depressed line. . . .

Type host and locality. *Quercus* sp., **CA**, Los Angeles.

Questionable identifications in literature. *Quercus agrifolia*, **CA**, Los Angeles Co., coll. LC (Essig, 1915:117, 1926:276; Hoy, 1963:151). **MEXICO**, Santa Cruz Peninsula (Ferris, 1920:26, 27; Essig, 1926:276). *Q. chrysolepis*, **MEXICO**, Chihuahua, Sierra Madre, mouth of San Diego Canon, May 22, 1899, coll. C.H.T. Townsend (Cockerell, 1899a:10, King, 1900b:80). *Q. kelloggii*, **CA**, **MEXICO** (Essig, 1926:276). *Q. wislizenii*, **CA** (Essig, 1926:276); **MEXICO**, Santa Cruz Peninsula (Ferris, 1920:26, 27; Essig, 1926:276); *Quercus* sp., **CA**, San Jacinto, Apr. 1899, coll. E. M. Ehrhorn (Cockerell, 1899a:10); southern portion, coll. E. R. Sasscer (Howard, 1919:257); Whittier, coll. E.W. Rust (Howard, 1919:257); (Hoy, 1963:151); **MEXICO** (Cockerell, 1900:45; Fernald, 1903:63).

Other literature citations. Balachowsky, 1950a:344; Carnes, 1906:17,18; Cockerell, 1899b:393; Doane *et al.*, 1936:383; Essig, 1915:115; Ferris, 1921:61, 1955b:200; Fulmek, 1943:38; Garcia Mercet, 1912:245; Howard, 1911:277; King, 1900b:82, 1914a: 48, 1914b: 100; Lindinger, 1943:148; MacGillivray, 1921:198; Peck, 1963:935; Ruhl, 1913:79.

Remarks. Judging from the species of oaks that this *Kermes* has been recorded from, one would suspect that it is identical to *Allokermes essigi* (King).

Etymology. Ehrhorn and Cockerell named this species for the black specks covering its yellow ochreous mid-dorsum.

KERMES OCCIDENTALIS KING

Synonymy: *Kermes occidentalis* King, 1913b:206, 207.
Talla occidentalis (King), Lindinger, 1933:143.
Kermes rattani, Ferris, 1955b:201 (misidentification?).

Post-reproductive female. King (1913b) described the post- reproductive female as

> Globular in outline; 5 mm. in diameter; of a dull gray color. Segmentation indicated by five transverse narrow blackish bands, which are broken at intervals by somewhat larger round black dots. Surface between the bands of a marbled light gray-brown. The entire surface is dull, not shiny, and is covered with very minute black specks seen only under a hand lens.

Type host and locality. *Quercus* sp., CA.

Other literature citations. Balachowsky, 1950a:344; Essig, 1915:117; King, 1914b:100; MacGillivray, 1921:197.

Etymology. King named this species for its occurrence in the western United States.

KERMES PERRYI KING

Synonymy: *Kermes perryi* King, 1900b:81,82.
Talla perryi (King), Lindinger, 1933:143.

Post-reproductive female. King (1900b) described the post- reproductive female as:

> . . .very globular, small, 3 mm. in diameter. Superficially [sic] examined, its color appears to be dark gray, dull, not shining, very near the color of the bark upon the twig. Viewed with a hand lens the segmentation is nearly obsolete and indicated by fine black lines, upon a dark yellowish brown surface. Parallel with the segments are several depressed dots, which are darker than the surface. The entire surface of the scale is covered more or less with a dirty white wax; under a low power of the microscope this appears to be small white granular crystals.

Type host and locality. *Quercus ilicifolia*, MA, Lawrence.

Questionable identifications in literature. *Quercus* sp., E coast (Doane *et al.*, 1936:382, 383).

Other literature citations. Balachowsky, 1950a:344; Britton, 1923:350, 351; Fernald, 1903:64; Ferris, 1955b:201; Hoy, 1963: 152; King, 1902a:60; MacGillivray, 1921:196.

Etymology. King named this species in honor of A. F. Perry.

KERMES PETTITI EHRHORN

Synonymy: *Kermes pettiti* Ehrhorn, 1899b:7.
Talla pettiti (Ehrhorn), Lindinger, 1933:143.

Post-reproductive female. Ehrhorn (1899b) described the post-reproductive female as:

> . . .about 4 mm. broad, 3 mm. long, and 3 mm. high, dark purplish-brown; some individuals of a lighter colour and marbled with brown. A distinct longitudinal groove on the meson indicated by a dark line. Surface without minute black specks. Segmentation not very distinct, indicated by rows of black spots plainly seen through a pocket lens. Ventral surface, where it touches the bark, flattened and more or less covered with a yellow secretion. Beak very prominent.

Type host and locality. *Quercus* sp., NY, Ithaca, 1893.

Questionable identifications in literature. *Quercus alba*, **IN**, (MacGillivray, 1921:198); **MA**, Lawrence, Sep., 1897, coll. GBK (King, 1900b:81; MacGillivray, 1921:198); **NY, OH** (MacGillivray, 1921:198); **CANADA**, Ontario, Toronto (Jarvis, 1908:50; MacGillivray, 1921:198). *Q. borealis*, **IN** (MacGillivray, 1921:198); Tippecanoe Co. (Amos, 1933: 206); **MA**, Lawrence, Sep., 1897, coll. GBK (King, 1900b: 81, 82; Cockerell, 1900:45; King, 1902a:59; Fernald, 1903:64; Merrill and Chaffin, 1923:284; MacGillivray, 1921:198); **NY, OH** (MacGillivray, 1921:198); United States of America (Hoy, 1963:152, 153); **CANADA**, Ontario, near Peterborough, Rice Lake, Jubilee Point, 1899, coll. JF (King, 1900b:81; Cockerell, 1900:45; King 1901:193, 1902a:59; Fernald, 1903:64; Jarvis, 1911:68; MacGillivray, 1921:198; Hoy, 1963:152, 153). *Q. imbricaria* **MD**, Gentry Co., near Albany, Apr. 26, 1917, coll. H. B. Parks (Hollinger and Parks, 1919:94); **OH**, Newark (Sanders, 1904: 36,37); **USA, CANADA** (Hoy, 1963:153). *Q. laurifolia*, **FL**, Ft. Pierce (Merrill and Chaffin, 1923:284). *Q. velutina*, **OH**, Columbus Co., Lisbon, coll. JGS (Sanders, 1904:36, 37); **PA**, (Trimble, 1928:43). *Quercus* sp., **IN** (Merrill and Chaffin, 1923:284; Dietz and Morrison, 1916: 236); **MO**, coll. AHH and H. B. Parks (Balduf, 1939:21); NY (King, 1903a: 22; Merrill and Chaffin, 1923:284); Middletown, coll. E. E. Bogue (Felt and Morrison, 1928:194); **OH** (Merrill and Chaffin, 1923:284); Sandusky (Sanders, 1904: 37); E coast (Doane *et al.*, 1936:382, 383); **eastern USA** (Baker, 1972:97); **USA** (Hoy, 1963:153); **CANADA**, Ontario, Guelph, Toronto, and Ottawa, coll. T. D. Jarvis (Jarvis, 1911:68; Britton, 1923:351; Merrill and Chaffin, 1923:284; Balachowsky, 1950a:344; Hoy, 1963:153).

Other literature citations. Balachowsky, 1950a:344; Britton, 1923:350; Cockerell, 1899b:393; Felt, 1901:356; Ferris, 1955b:201; Fulmek, 1943:38; King, 1900a:22; Smith, 1910:122.

Remarks. Judging from the northeastern type locality, and the species of oaks that this *Kermes* has been reported from, one would suspect that this species is a synonym of *Allokermes kingi* (Ckll.).

Etymology. Ehrhorn named this species after its first collector, R. H. Pettit.

KERMES SASSCERI KING

Synonymy: *Kermes sassceri* King, 1914a:48, 49.
Talla sassceri (King) Lindinger, 1933:143.

Post-reproductive female. King (1914a) described the post- reproductive female as:

> . . .turning nearly white when the hard shell is formed. After the scale has been collected and placed in a vial or box the color turns to a very light tint of lemon yellow. The form is not perfectly globular, but rather somewhat transverse and with a more or less pronounced and rather broad medio-dorsal depression which gives it a bilobed appearance. In many specimens this depression forms a rather broad, black or dark brown band following frequently its entire length and generally crossed by narrow blackish or brownish transverse lines of various lengths. Between these lines are several black specks as large as a pin head. The entire surface of the scale is covered with minute black specks.

Type host and locality. *Quercus "rubra,"*. MA, Lawrence.

Questionable identifications in literature. *Quercus borealis*,, **eastern USA** (Essig, 1915:118). *Quercus* sp., **CA** (Carnes, 1906:18; King, 1914a:49; Essig, 1915:118; Hoy, 1963:160); **CT**, Meriden, Aug. 27, 1913, coll. H. Johnson, New Haven, Jul. 26, 1906, coll. BHW, Oct. 12, 1908, coll. BHW, Nov. 11, 1913, coll. BHW, Putnam, Apr. 17, 1906, coll. BHW (King, 1914d:151; Britton, 1923:351); **CT**, New Haven, Aug. 26, 1913, coll. QSL (King, 1914d:151); Yalesville, Apr. 13, 1916, coll. BHW (Britton, 1916:143; Hollinger and Parks, 1919:92); (Britton, 1920:63); **MA**, **NY**, **PA**, **RI**, coll. Pergande (King, 1914a:49); eastern USA (Hoy, 1963:160);**CANADA**, Toronto, coll. Pergande (King, 1914a:49).

Other literature citations. Balachowsky, 1950a:344; Britton, 1923:350; Ferris, 1955b:204; MacGillivray, 1921:198; Ruhl, 1923:4.

Etymology. King named this species in honor of E. R. Sasscer.

KERMES TRINOTATUS BOGUE

Synonymy: *Kermes trinotatus* Bogue, 1900:205, 206.
Talla trinotata (Bogue), Lindinger, 1933:143.

Post-reproductive female. Bogue (1900) described the post- reproductive female as

> . . . variable in size, averaging about 5 1/2 mm. long, 6 mm. wide, and 4 1/2 mm. high; rounded above, somewhat flattened behind, convex beneath, front turned down into a more or less beak-like prominence; median groove obscure or broad and shallow; color varies from bright argillaceous to dull gray; surface uniform, more or less conspicuously speckled with black; segmentation obscure or plainly marked with dark spots. When the median groove is present it is crossed with more or less dark lines showing segmentation. There is a rounded dark spot on each side of the front, and an elongated dark blotch extending for a short distance above and below the anal opening: hence the specific appellation.

Type host and locality. *Quercus nigra,* **OK,** Stillwater.

Questionable identifications in literature. *Quercus alba,* **OH,** Franklin Co., Georgeville, coll. J. S. Hine (Webster and Burgess, 1902:110; Sanders, 1904:37, 38). *Q. aquatica,* **GA,** Atlanta, Aug. 21, 1899, Tifton (Scott, 1900:53; King 1903a:22); **NY,** Albany, **NJ,** New Brunswick (Felt, 1901:356; King, 1903a:22). *Q. nigra,* **GA,** (Fernald, 1903:65); **NY,** Albany (Fernald, 1903:65; Felt and Morrison, 1928:194); **NJ, OH,** (Fernald, 1903:65); E of Rocky Mts. (MacGillivray, 1921:198). *Quercus* sp., **NJ** (Smith, 1910:122); **OH** (Britton, 1923:351); E coast to MS valley states (Doane *et al.*, 1936:382, 383); eastern USA (Baker, 1972:97).

Other literature citations. Balachowsky, 1950a:344; Britton, 1923:350; Ferris, 1955b:204; Hoy, 1963:161.

Etymology. Bogue named this species for the three dark blotches on its dorsum: two on the front and one surrounding the anal ring.

OLLIFFIELLA SECUNDA FERRIS

Synonymy: *Olliffiella secunda* Ferris, 1955a:23, 27.

Post-reproductive female. Unknown.

Type host and locality. *Quercus* sp., **MEXICO,** Guerrero, La Providencia (ca. 30 mi. E of Acapulco).

Other literature citations. Sternlicht, 1974:195-197.

Remarks. This species has apparently been collected only once. It forms a leaf gall similar to the leaf gall formed by *Olliffiella cristicola* Cockerell. Ferris used for his original description third instar females, and assumed that these were adults. The second author attempted without success in 1978 to re-collect topotype material for the clarification of the taxonomic status of this species.

Etymology. Ferris named this species for its being the second in the genus.

PHYLOGENY OF THE STUDIED KERMESIDAE

The conclusions from this study and the following one (Baer and Kosztarab, 1985) have been combined and are found at the end of the latter article.

LITERATURE CITED

(See at end of second article).

A MORPHOLOGICAL AND SYSTEMATIC STUDY OF THE FIRST AND SECOND INSTARS OF THE FAMILY KERMESIDAE IN THE NEARCTIC REGION (HOMOPTERA:COCCOIDEA)*

by

Ronald G. Baer**
Graduate Research Assistant

and

Michael Kosztarab
Professor of Systematic Entomology

Department of Entomology
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

*This research was supported by the National Science Foundation (Grant DEB 76-09676, also BSR-8415644) and the Agricultural Experiment Station, Virginia Polytechnic Institute and State University (Project No. 3239131).

**Now Assistant Entomologist, Department of Entomology, Mississippi State University, Mississippi State, Mississippi 39762

CONTENTS

ABSTRACT

This is the first study to describe and illustrate the first and second instar nymphs of the Nearctic Kermesidae, and to prepare keys for their determination.

The study provides 30 morphological descriptions with measurements and full plate illustrations which include: first instars of 14 species, second instar males of 4 species, and second instar females of 9 species, belonging to 15 species in six genera. The keys should help to separate first and second instars and sexes of second instars. Techniques used for collecting, preserving, slide-mounting, measuring, and illustrating the studied specimens are given.

The first instars of Kermesidae have well-developed legs and 6-segmented antennae; claws with a denticle; 1 pair of simple eyes, large clypeolabral shield; a 3-segmented labium; 2 pairs of thoracic spiracles, each with 0-4 associated quinquelocular pores, or seldom with 7-locular pores; absent spiracular spines; anal ring with 6 setae; dorsum with simple pores in longitudinal rows, also with marginal and submedial longitudinal rows of setae; venter with from bilocular to 7-locular disc pores and a variety of setae, normally in longitudinal rows; each anal lobe with a long apical and several anal lobe setae. Legs and antennae are retained in the second instars and some tubular ducts are formed, but the type, arrangement, and quantity of the pores and setae differ from that of the first instars.

Based on Hennig's (1965) method, phylogenetic relationships between the first instars of the four Nearctic genera are proposed. It was concluded the Kermesidae must have evolved from eriococcid-like ancestors. References to original descriptions, as well as remarks on relationships between genera, are given.

ACKNOWLEDGMENTS

The authors are grateful to the following persons for providing specimens and assistance: J. W. Beardsley, University of Hawaii; G. Frankie, University of California at Berkeley (formerly with Texas A & M University); R. J. Gill, California Department of Agriculture; A. B. Hamon, Florida Department of Agriculture; L. R. Hanning, Missouri Department of Agriculture; W. A. Iselin, Agricultural Biologist for California; D. R. Miller, U. S. Department of Agriculture; R. L. Penrose, Oregon Department of Agriculture; and B. Zirilli, Extension Service, Fairfax Co., Virginia.

In addition, the authors extend their appreciation to the institutions and collectors given in the "**Abbreviations**" section (see first article) for providing specimens for this study. Additional material was sent by: Peter Ashlock, University of Kansas, Lawrence; Edward M. Barrows, Georgetown University, Washington, DC; Dr. Joan Chapin, Louisiana State University, Baton Rouge; G. W. Dekle, Florida Department of Agriculture; F. W. Howard, University of Florida, Fort Lauderdale; Virgil Knapp, Department of Natural Resources, Indiana; Ruth Morse, S. W. Research Station, Portal, Arizona; E. M. Tereznikova, Ukranian Institute of Zoology, Kiev, USSR.

Collecting permits and assistance were provided by Frank Deckert, Naturalist, Big Bend National Park, Texas; Ms. Becky Thompson of Radford, Virginia, and by the managements of the American Museum of Natural History Field Stations at Lake Placid, Florida, and Portal, Arizona; Mammoth Lakes State Park, Mono County, California; Arboretum of the University of California at Davis; Welder Wildlife Foundation Reserve near Sinton, Texas; Yosemite National Park, and many other institutions and individuals.

Dr. M. J. Ramsay, U.S. Department of Agriculture, Plant Protection and Quarantine, provided Kermesidae species records; Dr. B. A. Foote, Kent State University, Ohio, provided records on dipteran predators of *Olliffiella*; J. F. McAlpine, Biosystematics Research Institute, Ottawa, Canada, provided determinations of *Leucopis* predators of *Olliffiella*. Dr. John Tucker, University of California at Davis, determined many of the collected oak hosts and verified old identifications. Sincere thanks are extended to Ms. Mary Rhoades for her technical assistance in the preparation and mounting of specimens, and for her help with the editing of this manuscript, and to Mrs. M. P. Kosztarab for assistance with the literature search. The first draft of this manuscript was reviewed and improved by Drs. John L. Eaton, Joseph A. Fox, Herman J. Heikkenen, and William H Robinson, each at this university. The final manuscript was retyped by Ms. Catherine Habegger and edited by Ms. Mary C. Holliman. Financial assistance for this research was provided to the authors by the National Science Foundation (Grant DEB-7609676, also BSR-8415644) and the Virginia Agricultural Experiment Station (Project 2024390).

INTRODUCTION

The Coccoidea or scale insects are among the most important pests of silvicultural, ornamental, agricultural, and greenhouse plantings throughout the world. There are 21 families comprising 6,000 species. The scale insects cause direct injury to plants by the withdrawal of sap while feeding and by the production of galls. Some scale insects are host specific while others are polyphagous. They feed on many different parts of plants including the roots, trunk, stems, leaves, buds, and fruit.

The Kermesidae or gall-like scale insects are found throughout the northern hemisphere. There are eight genera in the family: *Allokermes* Bullington and Kosztarab (1985), *Fulbrightia* Ferris (1950), *Kermes* Boitard (1828), *Nanokermes* Bullington and Kosztarab (1985), *Nidularia* Targioni-Tozzetti (1869), *Olliffiella* Cockerell (1896c), *Physeriococcus* Borchsenius (1959) and *Reynvaania* Reyne (1954). Of the 69 described species of Kermesidae, 32 occur in the Nearctic Region. The genus *Olliffiella* consists of two species found in the southwestern United States and Mexico. The genera *Nidularia, Fulbrightia,* and *Physeriococcus* are monotypic, and the latter two are known from the Palearctic Region in the Hunan Province of China, while *Nidularia* is of circum-Mediterranean distribution. Only the monotypic genus *Reynvaania* is non-Holarctic, but known from the Oriental Region. Species belonging to all eight genera are feeding on hosts in the genera *Quercus* L. (oaks) and *Chrysolepis* Hjelmqvist (chinquapins).

Ferris (1955b) stated "The genus *Kermes* presents to the student an almost impossible situation." The difficulty alluded to by Ferris stems from the fact that the mature females are extremely sclerotized. Early descriptions were based only on the external appearance because it was impossible to prepare slide mounts suitable for microscopic examination from such specimens. Color, shape, and size of adult females are so variable that one may think that one has collected ten to fifteen different species on the same host and at the same locality.

The early original descriptions were based primarily on the adult female. If the description included the morphology for the first instars, it provided only general information. A typical such description is given as "elongate oval, more than twice as long as broad; yellow, brown or red in color; antenna small, 6-segmented; anal setae large; stout bristles along body margin; rostral loop extending half way between base of third pair of legs and the anal ring; legs large with claws curved and long." The above morphological characters overlap in the Kermesidae species; thus they are of no value for species identification. More detailed descriptions with complete illustrations and numerical data were needed on the morphological characters to assist species recognition. Only eight descriptions or redescriptions (Ferris 1919, 1920; McConnell and Davidson 1959; Sternlicht 1974; Hamon *et al.* 1976; Baer 1980; Baer and Kosztarab 1981) of first instars in the Nearctic Region provided adequate morphological characters for species recognition. The value of using first instars for Kermesidae classification has been shown in studies on species of the Palearctic Region (Kuwana 1931; Balachowsky 1950a).

There has been no comprehensive systematic study of the first and second instars of the species of Kermesidae found in the Nearctic Region. Our present study provides keys, descriptions, and illustrations of the known first and second instars based on their external morphology and should reduce the nomenclatural and systematic problems with this family.

MATERIALS AND METHODS

Plate 1

Materials. Dry, alcohol-preserved and slide-mounted specimens were borrowed from institutions and private collections. Under each species, the processed lots are listed alphabetically by host, locality (state, county, city, etc.), date of collection, and collector(s). The number of slides, number of specimens (in parentheses), and repository follow. A list of repositories and major collectors is given in the "Abbreviations" section.

Collecting and Preservation. Dry, preserved first instars were collected from the brood chamber inside old sclerotized adult females of *Kermes* spp. (See first instar Kermesidae habitats, Pl. 1, fig. a) and from under females inside leaf galls of *Olliffiella* spp. (fig. b). Dead dry and live first and second instars were also collected from under *Kermes* females (fig. c), from crevices in the bark of the trunk or branches (fig. d), and from bud regions (figs. e, f). To obtain live nymphs, twigs infested with egg-laying females were placed with their base in a water-filled flask and kept inside glass cylinders covered with

---

Plate 1. - First Instar Kermesidae Habitats

Figure a. Cut open, old sclerotized adult female of *Allokermes branigani*, exposing: 1) empty egg shells and 2) few dry nymphs (4.5 X).

Figure b. Cut open *Olliffiella cristicola* gall, exposing: 1) eggs and nymphs, 2) sclerotized female showing circular dorsum, and 3) the opening of the gall on upper surface of leaf (3.8 X).

Figure c. Settled *Allokermes galliformis* nymphs under old sclerotized adult female (31 X).

Figure d. Settled *Kermes rimarum* nymphs in bark crevices (67 X).

Figure e. Settled *Allokermes galliformis* nymphs at base of leaf petiole (86 X).

Figure f. Settled *Nanokermes pubescens* nymphs near bud region (79 X).

Photographs for figs. a and b were made with a Nikon F2 Photomic camera with a Micro-Nikkor 55/3.5 lens. Figures c through f were made with a Zeiss Photomicroscope I using reflected light. Kodak Panatomic X film was used, and the negatives were enlarged and printed on Kodak Kodabromide F3 paper.

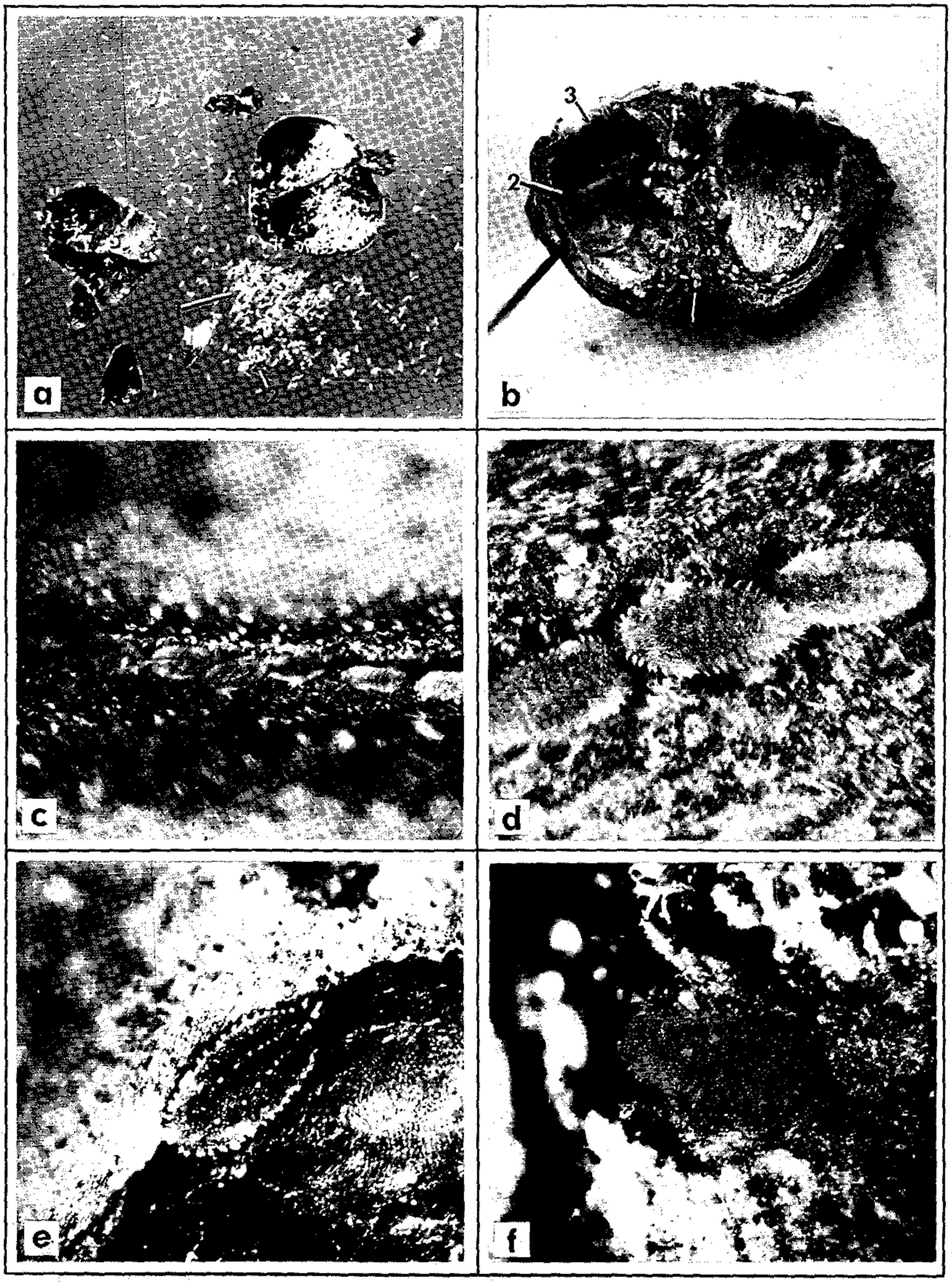


Plate I.- First instar Kermesidae habitats organdy cloth until the eggs hatched. Also, females on twigs were often placed in cellophane bags sealed with two paper clips. The emerging first instars were collected and preserved for study.

Most of the specimens obtained were preserved by air drying the infested plant material. Dry old females usually contain in their brood chambers first instars that can be mounted on slides. Some nymphs that had been entrapped for 98 years inside females were mounted for this study and provided excellent specimens. Such dry material can be stored in cellophane bags sealed with paper clips or in "pill" boxes. Live specimens were removed from the habitats mentioned in the "**Collecting and Preserving**" section and were placed in warm 70 % ethyl alcohol.

Clearing, Staining and Slide Mounting. The specimens were:

1. transferred into 10% KOH at room temperature for 24-48 hours;
2. pressed with a microspatula to remove body contents;
3. transferred to 70% EtOH for 15 minutes;
4. pressed again with the microspatula if some body contents still remained;
5. transferred to Essig's Aphid Fluid, containing three drops of Wilkey's modified double stain (see formulas in Wilkey 1962) for 24-48 hours;
6. dehydrated and fixed in ethyl alcohols (70, 95, 100%) and clove oil, in each for 15 minutes;
7. mounted in Canada Balsam on microscrope slides using 12 mm circular coverslips and marked with a diamond-tipped pencil;
8. placed in a drying oven at 40° C for two weeks and labelled.

Poorly stained or cleared specimens already on slides were soaked in xylene for 3-5 days or until the coverslip could be removed. These specimens were passed through a series of decreasing ethyl alcohol concentrations (100, 95, 70, 50%) and rinsed in distilled water for 15 minutes each. The procedure from this point on has been given above, starting with step 1.

Measurements and Illustrations. Measurements are rounded to the nearest micron unless otherwise stated. They were made with an ocular micrometer fitted to a Zeiss RA phase contrast microscope. In each description, measurements include the average followed by the range in parentheses. New species or species previously described on first instar have the morphology holotype measurement first, followed by (in parentheses) the average and range of the other material. Length and width measurements were made at the longest and widest points of each morphological structure. In each description, the measurements when possible were the average from 10 specimens.

Figures were outlined using a Leitz Prado 500 microslide projector. The details and enlargements were illustrated using a Zeiss RA phase contrast microscope. 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 surface. Setae located on the legs and antennae are solid if on the ventral surface and dashed if on the dorsal surface. Quantitative values of structures are for the entire dorsum or venter unless otherwise stated. Enlargements are not in proportion to each other within each plate. When questions of size arise, the reader must consult the measurements given in the descriptions.

Keys. The keys are designed to separate slide-mounted first and second instars of Kermesidae and to facilitate their identification based on their external morphology.

The keys to first instars separate the North American genera and then separate the species included in each genus. In cases where the genera are monotypic or only one species was available for study, the species is included in the generic key.

Because there were relatively few male and female second instars in each of the genera, species of different genera were included in each key to second instars. Couplets in these keys separate species included in each genus by group or generic characteristics first, and then by species.

Twelve species in four genera were included in the study of the first instars from North America: *Allokermes branigani, A. galliformis, A. gillettei, A. kosztarabi, Kermes cockerelli, K. concinnulus, K. prinus, K. rimarum, K. shastensis, Nanokermes iselini, N. pubescens*, and *Olliffiella cristicola*. First instars of *Olliffiella secunda, Nidularia pulvinata* and *Reynvaania gallicola* were not available for study. The Palearctic species, *Fulbrightia gallicola* and *Physeriococcus cellulosus* were also studied. Sexual dimorphism was not apparent among the first instars.

The study of the second instars included only species represented in the four genera in North America. Specimens representing the following species were studied: second instar males of *Allokermes galliformis, Kermes cockerelli, K. concinnulus, K. rimarum*; second instar females of *Allokermes branigani, A. galliformis, A. gillettei, Kermes cockerelli, K. concinnulus, K. rimarum, Nanokermes iselini, N. pubescens*, and "*Olliffiella secunda*". Second instars of *Olliffiella cristicola, Fulbrightia gallicola, Nidularia pulvinata, Physeriococcus cellulosus* and *Reynvaania gallicola* were not available for study.

Descriptions. The general descriptions of Kermesidae contain morphological characters for species in the genera *Allokermes, Kermes*, and *Nanokermes* of the nearctic Region. The general morphological characters for the genus *Olliffiella* are combined with the specific descriptions because relatively few specimens and developmental stages were available. The reference for the original description of each species is provided at the beginning of each description. Additional references on the species along with a synonym list, proposed common names, and etymology are given in the first article of this bulletin (Bullington and Kosztarab, 1985).

The morphological structures are given for both dorsal and ventral surfaces along with their measurements. The descriptions were based on the original "**type**" or topotype material. Under "**additional material studied**" we listed in alphabetical order, by host and locality (states and/or countries), all the specimens that were available for our study. The number of slides and specimens from each source are given in parentheses. For names of collectors and collections, see "**List of Abbreviations**" in the first article of this bulletin. Notes on relationships, distribution, and host preferences are included in the "**Remarks**" section of each species description.

Some of the species studied are distinguishable at present only through their immature stages, while others may be distinguished only through their pre-reproductive adult females. Additional studies on adult males, and on immature stages of species that were not available for our two studies, will assist with the clarification of some of the poorly understood species.

GENERAL MORPHOLOGICAL DESCRIPTIONS

Genera Morphology of Kermesidae First Instar

Plate 2

Description. Body (fig. a) oblong, widest at mesothorax, tapering posteriorly. Antennae, legs, anal lobes, and apical setae well developed.

Dorsum

Marginal setae (fig. b_{1-5}). Variable in size, shape, and number. Long, conical setae (fig. b_1, *Nanokermes iselini*); short, conical setae (fig. b_2, *N. pubescens*); short, thickened setae (fig. b_3, *Allokermes kosztarabi*); parallel-sided setae (fig. b_4, *Kermes shastensis*); setaceous setae (fig. b_5, *Allokermes galliformis* and *K. rimarum*). Each abdominal segment with 1 pair of dorsal marginal setae (*A. galliformis*) or each abdominal segment with 2 pairs of dorsal marginal setae (*N. pubescens*).

Marginal setae on anal lobe (fig. c_{1-4}). Variable, but longer and thicker than other marginal setae.

Submedial setae on head and thorax (fig. d_{1-6}). Variable in size and shape. Long, conical setae (fig. d_1, *N. iselini*); short, conical setae (fig. d_2, *N. pubescens*); parallel-sided setae (fig. d_3, *K. shastensis*); thick setaceous setae (fig. d_4, *K. cockerelli*); fusiform setae (fig. d_5, *A. kosztarabi*); slender, setaceous setae (fig. d_6, *K. concinnulus*).

Submedial setae on abdomen (fig. e_{1-2}). Short, conical setae (fig. e_1, *N. pubescens*); slender, setaceous setae (fig. e_2, *A. galliformis*); or thick setaceous setae (*K. prinus*).

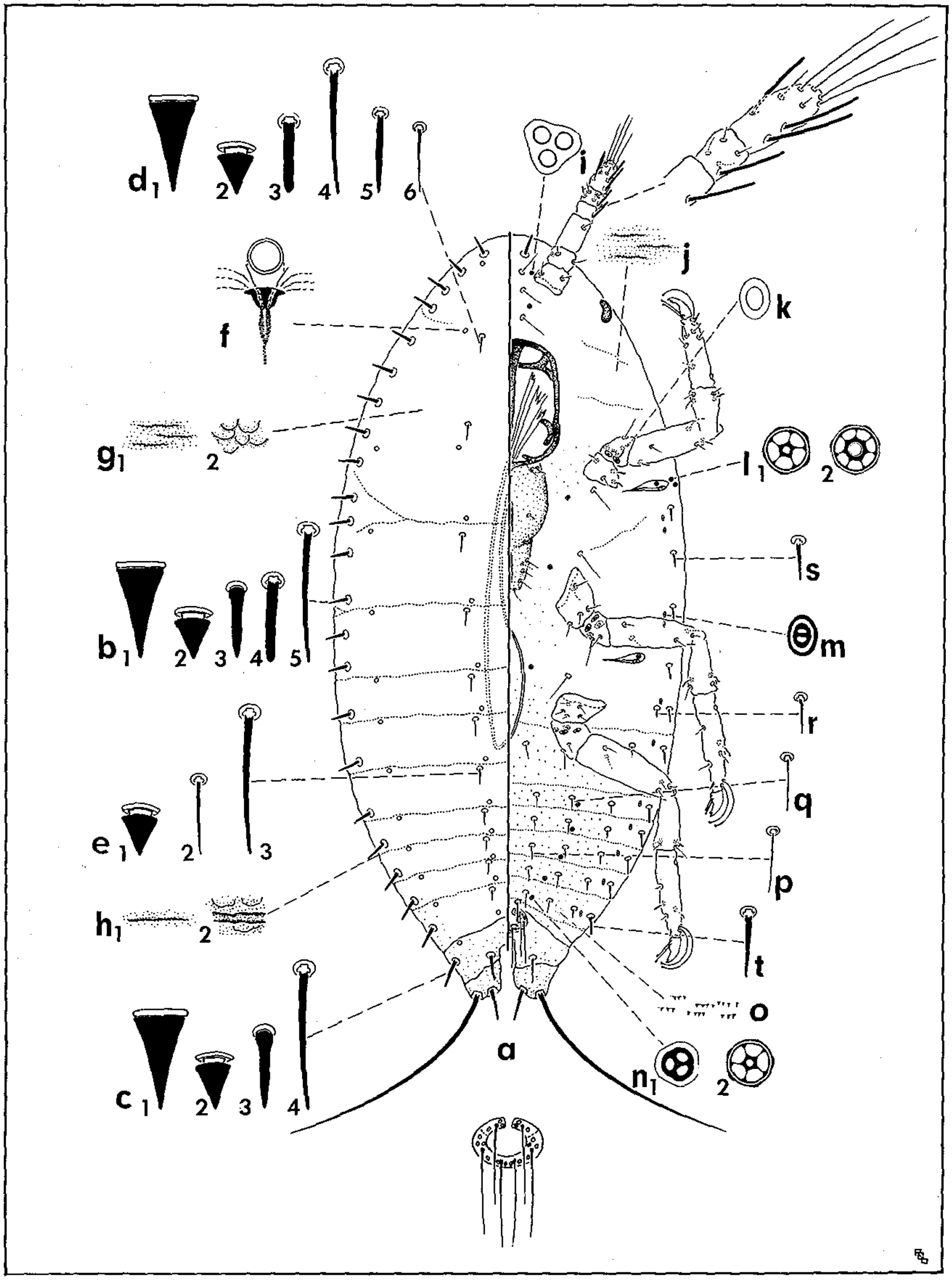


Plate 2.- General morphology of Kermesidae, first instar

Simple pores (fig. f). Composed of a sclerotized ring, with a membranous duct. Arranged in longitudinal rows on body, dia. ca. 2.

Derm (fig. g_{1-2}). Membranous. Simple (fig. g_1, *A. galliformis*); composed of overlapping plate-like areas (fig. g_2, *N. pubescens*).

Intersegmental membrane (fig. h_{1-2}). Apparent (fig. h_1, *A. galliformis*); pronounced (fig. h_2, *N. pubescens*).

Anal lobes (fig. a). Partially or fully sclerotized, with numerous setae.

Venter

Antennae. Six-segmented. Segment I with 2 slender setae, II with 2 slender setae and 1 sensory pore, III with 1 slender seta, IV with 1 fleshy seta, V with 3 or 4 slender setae and 1 fleshy seta, VI with 4-6 slender setae and 3 fleshy setae. See enlargement. One trilocular pore near antennal base (fig. i).

Clypeolabral shield. Sclerotized, tentorium-like structure containing the pharyngeal pump and the bases of stylets which are looped and extend to the second or third abdominal segments, enclosed in a crumena.

Labium. Sclerotized, elongate, triangular shaped, composed of 3 distinct segments. The basal segment collarlike, with 1 or 2 pairs of setae, the median segment with 1 pair of setae and the conical apical segment with 4 or 5 pairs of setae. Labial setae 14 (5-23) long. The stylets usually are freed from the labium in the slide-mounted specimens, thus the reason for illustrating these that way.

Derm (fig. j). Simple, membranous.

Legs. Sclerotized. Numerous, slender setaceous setae on each segment. Sensory pore (fig. k) on proximal lateral margin of each tarsus. Four sensory pores on each trochanter. Tarsal and claw digitules extending beyond apex of claw. Claws with a denticle.

Pores associated with spiracle (fig. l_{1-2}). Varying in numbers of pairs and locules. Quinquelocular pore (fig. l_1, *A. galliformis*), 7-locular pore (fig. l_2, *K. shastensis*); 1 pair (*K. shastensis*), 2 pairs (*A. branigani*), 3 pairs (*A. kosztarabi*), 4 pairs (*A. gillettei*), dia. ca. 5. Anterior spiracle 19 (12-22) long, 5 (5-9) wide, atrium ca. 2 wide. Posterior spiracle 18 (15-23) long, 6 (5-8) wide, atrium ca. 2 wide.

Bilocular pores (fig. m). Located near bases of submarginal or marginal setae. Two to 11 along each margin, dia. ca. 2.

Submedial pores on derm (fig. n_{1-2}). Varying in numbers of pairs and locules on head, thoracic, and abdominal regions. Either triloculars (fig. n_1, *A. galliformis*), dia. ca. 4 or quinqueloculars (fig. n_2, *K. cockerelli*), dia. ca. 5.

Microspines on derm (fig. o). Small spinelike projections of derm, varying in size and number. Found on abdominal segments and between the coxae.

Body setae (figs. p-t). In 6-8 longitudinal rows on abdomen and partly on thorax: medial row with 6 pairs (fig. p); submedial row with 5 pairs (fig. q); submarginal row with 7 pairs (fig. r); marginal row, if present, with 11 pairs (fig. s). Usually posteriormost seta in marginal row thicker than rest in row (fig. t). Other longer setaceous setae near coxae and antennal scape bases. One pair of setae similar to dorsal marginal setae near scape base.

Anal lobes and anal ring (fig. a). Partial or fully sclerotized. Anal ring with 18-23 translucent cells and 6 anal ring setae. See enlargement of anal ring.

Remarks. The Nearctic species in the genera *Allokermes, Kermes,* and *Nanokermes* have 11 pairs of dorsal submedial setae.

General Morphology of Kermesidae Second Instar Male

Plate 3

Description. Body (fig. a) oblong to elliptical, derm membranous, tubular ducts present on both dorsum and venter. Antennae, legs, and anal lobes well developed; latter with long apical setae.

Dorsum

Marginal setae (fig. b_{1-3}). Variable in size, shape, and number of pairs. Long, thin, setaceous (fig. b_1, *Kermes concinnulus* and fig. b_2, *K. cockerelli*) or stout, spinelike setaceous (fig. b_3, *Allokermes galliformis*).

Submedial setae (fig. c_{1-2}). Variable in size and number of pairs. Long, setaeceous (fig. c_1, *K. rimarum*) or short, setaceous (fig. c_2, *A. galliformis*).

Quinquelocular pores (fig. d_{1-2}). Absent, or if present, variable morphologically.

Simple pores (fig. e). Absent, or if present, composed of a sclerotized ring with a membranous duct, scattered over derm, dia. ca. 2.

Tubular ducts (fig. f). Numerous, distributed throughout derm. Cylindrical membranous portion with deep invaginated cup and filament; each 19 (18-23) long, 3 (2-4) wide. (Note: Length measurements include filament.)

Anal lobes (fig. a). Sclerotized. With numerous setae.

Venter

Antennae (fig. g). Seven-segmented. Segment I with 2 or 3 slender setae, II with 2 slender setae and 1 sensory pore, III longest, without setae, IV with 1 slender seta, V with 1 slender and 1 fleshy seta, VI with 1-3 slender setae and 1 fleshy seta, VII with three fleshy and 4 or 5 slender setae.

Clypeolabral shield. A tentorium-like structure containing the pharyngeal pump and the bases of stylets which are looped and extend to the second or third abdominal segments, enclosed in a crumena.

Labium. Triangular shaped, composed of three segments. The basal part with 2 pairs of setae, the middle part with 1 pair of setae, and the apical part with 5 pairs of setae. Labial setae 25 (21-30) long. In mounted specimens the labium opens and the stylets are freed.

Legs. With numerous slender setae on each segment. Sensory pore on proximal lateral margin of tarsus. Four sensory pores on each trochanter (fig. h). Tarsal and claw digitules extending beyond apex of claw. Claws with a denticle.

Pores associated with spiracle (fig. i_{1-2}). Variable morphologically but always quinquelocular (fig. i_1, *K. cockerelli* and fig. i_2, *K. rimarum*); from 2-7 in each anterior spiracular furrow and 1-7 in each posterior spiracular furrow. Anterior spiracle 34 (28-48) long, 12 (11-16) wide, atrium ca. 6 wide. Posterior spiracle 32 (30-38) long, 14 (12-19) wide, atrium ca. 6 wide.

Quinquelocular pores on derm (fig. j_{1-3}). Variable morphologically but always quinquelocular. Sometimes scattered over entire venter (fig. j_1, *K. concinnulus* and fig. j_2, *K. rimarum*) or restricted to body margins (fig. j_3, *A. galliformis*), (represented by solid circles), dia. ca. 5.

Tubular ducts (fig. k). Less numerous but similar morphologically to those on dorsum. Each 19 (20-23) long, 3 (2-4) wide. (Length measurement includes filament.)

Bilocular pores (fig. 1). Located near the bases of the sub- and marginal setae, dia. ca. 2.

Microspines on derm (fig. m). Small spinelike projections of the derm, varying in size and number; found on the abdominal segments and between the coxae.

Body setae (figs. n, o_{1-2}). In 8 longitudinal rows on abdomen and partly on head and thorax: medial row with 5 or 6 pairs (fig. n); submedial row with 5 pairs (fig. n); submarginal row with 6 or 7 pairs (fig. n); marginal row with 13-19 pairs, similar morphologically to the dorsal marginal setae (fig. o_1, *K. concinnulus* and fig. o_2, *A. galliformis*).

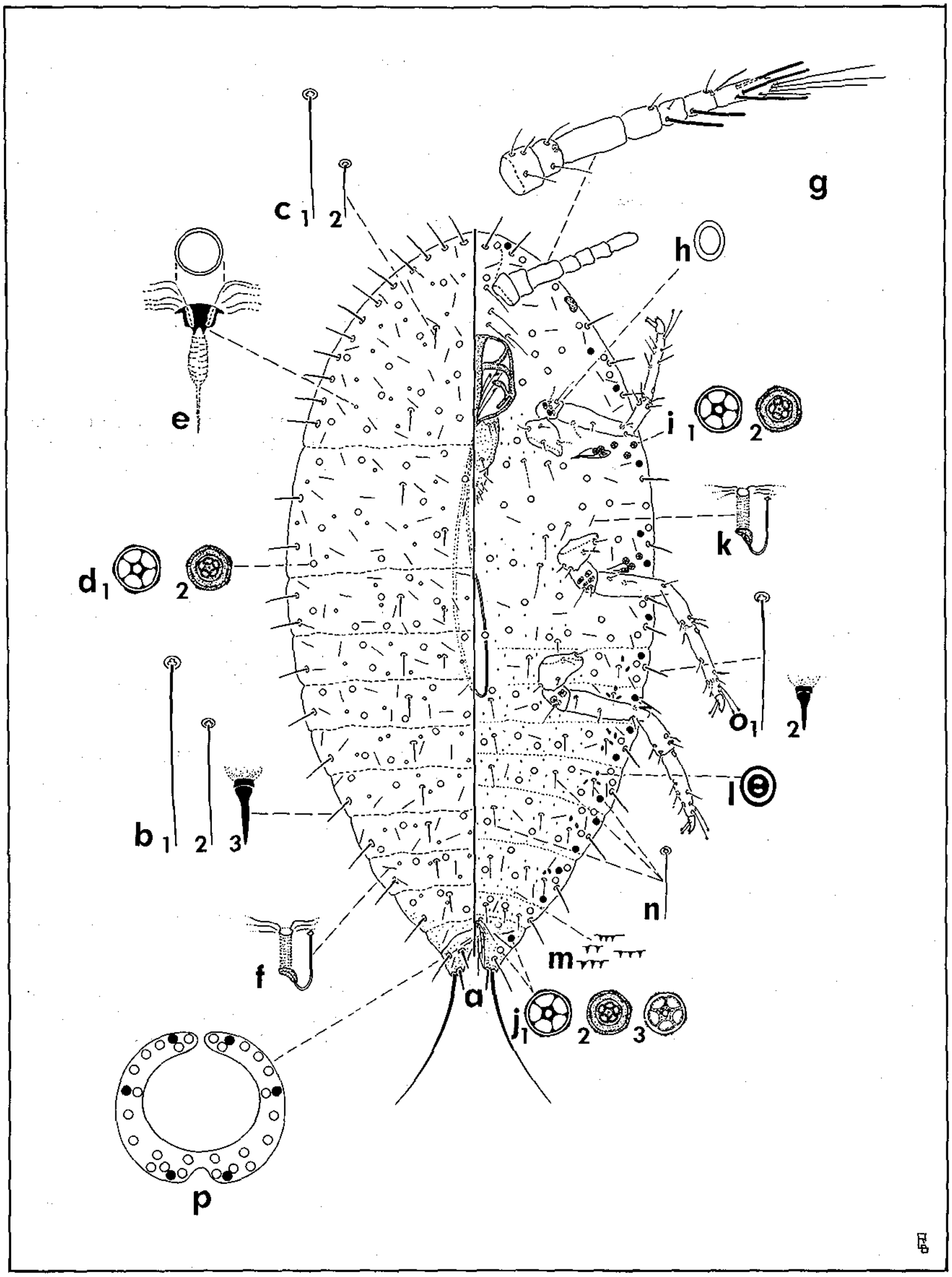


Plate 3. - General morphology of Kermesidae, second instar male

Anal lobes and ring (figs. a, p). Partially or fully sclerotized. Anal ring with 24-28 transparent cells (represented by empty circles) and 6 anal ring setae (setal bases represented by solid circles).

Remarks. The presence of a 7-segmented antenna and tubular ducts on the dorsum which are similar morphologically to those on the venter distinguishes the second instar males from females of the genera *Allokermes*, *Kermes*, and *Nanokermes*. No males of the genera *Olliffiella*, *Fulbrightia*, or *Physeriococcus* were available for this study.

General Morphology of Kermesidae Second Instar Female

Plate 4

Description. Body (fig. a) oblong to oval depending on time of collection, derm membranous. If tubular ducts present on dorsum, these larger than those on venter. Antennae, legs, and anal lobes well developed; latter with long apical setae.

Dorsum

Marginal setae (fig. b_{1-5}). Variable in size, shape, and number of pairs. Some species have 1 pair on each abdominal segment (*Allokermes gillettei*), but most have 2 pairs (*Kermes cockerelli*). Long, thick setaceous (fig. b_1, *K. rimarum* and fig. b_2, *A. galliformis*), thick setaceous (fig. b_3, *K. concinnulus*), thin, curved setaceous (fig. b_4, *Nanokermes pubescens*), and spinelike (fig. b_5, *A. branigani*).

Submedial setae (fig. c_{1-4}, d_{1-2}). Variable in size and shape. Head and thorax with thick, long setaceous (fig. c_1, *K. cockerelli*), thick, short setaceous (fig. c_2, *N. pubescens*), short setaceous (fig. c_3, *K. rimarum*), or short, rounded setae (fig. c_4, *A. branigani*). Setae on abdomen either short setaceous (fig. d_1, *A. gillettei*) or short rounded (fig. d_2, *K. concinnulus*).

Simple pores (fig. e_{1-2}). If present, composed of a sclerotized ring either being unilocular (fig. e_1, *K. concinnulus*) or bilocular (fig. e_2, *N. pubescens*), with a membranous duct, dia. ca. 2.

Tubular ducts (fig. f). If present, distributed throughout derm, larger than those on venter, cylindrical membranous portion with shallow invaginated cup and filament. (Length measurements in descriptions include filament.)

Anal lobes (fig. a). Sclerotized. With numerous setae.

Venter

Antennae (fig. g). Six-segmented. Segment I with 2 or 3 slender setae, II with 1 or 2 slender setae and 1 sensory pore, III longest with 1 slender seta,

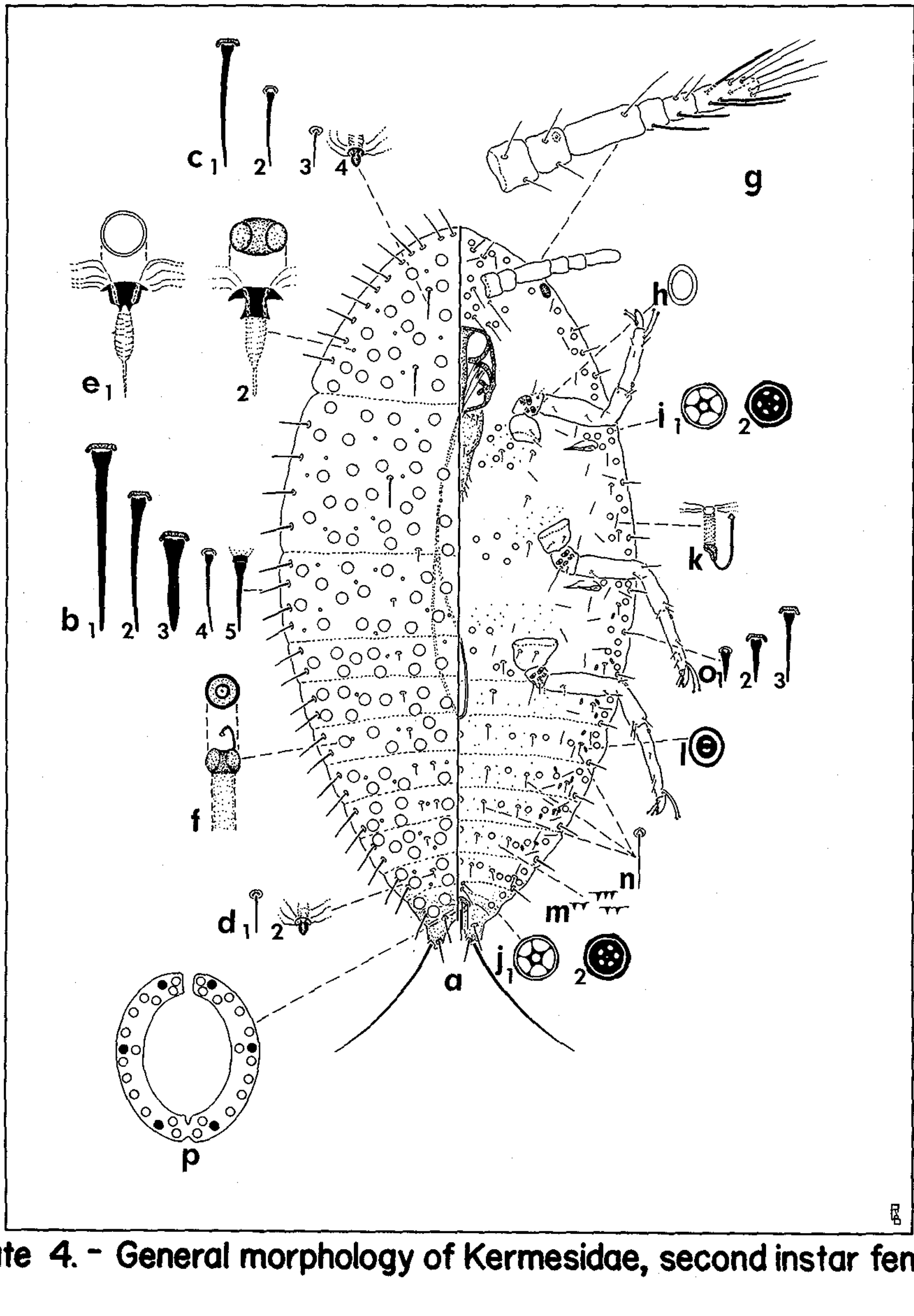


Plate 4. - General morphology of Kermesidae, second instar female

IV with 1 fleshy seta, V with 2 to 4 slender setae and 1 fleshy seta, VI with 3 to 6 slender setae and 3 fleshy setae.

Clypeolabral shield. A tentorium-like structure containing the pharyngeal pump and the bases of stylets which are looped and extend to the second or third abdominal segments, enclosed in a crumena.

Labium. Triangular shaped, composed of 3 distinct parts. The basal part with 2 pairs of setae, the middle part with 1 pair of setae, and the apical part with 5 pairs of setae. Labial setae 23 (11-41) long. In slide-mounted specimens the labium is usually compressed, thus freeing the stylets.

Legs. Numerous slender setae on each segment. Sensory pore on proximal lateral margin of tarsus. Four sensory pores on each trochanter (fig. h). Tarsal and claw digitules extending beyond apex of claw. Claws with a denticle.

Pores associated with spiracle (fig. i_{1-2}). Variable morphologically and always quinquelocular (fig. i_1, *A. gillettei*; fig. i_2, *K. rimarum*) from 1-13 in each anterior spiracular furrow and with 1-3 in each posterior spiracular furrow. Anterior spiracle 30 (27-41) long, 11 (9-14) wide, atrium ca. 6 wide. Posterior spiracle 29 (26-39) long, 10 (9-15) wide, atrium ca. 6 wide.

Quinquelocular pores on derm (fig. j_{1-2}). Absent or if present, variable morphologically, sometimes scattered over entire venter (fig. j_1, *K. concinnulus*), or in definite rows on abdomen and near coxal and antennal bases (fig. j_2, *K. rimarum*), dia. ca. 5.

Tubular ducts (fig. k). Always present, smaller than those on dorsum, cylindrical membranous portion with deep invaginated cup and filament. Each 19 (20-23) long, 3 (2-4) wide. (Note: length measurement includes filament.)

Bilocular pores (fig. l). Absent or if present located near the bases of the sub- and marginal setae, dia. ca. 2.

Microspines on derm (fig. m). Small, spinelike projections of the derm, varying in size and number; found on the abdominal segments and between the coxae.

Body setae (figs. n, o_{1-3}). In 8 longitudinal rows on abdomen and partly on thorax and head: medial row with 6 pairs (fig. n); submedial row with 5 pairs (fig. n); submarginal row with 7-11 pairs (fig. n); marginal row with 8-29 pairs (fig. o), variable morphologically. Several setae near coxae and antennal scape bases.

Anal lobes and ring (figs. a, p). Sclerotized. Anal ring with 24-28 transparent cells (represented by empty circles) and 6 anal ring setae (setal bases represented by solid circles).

Remarks. Second instar females of the genera *Allokermes, Kermes,* and *Nanokermes* distinguished from the second instar males by the presence of a

6-segmented antenna instead of 7-segmented in males. Also, if tubular ducts are present on the dorsum, they are larger and more numerous than those on the venter. *Olliffiella* second instar females are separated by the presence of 12 pairs of dorsal submedial setae and the presence of a dorsal submarginal row of quinquelocular pores. No second instar females of the genera *Fulbrightia* and *Physeriococcus* were available for study.

KEYS TO INSTARS OF KERMESIDAE

Key to First and Second Instars of Kermesidae[1]

1. Tubular ducts always absent on both dorsal and ventral derm (no sexual differences in this stage) . . . . first instar

   Tubular ducts always present on ventral derm, may or may not be present on dorsal derm 2

2. Antennae 6-segmented; dorsal tubular ducts usually absent, but if present (only in *Nanokermes iselini* and *N. pubescens*) ca 9µ wide and 19-33µ long . . second instar female

   Antennae 7-segmented; dorsal tubular ducts always present, 2-4µ wide and 18-23µ long . . . . second instar male

Key to First Instars of Genera and Some Species of Holarctic Kermesidae

1. Three pairs of acorn-shaped setae along the dorsal margin of each abdominal segment; ventral submedial seta on each anal lobe ca. 2/3 the length of apical seta; venter without longitudinal rows of submedial disc pores . . . . *Fulbrightia gallicola* Ferris, p. 227

   One or 2 pairs of conical or setaceous setae along the dorsal margin of each abdominal segment; ventral submedial seta on each anal lobe 1/4 or less the length of apical seta; venter with longitudinal rows of submedial disc pores 2

2. Dorsal submedial setae lacking on abdominal segments; 2 trilocular pores present anterior to each anterior spiracle . . . . *Physeriococcus cellulosus* Borchsenius, p. 230

---

[1] Due to lack of material and adequate descriptions, the genera *Nidularia* and *Reynvaania* are not included in these keys and descriptions.

Dorsal submedial setae present on abdominal segments; trilocular pores anterior to each anterior spiracle absent 3

3. Twelve pairs of dorsal submedial setae; these parallel-sided on abdomen; dorsal marginal setae anterior to the anterior spiracles thinner than those posterior to it . . . . *Olliffiella cristicola* Cockerell, p. 221

   Eleven pairs of dorsal submedial setae; if these parallel-sided, then lacking on abdomen; dorsal marginal setae similar on entire body margin 4

4. Two pairs of dorsal marginal setae on each abdominal segment; dorsal marginal setae conical . . . . *Nanokermes* Bullington and Kosztarab, p. 142

   One pair of dorsal marginal setae on each abdominal segment; dorsal marginal setae not conical 5

5. Pores in submedial longitudinal rows on venter trilocular; dorsal marginal setae short, 8-22μ long . . . . *Allokermes* Bullington and Kosztarab, p. 140

   Pores in submedial longitudinal rows on venter quinquelocular; dorsal marginal setae 19-48μ long, (except *Kermes shastensis*, 14-24μ, but its setae parallel-sided and blunt) . . . . *Kermes* Boitard, p. 141

Key to First Instars of Nearctic Allokermes

1. Three quinquelocular pores laterad of each anterior spiracle; 2 or 3 ventral bilocular pores along each body margin 2

   Two or 4 quinquelocular pores laterad of each anterior spiracle; 4-11 ventral bilocular pores along each body margin 3

2. Dorsal marginal setae 8-14μ long; dorsal submedial setae on head, thorax, and first abdominal segment thicker than those on abdomen . . . . *kosztarabi* (Baer), p. 170

   Dorsal marginal setae 16-21μ long; dorsal submedial setae on head, thorax and first abdominal segment similar to those on rest of abdomen . . . . *galliformis* (Riley), species complex, p. 150

3. Two quinquelocular pores laterad of each anterior spiracle; 3 or 4 pairs of submedial trilocular pores on abdominal venter; dorsal derm with plate-like areas . . . . *branigani* (King), p. 144

Usually 4 quinquelocular pores laterad of each anterior spiracle; usually 5 pairs of submedial trilocular pores on abdominal venter; dorsal derm simple, membranous . . . . *gillettei* (Cockerell), p. 164

Key to First Instars of Nearctic Kermes

1. All or some dorsal submedial setae on head, pro- and mesothorax thickened and similar to dorsal marginal setae 2

Dorsal submedial setae on head, pro- and mesothorax slender, small, and different from dorsal marginal setae 4

2. Dorsal marginal setae parallel-sided and blunt; one 7-locular pore laterad of each anterior spiracle . . . . *shastensis* Ehrhorn, p. 204

Dorsal marginal setae elongate and pointed; 1-3 quinquelocular pores laterad of each anterior spiracle 3

3. Dorsal submedial setae only on head, pro- and mesothorax similar to dorsal marginal setae; 1 quinquelocular pore laterad of each anterior spiracle . . . .*cockerelli* Ehrhorn, p. 173

Dorsal submedial setae along entire body similar to dorsal marginal setae; 3 quinquelocular pores laterad of each anterior spiracle . . . . *prinus* Baer and Kosztarab, p. 192

4. Four to 7 bilocular pores along each ventral body margin; terminal antennal segment 21-25µ long . . . .*concinnulus* Cockerell, p. 183

Eight to 10 bilocular pores along each ventral body margin; terminal antennal segment 26-30µ long . . . .*rimarum* Ferris, p. 195

Key to First Instars of Nearctic Nanokermes

1. Entire row of dorsal submedial setae similar to dorsal marginal setae; 2 or 3 quinquelocular pores laterad of each anterior spiracle; dorsal marginal setae less than $1\frac{1}{2}$ times longer than wide at base . . . . *pubescens* Bogue, p. 213

   Only the first 4 pairs of dorsal submedial setae similar to dorsal marginal setae; 1 quinquelocular pore laterad of each anterior spiracle; dorsal marginal setae about twice as long as wide at base . . . . *iselini* Baer and Kosztarab, p. 207

Key to Second Instar Males of Nearctic Allokermes and Kermes

1. Quinquelocular pores scattered over entire dorsal and ventral derm; dorsal and ventral marginal setae thin, setaceous; no simple pores on dorsum 2

   Quinquelocular pores absent from dorsal derm; dorsal and ventral marginal setae stout, spinelike; simple pores scattered on dorsum . . . . *Allokermes galliformis* (Riley), species complex, p. 158

2. Dorsal marginal setae 63-100μ long 3

   Dorsal marginal setae 50-59μ long . *Kermes cockerelli* Ehrhorn, p. 177

3. Antennae ca. 135μ long; anal ring setae ca. 30μ long . . . . *Kermes concinnulus* Cockerell, p. 186

   Antennae 179-202μ long; anal ring setae 38-47μ long . . . . *Kermes rimarum* Ferris, p. 198

Key to Second Instar Females of Nearctic Kermesidae

1. With 12 pairs of dorsal submedial setae; dorsal submarginal row of quinquelocular pores present . . . . *Olliffiella "secunda"* Ferris, p. 224

   With 11 pairs of dorsal submedial setae; dorsal submarginal row of quinquelocular pores absent 2

2. Large tubular ducts present on dorsum; abdominal venter without quinquelocular pores (*Nanokermes*) 3

Large tubular ducts absent from dorsum; abdominal venter with quinquelocular pores (*Allokermes* and *Kermes*) 4

3. With 120-150 tubular ducts on dorsum; 3 or 4 quinquelocular pores associated with each anterior spiracle . . . . *Nanokermes iselini* (Baer and Kosztarab), p. 210

With 70-100 tubular ducts on dorsum; 4-7 quinquelocular pores associated with each anterior spiracle . . . . *Nanokermes pubescens* (Bogue), p. 218

4(2) One pair of dorsal marginal setae on each abdominal segment (*Allokermes* spp.) 5

Two pairs of dorsal marginal setae on abdominal segments, except on 2 terminal segments (*Kermes*) spp. 7

5. Two to 10 simple pores on dorsal derm; ventral quinquelocular pores on abdomen scattered, not arranged in definite rows . . . *Allokermes gillettei* (Cockerell), p. 168

More than 10 simple pores on dorsal derm; ventral quinquelocular pores on abdomen arranged in definite rows 6

6. Each anterior spiracle with 1 quinquelocular pore; all dorsal submedial setae reduced to small rounded setae; 1 medial row of ventral quinquelocular pores on abdomen . . . . . *Allokermes branigani* (King), p. 147

Each anterior spiracle with 5-13 quinquelocular pores; only last pair of dorsal submedial setae reduced to small rounded setae; 3 rows of ventral quinquelocular pores on abdomen . . . . *Allokermes galliformis* (Riley), species complex, p. 161

7(4) With 0-5 simple pores on dorsal derm; quinquelocular pores absent along ventral body margin 8

With 100-150 simple pores on dorsal derm; quinquelocular pores present along ventral body margin . . . . *Kermes concinnulus* Cockerell, p. 189

8. Dorsal submedial setae on head, pro- and mesothorax thickened and similar to dorsal marginal setae; apical setae 151-181µ long; dorsal marginal setae ca 4µ wide at base; seta on inner margin of anal lobe venter 49-50µ long . . . . *Kermes cockerelli* Ehrhorn, p. 180

Dorsal submedial setae on head, pro- and mesothorax reduced to small slender setae and these not similar to dorsal marginal setae; apical setae 181-226µ long; dorsal marginal setae 7-9µ wide at base; seta on inner margin of anal lobe venter 30-33µ long . *Kermes rimarum* Ferris, p. 201

DESCRIPTIONS OF FIRST AND SECOND INSTARS BY SPECIES

ALLOKERMES BRANIGANI (KING), FIRST INSTAR

Plate 5

Kermes branigani King, 1914b:100.

Type material studied. Topotypes from *Quercus chrysolepis*, **CA**, Placer Co., Foresthill, Paragon, Bath mine, Jul. 11, 1975, coll. RJG, 5(30) CDA; 3(17), VPI; 2(10) USNM; 1(4) UCD.

Description. Body (fig. a) length 519 (483-574), width 257 (242-287).

Dorsum

Marginal setae (fig. b). Thick, setaceous, ca. 44-50, these 12 (9-16) long, 2 (2-3) wide.

Marginal setae on anal lobe (fig. c). Thicker than other marginal setae, 15 (9-19) long.

Submedial setae on head and thorax (fig. d). Thin, setaceous, similar to abdominal submedial setae but longer, 4 pairs, 12 (9-14) long, 2 (1-3) wide.

Submedial setae on abdomen (fig. e). Thin, setaceous, 7 pairs, 7 (5-9) long, 2 (1-3) wide.

Simple pores (fig. f). In 4 longitudinal rows (2 submarginal, 2 submedial), ca. 40-48 pores; a few pores sometimes missing in each row.

Derm (fig. g). Composed of overlapping platelike areas.

Intersegmental membrane (fig h). Pronounced due to type of derm.

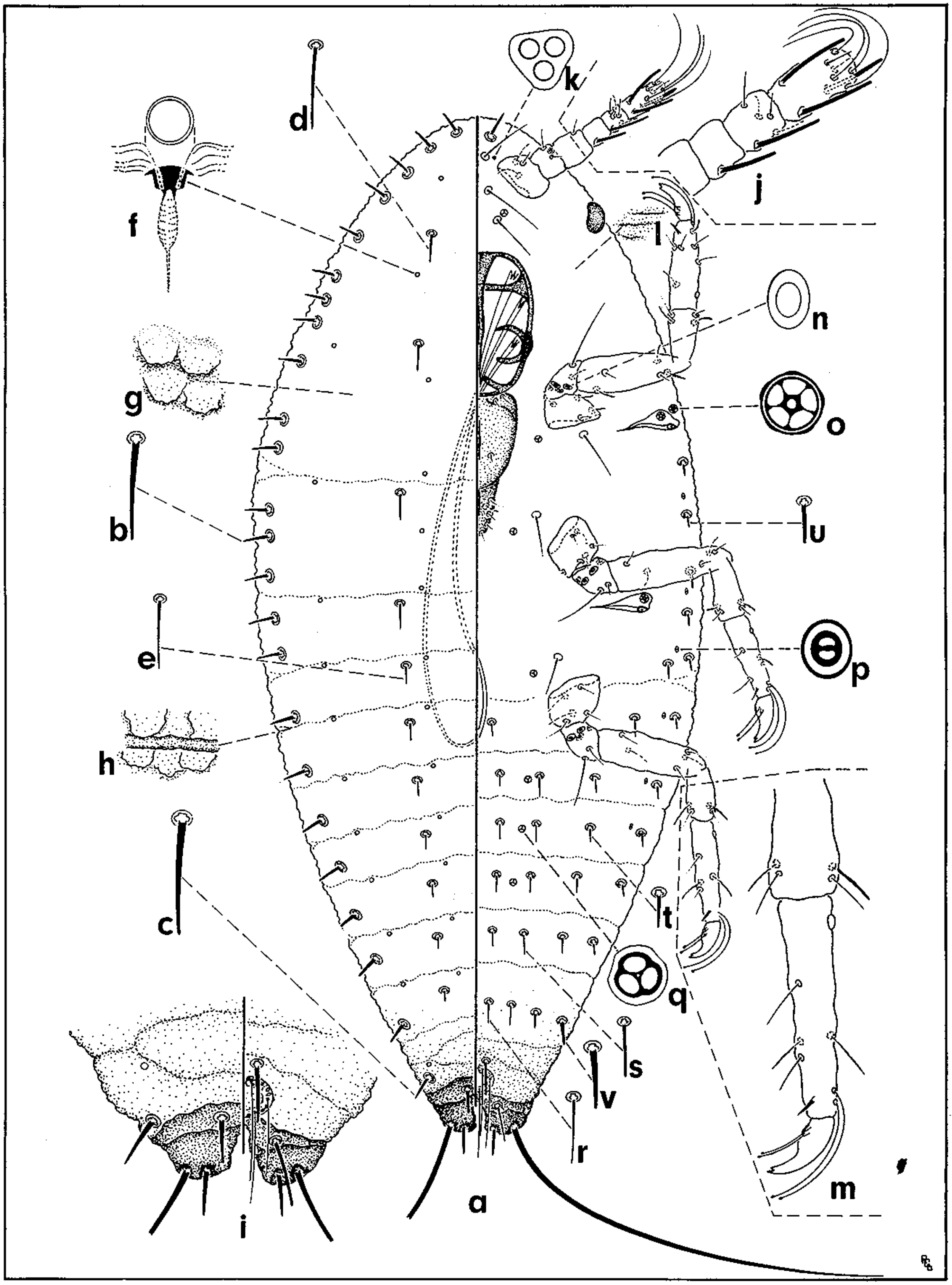


Plate 5. - *Allokermes branigani* (King), first instar

Anal lobes (figs. a,i). Sclerotized. One thick seta on inner margin of each lobe, 12 (10-16) long, another at posterior end, 14 (10-19) long; apical seta 168 (136-196) long.

Venter

Antennae (fig. j). Total length 97 (88-104). Scape 14 (12-16) long, and 29 (23-35) wide. Segments II to VI: 14 (12-16), 21 (19-23), 12 (11-13), 12 (12-15), 23 (21-26) long, respectively. One trilocular pore at scape base (fig. k).

Clypeolabral shield. Length 83 (79-91), width 64 (60-70).

Labium. Length 81 (72-91), width 47 (42-53).

Derm (fig.l). Membranous.

Legs. See chart below and enlargement of tibia, tarsus and claw of metathoracic leg (fig. m). Four sensory pores on each trochanter (fig. n).

Leg Segments and Claw	Lengths Prothoracic	Lengths Mesothoracic	Lengths Metathoracic
Coxa	25 (20-30)	25 (23-28)	23 (19-23)
Trocanter	28 (26-30)	26 (23-30)	27 (23-30)
Femur	57 (53-60)	57 (51-63)	57 (53-63)
Tibia	32 (28-35)	34 (30-39)	35 (32-39)
Tarsus	51 (49-56)	56 (53-60)	59 (58-60)
Claw	19 (16-21)	20 (19-22)	21 (16-23)
Entire leg	212 (195-232)	218 (202-234)	222 (209-234)

Pores associated with spiracle (fig. o). Anterior spiracle usually with quinquelocular pores, occasionally with a 3-, 4-, or 7-locular pore, usually 2, rarely 3 associated with each spiracle. Each posterior spiracle with 1 quinquelocular pore.

Bilocular pores (fig. p). Located near bases of marginal setae, usually associated with 9 anteriormost setae. Usually 4-7 pores along each margin.

Submedial pores on derm (fig. q). In 2 submedial longitudinal rows. Four pairs on head and thorax; mostly 3 pairs, sometimes 4 pairs, and rarely 5 pairs on abdomen; usually triloculars, but occasionally some quinquelocular.

Body setae (figs. r-v). In 8 longitudinal rows on abdomen and partly on thorax: medial 10 (7-12) long, ca. 1 wide (fig. r); submedial 8 (5-12) long, ca. 1 wide (fig. s); submarginal 5 (4-9) long, ca. 1 wide (fig. t); marginal 6 (5-7) long, ca. 2 wide (fig. u). Posteriormost seta in marginal row thicker than rest in the row 9 (7-10) long (fig. v).

Anal lobes and ring (figs. a,i). Sclerotized. With a submedial seta on each lobe, 20 (16-23) long. Ring oval, 18 (12-19) long, 26 (22-33) wide; anal ring setae 39 (37-44) long; 1 pair of thick setae at anterior margin of anal ring, each 16 (14-21) long.

Additional material studied. On *Quercus chrysolepis*, **CA**, Confidence, Jul. 31, 1919, coll. R. D. Hartman, 2(5) UCD, 1(3) VPI, 1(1) CDA; and May 1920, coll. H. E. Burke, 1(2) UCD; 1(2) VPI; 5 mi. east of Rancho Cordova, Mar. 7, 1979, coll. E. Paddock, 3(8) VPI; Forest Hills, Nov. 22, 1913, coll. EOE 2(7) CAS; Groveland, Jul. 1, 1976, colls. MMK, 2(5) VPI; 0.5 mi. before Groveland, Rt. 120, Jul. 1, 1976, colls. MMK, 4(9) VPI; Shasta Co., May 21, 1914, coll. L. Childs, 2(2) UCD; Shasta Springs, coll. EME, 1(2) UCD; near Shasta Springs, Dunsmuir City Pk., Jul. 7, 1976, colls. MMK, 2(5) VPI. On *Quercus* sp., **CA**, Sacramento Co., American River, Carmichael, Mar. 18, 1967, coll. RFW, 1(1) CDA; Tulare Co., Jul. 1976, coll. RJG, 5(27) CDA.

Remarks. King (1914b) placed *A. branigani* in close affinity with *A. galliformis* on the basis of the adult female. The original description contained no first instar information. It is believed *A. branigani* is closely allied with species in the *A. galliformis* group. This group of species has relatively short dorsal marginal setae and rows of trilocular pores in the venter. *Allokermes branigani* can be distinguished by the following morphological characters: 1) 1 pair of dorsal marginal setae on each abdominal segment; 2) dorsal derm composed of platelike areas; 3) setaceous dorsal marginal setae 9-16 long; 4) 2 quinquelocular pores associated with each anterior spiracle; and 5) 3 - 5 pairs of submedial trilocular pores on abdominal venter. This species was found only on *Quercus chrysolepis* in California.

ALLOKERMES BRANIGANI (KING), SECOND INSTAR FEMALE

Plate 6

Kermes branigani King, 1914b: 100.

Material studied. On *Quercus chrysolepis*, **CA**, Confidence, May 1920, coll. H. E. Burke, 1(1), UCD.

Description. Body (fig. a) length 780 (679-845), width 403 (287-468).

Dorsum

Marginal setae (fig. b). Short, spinelike, ca. 44, these 25 (18-35) long, 4 (3-5) wide.

Submedial setae (figs. c,d). In 2 submedial longitudinal rows, 11 pairs, all reduced to small rounded setae, ca. 2 wide.

Simple pores (fig. e). Randomly distributed on derm, ca. 65.

Tubular ducts. Absent.

Anal lobes. Sclerotized. One seta on inner margin of each lobe 16 (12-19) long, another at posterior end ca. 16 long; apical seta 97 (89-105) long.

Venter

Antennae. Total length 107 (104-109). Scape 12 (12-14) long, 25 (23-26) wide. Segments II to VI: 13 (12-14), 28 (26-30), 13 (12-14), 15 (13-16), 26 (24-30) long, respectively.

Clypeolabral shield. Length 110 (100-118), width ca. 83.

Labium. Length 85 (77-89), width ca. 59.

Legs. See chart below.

Leg Segments and Claw	Lengths Prothoracic	Lengths Mesothoracic	Lengths Metathoracic
Coxa	29 (28-30)	29 (28-30)	28 (28-30)
Trochanter	30 (30-33)	31 (30-33)	31 (30-33)
Femur	72 (70-74)	67 (65-70)	68 (65-71)
Tibia	38 (37-39)	44 (41-46)	39 (35-41)
Tarsus	68 (67-70)	69 (68-70)	74 (72-77)
Claw	ca.16	ca.16	ca. 16
Entire leg	ca.251	257 (255-259)	257 (250-264)

Pores associated with spiracle (fig. f). Each anterior and posterior spiracle with 1 quinquelocular pore.

Quinquelocular pores on derm (fig. g). About 5 in 1 medial longitudinal row on abdomen; also 1 or 2 pores usually associated with each coxal and antennal base.

Tubular ducts (fig. h). Distributed on derm mainly along submargin and in coxal areas, ca. 80.

Bilocular pores. Absent.

Body setae (figs. i,j). In 8 longitudinal rows on abdomen and partly on thorax and head: medial 15 (12-19) long, ca. 1 wide (fig. i); submedial 9 (7-12) long, ca. 1 wide (fig. i); submarginal 4 (4-5) long, ca. 1 wide (fig. i); marginal, similar morphologically to dorsal marginal setae 5 (5-7) long, 3 (2-4) wide (fig. j).

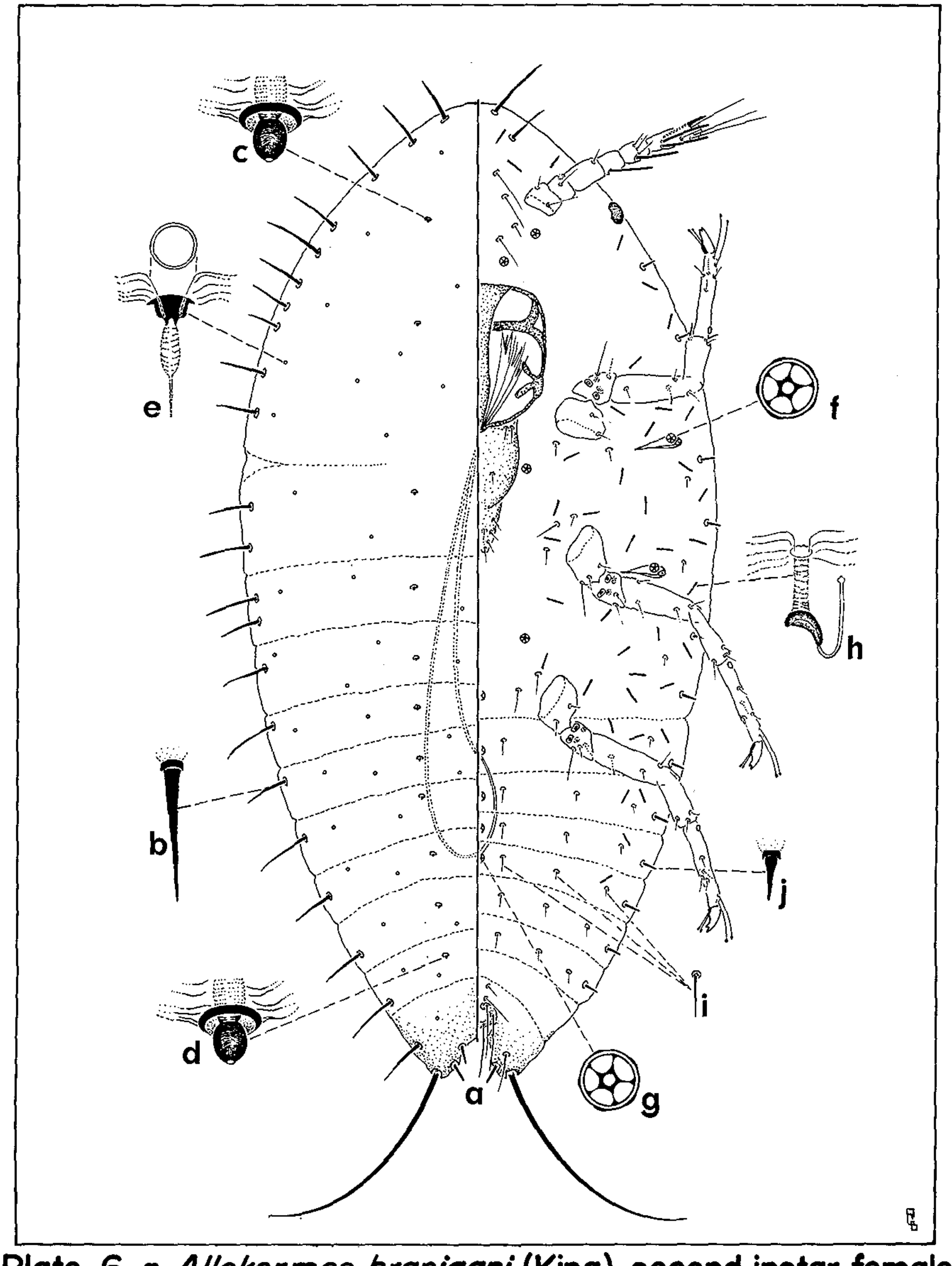


Plate 6. - *Allokermes branigani* (King), second instar female

Anal lobes and ring. Sclerotized. With 1 submedial seta on each lobe, 21 (19-23) long. Ring oval, ca. 21 long, 26 (21-28) wide; anal ring setae 48 (46-51) long.

Remarks. *Allokermes branigani* second instar females can be distinguished from other *Allokermes* spp. by the following morphological characters: 1) tubular ducts absent from dorsum; 2) abdominal venter with quinquelocular pores arranged in 1 row; 3) 1 pair of dorsal marginal setae on each abdominal segment; 4) ca. 65 simple pores on dorsal derm; and 5) each anterior spiracle with 1 quinquelocular pore; 6) all dorsal submedial setae reduced to small rounded setae.

ALLOKERMES GALLIFORMIS (RILEY), FIRST INSTAR

Plate 7

Kermes galliformis Riley, 1881: 482.

Type material studied. Paralectotypes from *Quercus palustris*, **MO**, Iron Mountain, (no date mentioned), coll. J. A. Warder, 2(20) USNM, 2(15) VPI, 1(11) UCD, 1(6) CDA.

Description. Body (fig. a) length 453 (408-498), width 223 (196-242).

Dorsum

Marginal setae (fig. b). Setaceous, ca. 44-46, these 18 (16-21) long, 3 (2-4) wide.

Marginal setae on anal lobe (fig. c). Longer and thicker than other marginal setae, 20 (19-21) long.

Submedial setae on head and thorax (fig. d). Slightly longer and thicker than abdominal submedial setae, 4 pairs, 11 (9-18) long, ca. 2 wide.

Submedial setae on abdomen (fig. e). Thin, setaceous, 7 pairs, 6 (2-8) long, ca. 1 wide.

Simple pores (fig. f). In 4 longitudinal rows, ca.40-46 pores.

Derm (fig. g). Simple, membranous.

Intersegmental membrane (fig. h). Apparent due to type of derm.

Anal lobes (figs. a, i). Sclerotized. One thick seta on inner margin of each lobe, 17 (14-19) long, another at posterior end, 21 (19-23) long; apical seta 118 (89-136) long.

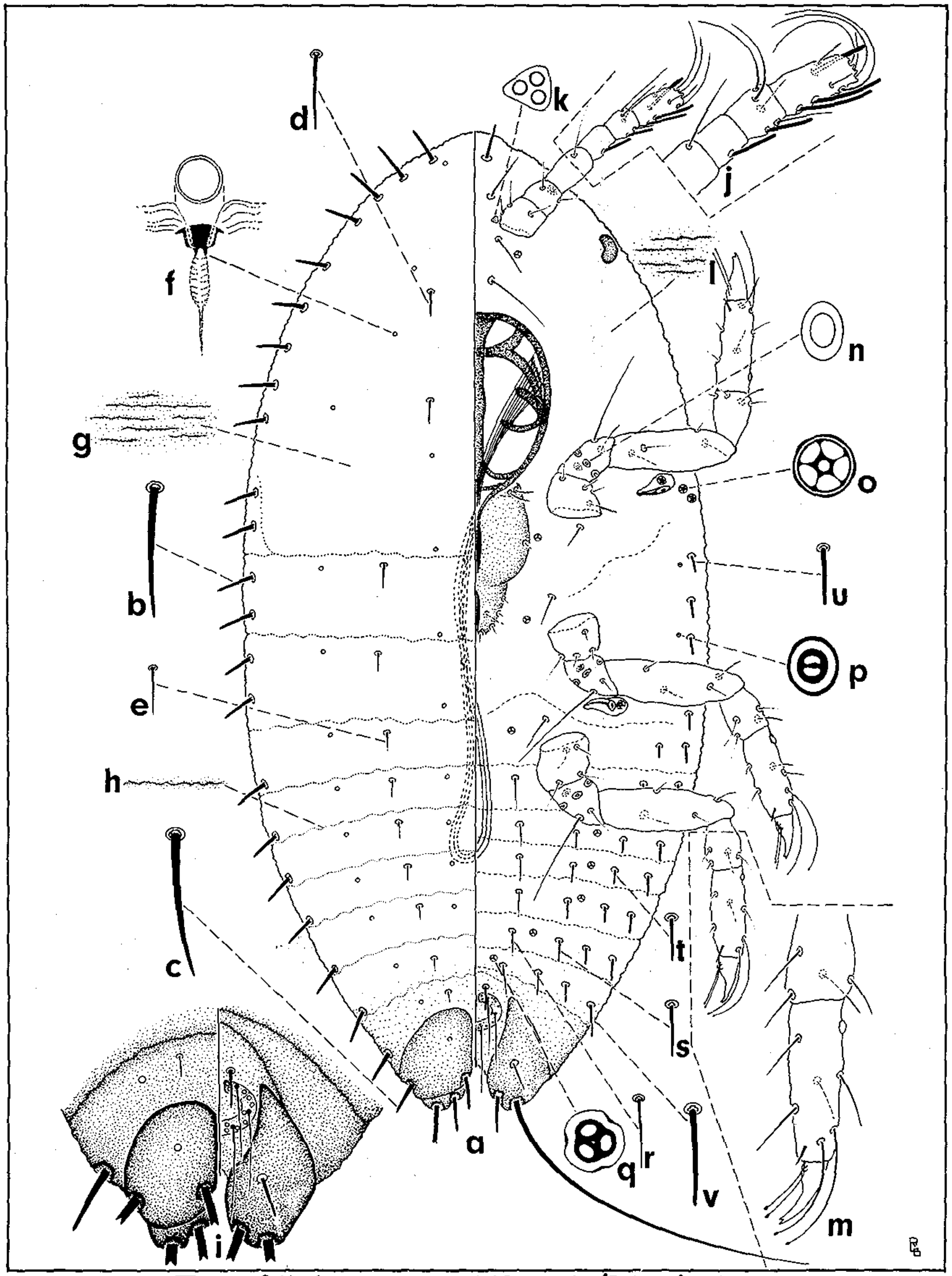


Plate 7. - *Allokermes galliformis* (Riley), first instar

Venter

Antennae (fig j). Total length 93 (84-99). Scape 14 (12-16) long, 24 (21-26) wide. Segments II to VI: 13 (12-14), 22 (21-23), 11 (9-12), 11 (9-14), 21 (19-25), long, respectively. Trilocular pore at scape base (fig. k).

Clypeolabral shield. Length 77 (72-81), width 57 (53-63).

Labium. Length 63 (60-65), width 45 (40-48).

Derm (fig. l). Membranous.

Legs (fig. m). See enlargement of tibia, tarsus and claw of metathoracic leg. Four sensory pores on each trochanter (fig. n).

Leg Segments and Claw	Lengths Prothoracic	Lengths Mesothoracic	Lengths Metathoracic
Coxa	23 (21-26)	22 (19-23)	22 (19-23)
Trochanter	28 (26-31)	26 (23-30)	26 (23-28)
Femur	61 (58-67)	57 (51-61)	61 (58-65)
Tibia	34 (30-37)	38 (37-39)	38 (35-39)
Tarsus	51 (49-52)	55 (53-58)	57 (51-65)
Claw	18 (16-19)	18 (17-19)	19 (18-21)
Entire leg	213 (209-220)	218 (214-227)	222 (206-234)

Pores associated with spiracle (fig. o). Each anterior spiracle usually with 3 quinquelocular pores, rarely with 4 pores. Each posterior spiracle with 1 quinquelocular pore.

Bilocular pores (fig. p). Located near the bases of the marginal setae. Usually associated with the anterior setae. Two or 3 along each margin.

Submedial pores on derm (fig. q). In 2 submedial longitudinal rows. Four pairs on head and thorax, 5 pairs on abdomen, mostly triloculars.

Body setae (figs. r-v). In 8 longitudinal rows on abdomen and partly on thorax: medial 7 (5-8) long, ca. 1 wide (fig. r); submedial 5 (4-7) long, ca. 1 wide (fig. s); submarginal 5 (3-6) long, ca. 1 wide (fig. t); marginal 7 (5-8) long, 1 (1-2) wide (fig. u). Posteriormost seta in marginal row thicker than rest in row 9 (7-12) long (fig. v).

Anal lobes and ring (figs. a, i). Sclerotized. With 1 submedial seta on each lobe, 12 (10-14) long. Ring oval, 13 (11-16) long, 21 (18-23) wide; anal ring setae 33 (28-35) long; 1 pair of thick setae at the anterior margin of anal ring, 12 (10-16) long.

Additional material studied. On *Chrysolepis* sp., **CA**, near San Jose, Loma Prieta Mt., Coll. GFF, 4(12) UCD. On *Quercus agrifolia*, **CA**, Los Angeles Co., 2(2) USNM; Los Gatos, coll. A. H. Herbert, 2(5) UCD; Ontario, Nov. 10, 1913, 3(6) CAS; Pasadena, Jul. 19, 1911, coll. Timberlake, 2(5) USNM; Santa Paula, Nov. 2, 1913, coll. EOE, 2(3) ORSU; Santa Rosa, Aug. 2 and Sep. 1905, coll. OEB, 2(6) and 4(15) UCD; Sonoma Co., Julupa Valley, Jul. 15, 1906, 1(3) USNM; Ventura Co., Santa Paula Canyon, Nov. 2, 1913, coll. EOE, 4(34) UCD and coll. RSG and R. F. Hobza, Aug. 14, 1975, 10(102) VPI. On *Q. alba*, **DC**, Aug. 15, 1916, coll. J. H. Payne, 2(8), USNM; **IN**, Indianapolis, Feb. 22, 1914, coll. HFD, 3(8) UCD and 1443 N Penn Str., June 17, 1921, coll. HFD, 2(7) USNM; **MA**, Lawrence, Sep. 9, 1899, 1(1) USNM, and 2(2) AMNH; Methuen, coll. GBK, 2(4) AMNH; Salem, coll. JGS, 2(4) AMNH; **OK**, Stillwater, Aug. 26, 1896, coll. EEB, 9(62) USNM; and Oct. 17, 1896, 4(14) USNM, 3(16) VPI. On *Q. borealis*, **AL**, Farmsdale, Sep. 2, 1918, coll. J. H. Comstock, 2(3) USNM; **DC**, near Washington Hilton, Aug. 20, 1976, coll. MK, 1(1) VPI; **DE**, Wilmington, May 21, 1920, coll. E. R. Mack, 2(6) USNM; **GA**, Cassville, Oct. 30, 1929, coll. L. H. Weld, 1(2) USNM. **IN**, Lafayette, Murdock Pk., Sep. 26, 1931, coll. JMA, 5(23) USNM; W. Lafayette, Oct. 21, 1931, coll. JMA, 2(4) USNM; Lafayette Country Club, Oct. 26, 1931, 1(1) VPI; Orange Co., Oct. 21, 1931, coll. JMA, 3(5) VPI; **KS**, Lawrence, Aug. 25, 1908, coll. GBK, 1(2) USNM; **MA**, Andover, coll. GBK, 4(28) AMNH; Lawrence, 1898, coll. GBK, 1(2) SEM; Sep. 9, 1899, 1(1) USNM; Nov. 1912, coll. GBK, 14(72) USNM; coll. GBK, 6(21) CAS; 10(39) AMNH; **MN**, Ramsey Co., coll. F. Pond, Oct. 17, 1922, coll. G. Hoke, 1(1) UMN; **NY**, Mt. Vernon, Nov. 1, 1918, coll. J. J. de Vyver, 4(16) CDA; Staten Island, coll. RWD, Sep. 4, 1917, 4(24) UCD; **OH**, Cincinnati, Oct. 5, 1916, coll. JSH, 2(6) OHSU; Cleveland, Mar. 6, 1912, coll. JSH, 1(1) OHSU; Columbus, Ohio State Univ. USNM; Across B + Z Bldg., Jul. 19, 1976, colls. MMK, 6(18) VPI; Maryville, Rt. 33, Rest area no. 63, Jul. 18, 1976, coll. MK, 2(5) VPI; Pomeroy, Aug. 28, 1903, coll. JGS, 2(3) USNM; Wooster, Sep. 8, 1912, coll. JSH, 2(5) OHSU;**PA**, Chestnut Hill, Jan. 28, 1918, coll. FMT, 4(8) USNM; Philadelphia, Mar. 6, 1915, coll. S. N. Baxter, 4(9) USNM; Rockville, 1922, coll. FMT, 2(5) USNM; **TN**, Memphis, Apr. 16, 1927, coll. E. F. Owens, 2(6) USNM; **VA**, Blacksburg, VPI&SU Campus, Jun. 9, 1965, coll. MK, 2(4) VPI; Blacksburg, VPI&SU, Price Hall parking lot, Nov. 4, 1974, coll. ABH, 2(4) VPI; Elliston, Yagle Nursery, Sep. 8, 1977, coll. S. Winfrey, 2(5) VPI. On *Q. chrysolepis*, **MEXICO**, Baja California, Sierra San Pedro, Arroyo Copal, Aug. 24, 1968, 2(7) VPI; **CA**, Mountain View, Aug. 1899, coll. EME, 5(6) USNM; San Jose, Loma Prieta Mt., coll. GFF, 4(22) UCD; Santa Clara Co., Stevens Creek, coll. GFF, 6(18) UCD; Shasta Springs, coll. EME, 1(3) IAE; Shasta Springs, Aug. 9, 1906, coll. EME, 4(21) USNM; Shasta Springs, Dunsmuir City Pk., Jul. 7 & Aug. 6, 1976, colls. MMK, 4(9) VPI; Twin Peaks, July 20, 1930, coll. NWC, 2(5) USNM; Yosemite Natl. Pk., Jul. 1, 1976, colls. MMK, 2(4) VPI. On *Q. coccinea*, **IN**, St. Joe Co., Nov. 18, 1976, coll. R. B. Cummins, 2(4) VPI; **MA**, Cape Cod, Sep. 15, 1977, coll. RGB and SWB, 2(4) VPI. On *Q. douglasii*, **CA**, Davis, Univ. of California, Jul. 5, 1976, colls. MMK, 2(4) VPI, Putah Creek, Monticello Dam, Dec. 6, 1967, coll. JWB, 3(7) JWB. On *Q. emoryi*, **AZ**, between Benson and Dragoon, Jun. 1918, coll. GFF, 2(8) UCD; S of Flagstaff, Rock Creek Canyon, 1940, coll. GFF, 1(1) UCD; Huachucha Mts., Miller Canyon, 1940, coll. GFF, 2(2) UCD; 3 mi. E of Oraoley, Jan. 7, 1940, coll. E. C. Marshall, 1(3) UCD; Portal, Jun. 22, 1976, coll. MK and I. Storks, 2(6) VPI; Prescott, Jul.

1921, coll. RWD, 4(31) UCD; Santa Cruz Co., Nogales, Aug. 28, 1975, coll. G. Ehni, 4(17) VPI; **NM**, Silver City, Dec. 17, 1880, coll. H. H. Rusby, 8(33) USNM. On *Q. falcata*, **AR**, Paragould, Paragould Country Club, North Hampton Co., Exmore, near Shuckinghouse Restaurant, Aug. 16, 1978, MMK, 2(6), VPI; Jul. 1, 1968, coll. MLW, 2(5) AU; **VA**, Occoneechee St. Pk., near Clarksville, Sep. 24, 1976, colls, MMK and M. Rhoades, 2(6) VPI. On *Q. gambelii*, **NM**, Otero Co., Jun. 11, 1976, coll. WAI, 1(2) VPI. On *Q. grisea* , **TX**, Big Bend Natl. Pk., 1 mi. N of Chisos Mt. Lodge, Jun. 15, 1976, colls. MMK, 2(6) VPI. On *Q. havardii*, **TX**, Comanche, Sep. 1, and 12, 1918, coll. Hollinger, 4(7) UCD; near Quitaque, escarpment of the Statseel Plains, 1921, coll. GFF, 2(4) UCD. On *Q. hypoleucoides*, **AZ**, Chiricahua Mts., Cave Creek, 1940, coll. GFF, 1(4) UCD; Cochise Co., Chiricahua Mts., Jun. 14, 1964, coll. MK, 2(6) SWRS; Madera Canyon, Jun. 25, 1976, coll. R. Lenczy and MK, 1(3) VPI; Santa Rita Mts., Jun. 24, 1943, coll. LPW, 2(6) UCD. On *Q. ilicifolia*, **MA**, Lawrence, 10(28) AMNH; **PA**, New Bloomfield, 1922, coll. T. L. Guyton, 2(6) USNM; **VA**, Blacksburg, VPI&SU Campus, Oct. 18, 1968, coll. MK, 3(11) VPI. On *Q. imbricaria*, **IN**, W Lafayette, Oct. 21, 1931, coll. JMA, 1(4) VPI; **MO**, Concordia, rest area on Rt. I-70, Jul. 15, 1976, colls, MMK, 2(8) VPI; **OH**, Ohio State Univ., May 5 and Jul. 16, 1960, coll. MK, 4(14) VPI. On *Q. incana*, **FL**, Sopchoppy, Nov. 4, 1929, coll. L. H. Weld, 1(3) USNM. On *Q. kelloggi*, **CA**, North Fork of Feather River, 1939, coll. GFF, 1(2) UCD; Santa Clara Co., Los Gatos, coll. GFF, 2(5) UCD; Shasta Springs, Dunsmuir City Pk., Jul. 7, 1976, colls. MMK, 2(4) VPI. On *Q. laurifolia*, **LA**, New Orleans, Jun. 10, 1905, coll. R. S. Cooks, 2(6) USNM; **SC**, Charleston, St. Phillip's Church, Cemetery Grounds, Jun. 16, 1971, coll. MK, 2(7) VPI. On *Q. lobata*, **IN**, Indianapolis, 4(8) UCD; **VA**, Blacksburg, VPI&SU Campus, Sep. 20, 1975, coll. RGB, 1(1) VPI. On *Q. macrocarpa*, **IA**, CPG, 7(19) USNM. On *Q. marilandica*, **TX**,Goliad, 1921, coll. GFF, 2(5) UCD; **VA**, Amelia Co., Aug. 14, 1963, coll. MK and D. Vest, 2(4) VPI. On *Q. neo-tharpii*, **TX**, 27 mi. S of Kingsville, Oct. 9, 1976, coll. GF, 2(6) VPI. On *Q. nigra*, **GA**, Atlanta, Dec. 30, 1913, coll. Cooley, 2(7) USNM; Henry Co., Jun. 8, 1976, coll, RB, 1(2) VPI; **LA**, New Orleans, Dec. 1, 1924, coll. N. D. Blut, 1(3) USNM; Roseland, Sep. 26, 1913, coll. E. S. Tucker, 2(7); **MS**, Orange Grove, Jun. 18, 1906, coll. L. Rapp, 2(5) USNM; **OK**, Stillwater, 12(74) USNM; Stillwater, Nov. 2, 1896, coll. EEB, 4(26) USNM; Stillwater, Oct. 1897, coll. S. E. Myers, 2(7) USNM; Stillwater, Dec. 27, 1898, coll. EEB, 4(22) USNM; **SC**, Charleston, Jul. 3, 1974, coll. D. Pollet, 4(13) VPI; **VA**, Virginia Beach, Seashore State Pk., Sep. 25, 1976, colls, RGB, SWB, and MMK, 6(15) VPI. On *Q. oblongifolia*, **AZ**, Superior, Craig Ranch, Apr. 16, 1928, coll. A. A. Nichols, 2(4) UCD; **CA**, San Diego Co., Escondido, coll. F. Austin, 7(15) USNM; 8 mi. E of Escondido, coll. F. Austin, 4(15) USNM. On *Q. palustris*, **IN**, Plymouth, Price Nursery, Sep. 16, 1977, coll. R. B. Cum, 2(4) VPI; **LA**, New Orleans, Jul. 8, 1921, coll. H. C. Land, 2(7) USNM; **MO**, Sikeston, Mar. 18 and Apr. 9, 1976, coll. LRH, 2(4) VPI; **NJ**, Newark, Feb. 14, 1925, coll. FMS, 4(23) USNM; **NY**, Manhattan, Feb. 17, 1932, coll. R. Sheehan, 4(14) USNM; **PA**, Chestnut Hill, Jun. 28, 1918, coll. FMT, 3(5) USNM; Philadelphia, Mar. 31, 1922, coll. A. J. Bonsall, 4(30) USNM; **VA**, Roundhill, Sep. 1, 1909, coll. JGS, 2(8) USNM. On *Q. phellos*, **VA**, Lynchburg, coll, D. Barnes, 1(2) VPI. On *Q. prinus*, **NJ**, Palisades, Dyckman Str. Ferry, May 30, 1930, coll. J. C. Bridwell, 2(6) USNM; **VA**, Apr. 22, 1880, coll. T. Pergande, 2(12) USNM. On *Q. pungens*, **AZ**, Camp Creek, Dec. 27, 1928, coll. NWC, 2(7)

USNM. On *Q. robur*, **CA**, Davis, Univ. of California, Jul. 5, 1976, colls. MMK, 1(2) VPI. On *Q. stellata*, **AL**, Auburn, Auburn Univ., Comer Hall area Jun. 8, 1976, colls. MLW and MK, 1(2) AU; **OH**, sand dunes near Columbia, Sep. 4, 1960, coll. MK, 2(4) VPI; TX, Bryan, Apr. 19, 1919, 2(5) UCD; Corsicaus, Apr. 11, 1918, 1(1) UCD; Dallas, May 18, 1882, 2(6) USNM. On *Q. undulata*, **AZ**, Camp Creek, Dec. 1928, coll. NWC, 2(6) USNM; **NM**, Guadalupe Mts., Jun. 15, 1976, coll. WAI, 2(7) VPI; Otero Co., 2 mi. N junction from Weed, Jun. 15, 1976, coll. WAI, 1(2) VPI. On *Q. velutina*, **DC**, near Washington Hilton, Aug. 27, 1976, colls. MK and SWB, 1(2) VPI; **NY**, Long Island, Melville, Jan. 3, 1926, colls. FMS, 1(2) USNM; **OH**, Sandusky, Cedar Point, Aug. 27, 1906, coll. JGS, 3(9) USNM; **PA**, Hershey, Hershey Hotel, Sep. 26, 1974, colls. RGB and ABH, 2(7) VPI; Shamokin, 1922, coll. FMT, 6(19) USNM; West Chester, Nov. 5, 1908, coll., F. Windle, 2(7) USNM; **VA**, Craig Co., Broad Run, Jul. 26, 1967, coll. MLW, 2(5) VPI; Montgomery Co., Blacksburg, VPI&SU Campus, Jan. 28, Apr. 22 and 29, 1975, coll. ABH, 4(60) VPI. On *Q. virginiana*, **AL**, Mobile, Aug. 11, 1918, coll. HM, 2(4), USNM; **CA**, San Mateo, 2(8) UCD; Santa Rosa, Oct. 3, 7, 1880, coll. Comstock, 4(10) USNM; **FL**, Cedar Key, Mar. 19, 1970, coll. MLW, 1(2) AU; Dade Co., Coral Gables, Jul. 1, 1976, coll. F. W. Howard, 1(4) VPI; Dixie Co., Aug. 4, 1977, colls. F. L. Carle and SWB, 5(15) VPI; Manatee Co., Ft. DeSoto Natl. Memorial, Jan. 10, 1977, coll. ABH, 2(4) VPI; Tampa, 5(28) USNM; **GA**, Clinch Co., Hwy. 117E, May 10, 1977, coll. RB, 1(2) VPI; Savannah, Aug. 18, 1900, coll. P. D. Daffin, 2(4) USNM; Savannah, Mar. 30, 1901, coll. W. F. Fiske, 2(5) DSIR; St. Marys, May 26, 1976, coll. RB, 1(1) VPI; **LA**, Baton Rouge, Aug. 26, 1976, coll. GF, 2(5) VPI; New Orleans, Jul. 13, 1911, coll. T. C. Barter, 1(8) USNM; New Orleans, Jan. 12, 1932, coll. H. L. Dozier, 1(1) USNM; New Orleans, Jul. 12, 1938, coll. H. A. Hetrick, 3(20) USNM; New Orleans, Audubon Pk., Dec. 28, 1908, coll. F. N. Meyer, 1(2) USNM; New Orleans, Audubon Pk., Dec. 2, 1975, coll. MK, 4(33) VPI; 43 mi. E of Slidell, Aug. 26, 1976, coll. Hammond, 4(8) VPI; **MS**, Long Beach, Gulf View Motel, Jun. 9, 1976, colls. MMK, 5(26), VPI; Meridian, 1922, 3(13) UCD; **SC**, Branfort, Jul. 6, 1896, 2(5) USNM; Charleston, Jul. 8, 1933, coll. P. U. Siggers, 4(44) USNM; Charleston, Hampton Pk., Jun. 26, 1936, coll. Holcombe, 2(9) USNM; Columbia, Aug. 24, 1976, coll. GF, 1(1) VPI; Fort Sumpter, Jul. 9, 1949, coll. J. H. Pruitt, 5(51) USNM; **TX**, Cuero, Jun. 12, 1976, coll. MK, 10(80) VPI; Cuero, Rt. 87, across from Cuero High School, Jun. 12, 1976, colls. MMK, 2(5) VPI; Dallas, Fair Grounds, Nov. 27, 1973, coll. MK, 1(3) VPI; La Grange, Haidusek Memorial Pk., Jun. 12, 1976, colls. MMK, 2(7) VPI; San Antonio, Nov. 27, 1895, 1(1) USNM; Sinton, Welder Wildlife Foundation Grounds, Aug. 6, 1976, coll. MK, 4(11) VPI; **VA**, Va. Beach, Seashore State Pk., Bay Zone, Mar. 20, 1969, colls. MLW and JOH, 2(6) VPI. On *Q. virginiana* var. *fusiformis*, **MEXICO**, Monterey, Oct. 11, 1976, coll. GF, 1(3) VPI; **TX**, Austin, 1975, coll. GF, 1(3) VPI; Austin, Natural Area, Sep. 3, 1976, coll. GF, 1(2) VPI; Austin- urban, Sep. 3, 1976, coll. GF, 2(6) VPI. On *Q. wislizenii*, **CA**, Big Oak Flat, along Rt. 120, Jul. 1, 1976, coll. MK, 2(4) VPI; Folsom, Jul. 13, 1885, coll. AK, 4(21) USNM; Kernville, Mar. 29, 1950, coll. GFF, 3(9) UCD; Santa Clara Co., Stevens Creek Canyon, Nov. 22, 1914, coll. A. F. Swain, 2(8) USNM; Solano Co., Jul. 5, 1976, colls. MMK and D. V. Beres, 4(9) VPI. On *Quercus* sp., **CANADA**, Toronto, Aug. 1891, coll. J. Brodie, 2(6) USNM; **AL**, Auburn, Aug. 13, 1976, coll. MLW, 2(7) VPI; Jefferson Co., Dec. 5, 1975, coll. D. Bradford, 2(5) AU; **AZ**, Camp Creek, Nov. 20, 1928, coll. NWC, 2(7) USNM;

Chiricahua Mts., Jul. 14, 1938, coll. (RTS), 2(3) SEM; Empire Mts., Apr. 4, 1937, coll. LPW, 4(9) UCD; Nogales, Jul. 13, 1934, coll. EDB, 2(5) UCD; 10 mi. E Nogales, Sep. 2, 1968, coll. T. R. Haig, 3(12) CDA; Prescott, coll. TDAC, 10(80) UCD; E of Superior, 1940, coll. GFF, 2(4) UCD; 7 mi. E of Superior, Sep. 1, 1969, colls. P. F. Min and D. B. Carver, 4(13) CDA; Walnut Creek Canyon, 16(97) AMNH; **CA**, Butte Co., Oroville, Aug. 20, 1969, colls. B. Adkins and F. McCraken, 2(5) RFW; Fresno Co., coll. Clarke, 3(12) UCD; Los Angeles Co., Aug. 7, 1909, coll. Woods, 5(30) USNM; Los Angeles, coll. A. Craw, 4(9) USNM; Los Angeles, Mt. Lowe, Sep. 29, 1968, 2(7) IAE; Sacramento Co., American River, Carmichael, Mar. 18, 1967, coll. RFW, 3(3) RFW; San Anita Canyon, 1909, coll. F. Maskero, 2(4) USNM; San Bernadino, Sep. 13, 1913, coll. S. A. Pease, 2(4) USNM; San Diego, coll. A. Craw, 2(5), UCD; San Jacinto, Oct. 15, 1899, 4(31) USNM; Tulare Co., Leavi Camp Ground, Jul. 8, 1976, coll. A. Kana, 2(6) VPI; **CO**, Moncos, Mesa Verde Natl. Pk., Oct. 3, 1928, coll. W. H. Weld, 2(5) USNM; Trinidad Raton Pass, 1921, coll. GFF, 1(2) UCD; **CT**, Hartford, Aug. 20, 1974, 2(7) USNM; Portland, Aug. 12, 1913, coll. B. H. Walden, 5(22) CAES; Stanford, Apr. 9, 1831, coll. E. P. Felt, 4(11) USNM; **DC**, USDA Grounds, Oct. 8. 1916, coll. HM, 2(6) USNM; USDA Grounds, Sep. 4, 1918, coll. ERS, 2(6) USNM; **FL**, Bradenton, Jun. 15, 1917, coll. F. Poos, Jr., 4(26) USNM; Brooksville, Apr. 8. 1918, coll. ERS, 1(2) USNM; Jacksonville, 1887, coll. Ashmead, 2(4) USNM; Miami, Dec. 27, 1974, coll. CHR, 2(4) AU; Putnam Co., Mar. 17, 1968, 1(1) VPI; near Shady, on Hwy. 475A, Sep. 17, 1976, colls. CHR and L. R. Ray, 2(5) VPI; **GA**, Henry Co., Jun. 8. 1976, coll. RB, 2(5) VPI; Valdosta, Aug. 15, 1976, coll. GF, 2(7) VPI; **IN**, Elkart Co., Jul. 14, 1939, coll. A. Tripple, 4(21) USNM; Indianapolis, 3(7) UCD; New London, coll. C. C. Beals, 2(9) USNM; W Lafayette, Feb. 27, 1932, coll. G. Gould, 1(4) USNM; **KS**, Manhattan, coll. JBN, 2(12) USNM; **LA**, Baton Rouge, Oct. 11, 1921, coll. W. Bradley, 4(17) UCD; New Orleans, Nov. 22, 1903, 5(11) USNM; **MA**, Cambridge, Apr. 1, 1885, 2(4) USNM; Cape Cod, Sep. 15, 1977, colls. RGB and SWB, 2(6) VPI; Lawrence, 4(12) AMNH; Lawrence, coll. GBK, 4(40) UCD; Lawrence, Jun. 17, 1898, coll. GBK, 5(26) USNM; Lawrence, Aug. 12, 1900, coll. GBK, 2(9) USNM; **MD**, Beltsville, May 31, 1974, coll. MK, 1(3) VPI; LaPlata, Dec. 1914, coll. ERS, 3(6) USNM; Plummers Sel., Jun. 7, 1914, coll. McAfee, 1(1) USNM; St. Michaels, Nov. 10, 1971, coll. MLW, 1(3) AU; **MI**, Cheboygan Co., Vincent, Aug. 1927, coll. H. B. Hingafok, 2(6) SEM; **MN**, St. Paul Univ. Farm, Apr. 23, 1923, coll. G. Hoke, 2(4) UMN; **MO**, St. Louis, Aug. 12, 1876, 2(4) USNM; **MS**, Cat Island, Sep. 9, 1920, coll. J. E. Graf, 2(6) USNM; Meridian, Sep. 4, 1924, coll. M. L. Grimes, 1(10) USNM; **NC**, Aberdeen, Feb. 6, 1904, coll. F. Sherman, 3(5), USNM; **NJ**, Bayonne, Aug. 18, 1908, coll. O. Farley, 4(37) USNM; Hoboken, Aug. 20, 1947, coll. Grayson, 2(9) USNM; **NY**, Ithaca, 5(6) USNM; Ithaca, 1893, 1(1) UCD; Ithaca, coll. LOH, 2(15) USNM; Jaffrey, Sep. 1896, 2(2) USNM; Long Island, Masbeth, Apr. 5, 1914, coll. C. E. Olsen, 2(9) CDA; Long Island, Riverhead, May 20, 1950, coll. L. H. Weld, 1(2) USNM; New Rochelle, Oct. 19, 1921, coll. T. Ladenburger, 2(7) USNM; **OH**, Cincinnati, Oct. 9, 1909, coll. N. Longsworth, 3(11) USNM; Cincinnati, Aug. 3, 1916 , coll. J. M. McCullough, 2(4) OHSU; Cincinnati, Dec. 30, 1921, coll. C. R. Crisby, 1(3) USNM; Cleveland, Aug. 19, 1925, coll. A. D. Taylor, 2(5) OHSU; Rock Bridge, Apr. 23, 1916, coll. JSH, 1(3) OHSU; Wooster, Sep. 22, 1899, coll. W. Newell, 1(1) OHSU; **PA**, Narberth, Oct. 31, 1917, coll. A. R. Wohlert, 1(3) USNM; Philadelphia, Aug. 16, 1919, coll. L. Morse, 2(8) USNM;

Philadelphia, Mt. Airy, Mar. 12, 1914, coll. W. Brooks, 2(5) USNM; Wash. Co., Fredericktown, Aug. 29, 1944, coll. F. R. Smith, 1(13) USNM; SC, Bluffton, coll. J. H. Mellichamp, 2(3) USNM; Charleston, Jun. 28, 1921, coll. D. L. Bissell, 1(2) USNM; Charleston, Jul. 28, 1922, coll. W. M. Jennings, 2(4) USNM; Charleston, Charleston Museum, Jul. 22, 1921, coll. L. M. Bragg, 2(4) USNM; Clemson Univ., Mar. 1, 1916, coll. J. A. Berly, 1(5) USNM; Wayside Pk., 2 mi. N on US 21 from Fairfield Co., Mar. 16, 1968, coll. MK, 1(3) VPI; TN, 6.5 mi. E of Maryville, Jun. 6, 1976, colls. MMK, 2(4) VPI; TX, Beaumont, Oct. 13, 1920, coll. L. R. Levy, 2(6) USNM; Cloverdale, Apr. 8, 1918, 1(2) UCD; Cuero, coll. Townsend, 1(1) USNM; Cuero, May 21, 1976, coll. DRM, 6(45) VPI; Dallas, Sep. 12, 1907, coll. R. Cushman, 4(13) UCD; Paris, Apr. 4, 1904, 8(50) USNM; Tyler, Jul. 10, 1918, 1(3) UCD; VA, Blacksburg, VPI&SU Campus, Apr. 25, 1969, coll. R. C. Brachman, 2(5) VPI; Blacksburg, VPI&SU Campus, May 18, 1969, coll. A. D. Ascoli, 1(2) VPI; Blacksburg, VPI&SU Campus, near Seitz Hall, Jul. 22, 1974, coll. ABH, 2(7) VPI; Blacksburg, VPI&SU Campus, Mar. 6, 1975, 2(4) VPI; Craig Co., Broad Run, Jun. 24, 1974, coll. CHR, 1(1) AU; Leesburg, May 20, 1947, coll. F. Marr, 5(12) USNM; Skyline, Oct. 20, 1958, coll. MK, 2(4) VPI; Skyline, Hazel Overlook, Jul. 29, 1958, coll. MK, 2(6) VPI; Virginia Beach, Seashore State Pk., Mar. 19, 1969, colls. MLW and JOH, 2(7) VPI; Virginia Beach, Seashore State Pk., Sep. 25, 1976, colls. MMK, 1(3) VPI; Winchester, Oct. 25, 1921, 2(4) VPI; WI, Madison, Apr. 4, 1965, 2(17), USNM.

Remarks. The first instars of *Allokermes galliformis* cannot be differentiated from *K. arizonensis* (King 1903a), *A. austini* Ehrhorn (1899b), *K. boguei* (Cockerell 1897b), *A. cueroensis* (Cockerell in King 1900b), *K. ehrhorni* (Cockerell manuscript species), *K. emoryi* (Ferris 1955b), *A. essigi* (King 1913a), *K. fuscata* (King manuscript species), *A. kingi* (Cockerell 1898c), *K. mirabilis* (King 1914b), *K. niger* (King manuscript species), *K. nigropunctatus* (Ehrhorn and Cockerell in Ehrhorn 1898), *A. nivalis* (King and Cockerell in Cockerell 1898a), *K. occidentalis* (King 1913b), *K. perryi* (King 1900b), *K. pettiti* (Ehrhorn 1899a), *A. rattani* (Ehrhorn 1906), *K. sassceri* (King 1914c), *K. trinotatus* (Bogue 1900) and *K. waldeni* (King 1914d).

The original description contained no information on the first instars. The description by Hamon *et al.* (1976), provided adequate morphological characters for species recognition. Based on the present study, the authors have designated *A. galliformis* to represent a group of species containing *A. branigani*, *A. gillettei* and *A. kosztarabi*. These four species have 2 rows of trilocular pores on the venter and relatively small, setaceous dorsal marginal setae. *Allokermes galliformis* can be distinguished by the following characters: 1) 1 pair of dorsal marginal setae on each abdominal segment; 2) setaceous dorsal marginal setae 16-21 long; 3) 3 quinquelocular pores laterad of each anterior spiracle; and 4) dorsal submedial setae on head, thorax and first abdominal segment similar to those on rest of abdomen.

A. galliformis is widely distributed in the U.S. and occasionally is found in Canada and Mexico. It infests chinquapin and many species of oaks.

Allokermes galliformis is a species which apparently exhibits host-induced morphological variation. For example, in the samples studied there is variation in the morphology of the dorsal marginal setae. The shape ranged from slender to thickened and from sharp to relatively blunt at the apex of the setae. Therefore, we were not able to consistently separate all the first instar specimens from the paratype series of the species listed above. Earlier studies of these species were based solely on the external morphology of the adult female. These descriptions usually included an external morphological comparison of many of the closely related species that was unclear, overlapping, and very generalized. Some of these species were considered synonyms by us; however, in the slide-mounted adult study (Bullington & Kosztarab, 1985), some of these species were considered valid. Only additional studies on the adult males of the species in question can satisfactorily clarify their status. It is expected that such studies may reveal bonafide subspecific differences within the *A. galliformis* species complex.

ALLOKERMES GALLIFORMIS (RILEY), SECOND INSTAR MALE

Plate 8

Kermes galliformis Riley, 1881: 482.

Material studied. On *Quercus velutina*, VA, Blacksburg, VPI&SU Campus, near Chapel, May 14-27, 1975, coll. ABH, 10(26), VPI.

Description. Body (fig. a) length 753 (649-830), width 355 (332-392).

Dorsum

Marginal setae (fig. b). Stout, spinelike setae, ca. 48, these 21 (18-26) long, 4 (3-5) wide.

Submedial setae (fig. c). In 2 longitudinal rows, 11 pairs of similar slender setaceous setae on head, thorax and abdomen, these 9 (7-12) long, ca. 2 wide.

Quinquelocular pores. Absent except for simple pores.

Simple pores (fig. d). Randomly distributed over derm, ca. 150; ca. 2 wide.

Tubular ducts (fig. e). Distributed throughout derm, ca. 200-400, 19 (18-21) long.

Anal lobes. Sclerotized. One seta on inner margin of each lobe 17 (16-19) long, another at posterior end, 18 (16-19) long; apical seta 119 (75-135) long.

Venter

Antennae. Total length 154 (138-165). Scape 18 (13-21) long, 40 (35-44) wide. Segments II to VII: 17 (14-19), 36 (35-37), 23 (14-30), 16 (14-18), 17 (15-19), 29 (28-30) long respectively.

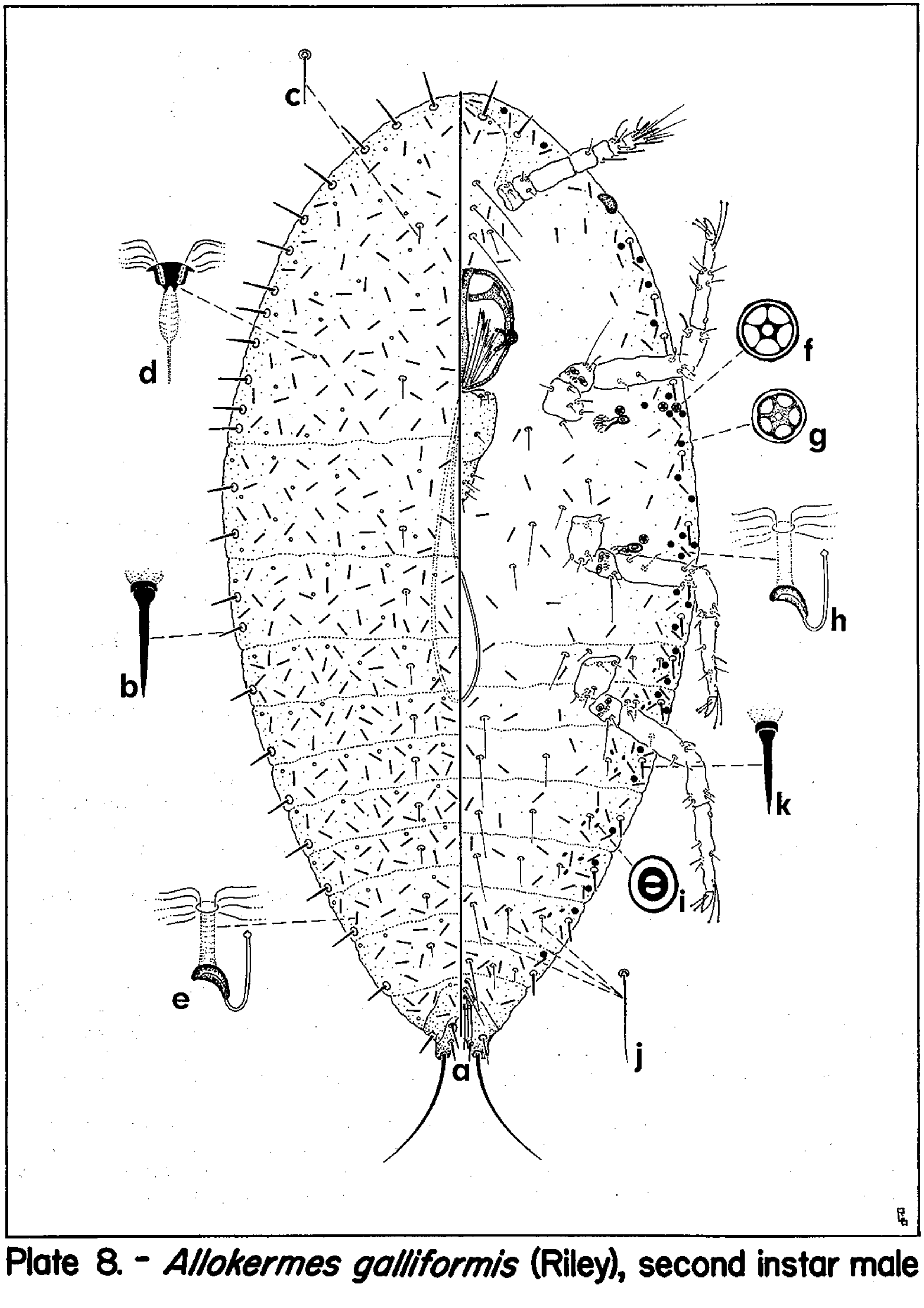


Plate 8. - *Allokermes galliformis* (Riley), second instar male

Clypeolabral shield. Length 104 (83-123), width 88 (71-95).

Labium. Length 83 (70-91), width 76 (59-91).

Legs. See chart below.

Leg Segments and Claw	Lengths Prothoracic	Lengths Mesothoracic	Lengths Metathoracic
Coxa	32 (26-37)	41 (37-44)	44 (39-49)
Trochanter	42 (35-46)	45 (41-49)	43 (35-49)
Femur	94 (90-100)	95 (93-97)	96 (93-100)
Tibia	56 (51-60)	58 (55-60)	55 (53-58)
Tarsus	94 (90-97)	95 (91-97)	96 (93-100)
Claw	17 (14-21)	16 (14-19)	16 (14-19)
Entire leg	334 (319-349)	350 (340-361)	351 (334-364)

Pores associated with spiracle (fig. f). Each anterior spiracle with 2-4 quinquelocular pores. Each posterior spiracle with 1 quinquelocular pore.

Quinquelocular pores on derm (fig. g). Along margin only, ca. 60.

Tubular ducts (fig. h). Less numerous than on dorsum, ca. 200, about the same shape and size as those on dorsum.

Bilocular pores (fig. i). Located near the bases of the submarginal and marginal setae, ca. 15 along each margin.

Body setae (figs. j,k). In 8 longitudinal rows in abdomen and partly on thorax and head: medial 42 (39-46) long, ca. 2 wide (fig. j); submedial 15 (14-19) long, ca. 2 wide (fig. j); submarginal 8 (5-14) long, ca. 2 wide (fig. j); marginal, similar to dorsal marginals, 15 (11-16) long, ca. 3 wide (fig. k).

Anal lobes and ring. Sclerotized. With 1 submedial seta on each lobe, 23 (19-26) long. Ring oval, ca. 28 long, ca. 30 wide; anal ring setae 30 (28-33) long.

Additional material studied. On *Quercus emoryi*, AZ, Rock Creek Canyon, Jul. 1940, coll. GFF, 1(1), UCD. On *Q. wislizenii*, CA, 2.5 mi. below Monticello Dam, Putah Creek, Apr. 5, 1968, coll. JWB, 2(5) JWB. On *Quercus* sp., CA, Sacramento Co., American River, Carmichael, May 21, 1966, coll. RFW, 1(1) RFW; VA, Blacksburg, VPI&SU Campus, May 9, 1975, coll. ABH, 1(5) VPI.

Remarks. Hamon *et al.* (1976) described and illustrated the second instar male. The first instars of *A. galliformis* were designated to represent a species group. Second instar males differ from those in the *K. concinnulus* group. The dorsal marginal setae are shorter and spinelike and the quinquelocular pores are absent on the dorsum. Material was not available for other second instar males in the *A. galliformis* group.

K. galliformis second instar males can be distinguished by the following characters: 1) quinquelocular pores absent from the dorsum; 2) dorsal and ventral marginal setae stout, spinelike; and 3) ca. 150 simple pores scattered on dorsum.

ALLOKERMES GALLIFORMIS (RILEY), SECOND INSTAR FEMALE

Plate 9

Kermes galliformis Riley, 1881: 482.

Material studied. On *Quercus palustris*, **MO**, Sikeston, May 4-July 6, 1976, coll. LH, 24(151), VPI.

Description. Body (fig. a) length 738 (604-966), width 361 (302-528).

Dorsum

Marginal setae (fig. b). Long, spinelike, ca. 46, these 35 (18-49) long, 3 (2-4) wide.

Submedial setae (figs. c,d). In 2 longitudinal rows, slender setaceous, 6-8 pairs restricted to head, thorax, and first few abdominal segments, these ca. 4 long, ca. 1 wide; posteriormost pair on abdomen reduced to small rounded setae (fig. d).

Simple pores (fig. e). In 8 longitudinal rows on abdomen, randomly scattered over thorax and head, ca. 100.

Tubular ducts. Absent.

Anal lobes. Sclerotized. One seta on inner margin of each lobe, 21 (16-26) long, another at posterior end, 23 (18-26) long; apical seta 88 (76-106) long.

Venter

Antennae. Total length 109 (102-115). Scape 12 (9-14) long, 25 (23-28) wide. Segments II to VI, 14 (11-16), 33 (30-35), 13 (11-14), 12 (12-14), 25 (23-28), long respectively.

Clypeolabral shield. Length 93 (88-100), width 82 (74-89).

Labium. Length 70 (65-83), width 59 (47-65).

Legs. See chart below.

Leg Segments and Claw	Lengths Prothoracic	Lengths Mesothoracic	Lengths Metathoracic
Coxa	32 (28-35)	33 (30-35)	35 (32-39)
Trochanter	36 (33-42)	34 (30-39)	37 (32-42)
Femur	76 (74-79)	71 (64-79)	78 (74-81)
Tibia	37 (34-42)	39 (37-42)	39 (35-42)
Tarsus	67 (64-70)	69 (67-72)	74 (70-79)
Claw	15 (12-19)	15 (12-16)	15 (12-19)
Entire leg	264 (256-274)	261 (249-266)	276 (266-283)

Pores associated with spiracle (fig. f). Each anterior spiracle with 5-13 quinquelocular pores. Each posterior spiracle with 1 or 2 quinquelocular pores.

Quinquelocular pores on derm (fig. g). In 3 longitudinal rows on abdomen, ca. 16, also, 1 or 2 pores associated with each coxal and antennal base.

Tubular ducts (fig. h). Distributed in derm mainly along submargin and coxal areas, ca. 80.

Bilocular pores. Absent.

Body setae (figs. i,j). In 8 longitudinal rows on abdomen and partly on head and thorax: medial 8 (7-11) long, ca. 2 wide (fig. i); submedial 7 (7-9) long, ca. 2 wide (fig. i); submarginal 4 (4-7) long, ca. 2 wide (fig. i); marginal row similar morphologically to dorsal marginals, 12 (9-19) long, 3 (2-4) wide (fig. j).

Anal lobes and ring. Sclerotized. With 1 submedial seta on each lobe, 14 (11-16) long. Ring oval, 22 (21-23) long, 23 (20-26) wide; anal ring setae 36 (30-39) long.

Additional material studied. On *Chrysolepis* sp., **CA,** Loma Prieta Mt., near San Jose, coll. GFF, 3(5) UCD. On *Quercus agrifolia,* **CA,** Sonoma Co., Julupa Valley, Jul. 15, 1906, coll. OEB, 1(1) USNM. On *Q. borealis,* **MA,** Lawrence, off Rt. 114, Jun. 16-18, 1976, coll. SWB, 5(23) VPI; **OH,** Columbus, OHSU, Jul. 19, 1976, colls, MMK, 4(20) VPI; **VA,** Blacksburg, VPI&SU Campus, May 27, 1974, coll. P. L., 1(9) VPI; June 12, 1974, coll. ABH 1(4) VPI; May 28, 1976, coll. SWB, 1(2) VPI. On *Q. douglasii,* **CA,** Tulare Co., E of Orange Cove, Sandcreek Rd., Apr. 28, 1964, coll. HM, 1(3) CDA. On *Q. grisea,* **TX,** Big Bend Natl. Pk., Jun. 15, 1976, colls. MMK, 1(1) VPI. On *Q. ilicifolia,* **IN,** Chesterton, Indiana Dunes State Pk., Jul. 10, 1979, coll. M. Rhoades, 1(1) VPI. On *Q. kelloggii,* **CA,** Yosemite Natl. Pk., Curry Village, Jun. 30, 1976, colls. MMK, 2(6) VPI. On *Q. nigra,* **AL,** Auburn, S Gay Str., Jun. 8, 1976, colls. MLW and MK, 1(1) VPI; *VA,* Virginia Beach, Seashore State Pk., May 10, 1974, coll. MK, 4(27) VPI. On *Q. palustris,* **NY,** Brooklyn Botanical Garden, Jul.

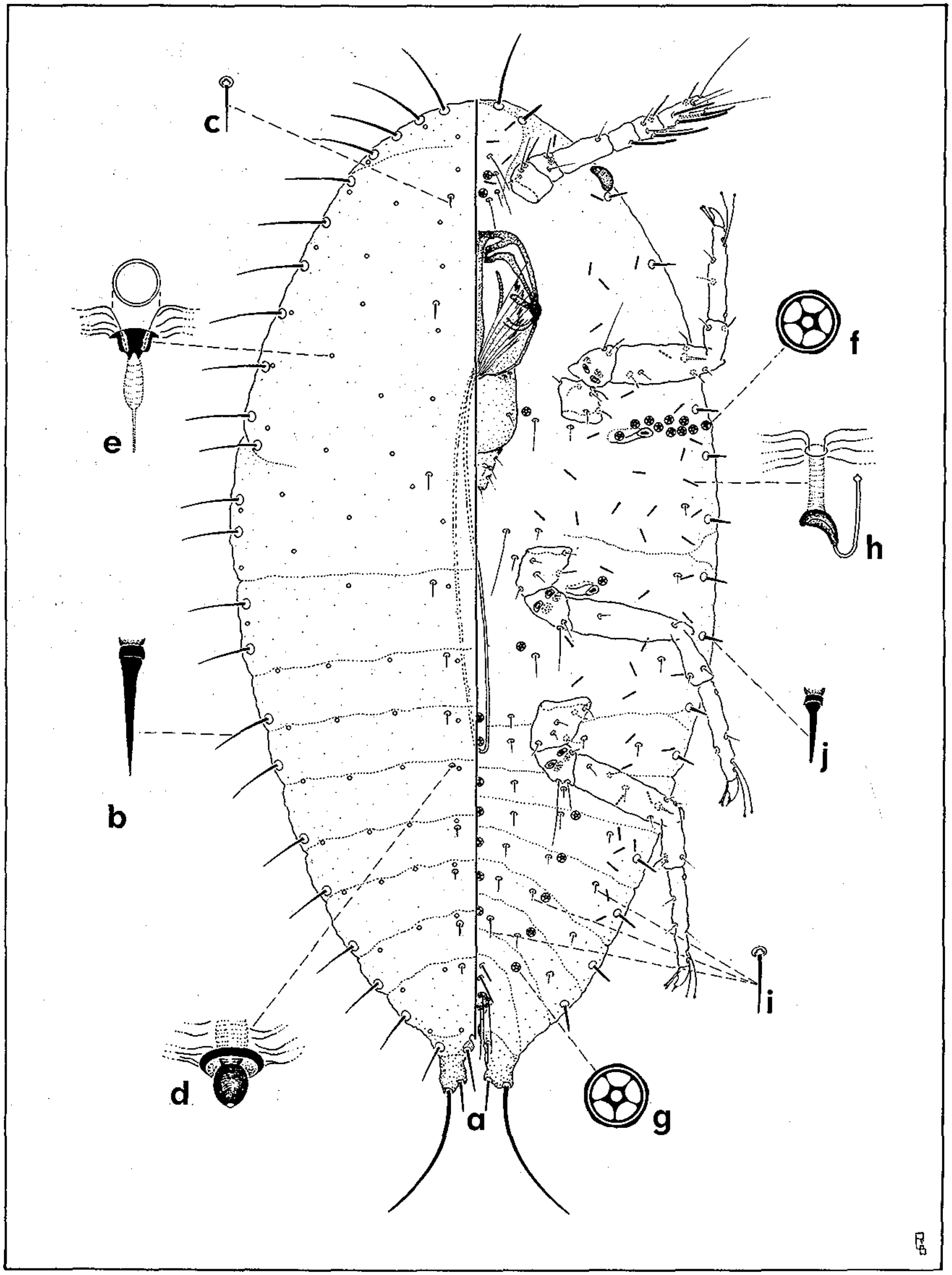


Plate 9. - *Allokermes galliformis* (Riley), second instar female

1921, coll. G. L. Griffith, 1(2) USNM. On *Q. stellata*, **TX**, Bryan, Apr. 6, 1918, 1(2) UCD. On *Q. velutina*, **IA**, Federal, Sep. 7, 1919, coll. RWD, 2(5) UCD; **MA**, N Andover, Merrimack College Campus, Jun. 15, 1976, coll. SWB, 5(34) VPI; Lawrence, off Rt. 114, Jun. 16- 18, 1976, coll. SWB, 20(93) VPI; **VA**, VPI&SU Campus, May 19-Jun. 5, 1975, coll. ABH, 9(64) VPI. On *Q. virginiana*, **FL**, Ft. Desoto Pk., Apr. 28, 1977, coll. K. Hickman, 3(3) FDA; **GA**, Emanuel Co., Feb. 15, 1976, coll. RB, 1(3) AU. On *Q. wislizenii*, **CA**, Putah Creek, Apr. 5, 1968, coll. JWB, 1(3) JWB; Putah Creek, 2.5 mi. below Monticello Dam, Apr. 5, 1968, coll. JWB, 1(3) JWB; Putah Creek, 7 mi. W of Winters, May 17, 1968, coll. JWB, 1(2) JWB; Sacramento Co., American River, Carmichael, Oct. 19, 1977, coll. RJG, 1(2) VPI; 1(2) JWB. On *Quercus* sp., **AZ**, Oak Creek Canyon, Indian Gardens, Jun. 26, 1976, colls. MMK, 1(2) VPI; 7 mi. E of Superior, Sep. 1, 1969, colls. P. F. Mint and D. B. Carver, 1(1) CDA; **CA**, Sacramento Co., American River, Carmichael, May 21, 1966, coll. RFW, 1(4) RFW; Siskiyou Co., Shasta Springs, May 20, 1976, 3(4) VPI; **CO**, Manitou, coll. CPG, 2(4) USNM; **CT**, Portland, Aug. 12, 1913, coll. B. H. Walden, 1(1) CAES; **FL**, Miami, Sep. 8, 1973, coll. CHR, 4(7) AU; Miami, Dec. 27, 1974, coll. CHR, 1(1) AU; **MD**, Beltsville, May 25, 1976, coll. S. Nakahara, 1(1) USNM; **PA**, Philadelphia, Aug. 16, 1919, coll. L. Morse, 1(1) USNM; **TX**, Cuero, May 21, 1976, coll. DRM, 3(5) USNM; **VA**, Blacksburg, VPI&SU Campus, Price Hall parking lot, May 14, June 16, 1975, coll. ABH, 3(11) VPI.

Remarks. Hamon *et al.* (1976) adequately described and illustrated the second instar female for species recognition. *A. galliformis* second instar females can be distinguished from other Kermesidae spp. in North America by the following characters: 1) tubular ducts absent from dorsum; 2) 1 pair of dorsal marginal setae on each abdominal segment; 3) with ca. 100 simple pores on dorsal derm; 4) ventral quinquelocular pores on abdomen arranged in 3 definite rows; and 5) each anterior spiracle with 5-13 quinquelocular pores.

ALLOKERMES GILLETTEI (COCKERELL), FIRST INSTAR

Plate 10

Kermes gillettei Cockerell, 1895b: 101.

Type material studied. Paralectotypes from *Quercus undulata*, **CO**, Manitou, coll. CPG, 3(18) USNM, 1(5) UCD, 2(10) VPI.

Description. Body (fig. a) length 483 (438- 574), width 211 (196-242).

Dorsum

Marginal setae (fig. b). Thick, setaceous, ca. 46-50, these 15 (12-22) long, ca. 2 wide.

Marginal setae on anal lobe (fig. c). Longer and thicker than other marginal setae, 21 (16-25) long.

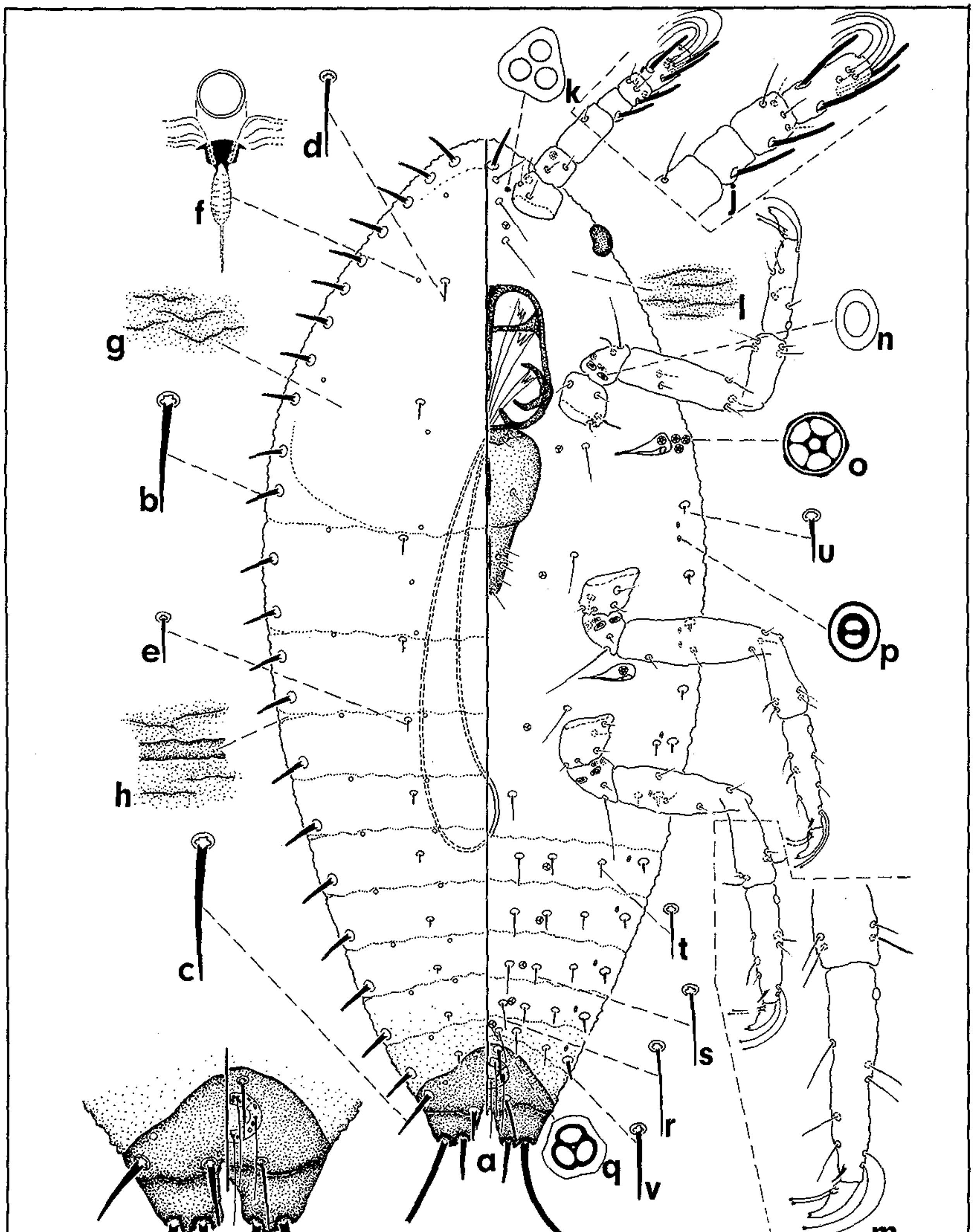


Plate 10. - *Allokermes gillettei* (Cockerell), first instar

Submedial setae on head and thorax (fig. d). Slightly thicker than abdominal submedial setae, 4 pairs, 10 (9-11) long, ca. 2 wide.

Submedial setae on abdomen (fig. e). Thin setaceous, 7 pairs, 5 (4-7) long, ca. 1 wide.

Simple pores (fig. f). In 4 longitudinal rows, ca. 42-48.

Derm (fig. g). Simple, membranous.

Intersegmental membrane (fig. h). Apparent due to type of derm.

Anal lobes (figs. a,i). Sclerotized. One thick seta on inner margin of each lobe, 16 (14-19) long, another at posterior end 19 (16-21) long; apical seta 166 (121-196) long.

Venter

Antennae (fig. j). Total length 103 (95-116). Scape 13 (12-16) long, 28 (26-33) wide. Segments II to VI: 15 (12-19), 24 (21-28), 12 (12-14), 13 (12-16), 26 (23-28), long respectively. Trilocular pore at scape base (fig. k).

Clypeolabral shield. Length 81 (77-88), width 63 (58-67).

Labium. Length 78 (72-91), width 54 (46-60).

Derm (fig. l). Membranous.

Legs (fig. m). See enlargement of tibia, tarsus and claw of metathoracic leg. Four sensory pores on each trochanter (fig. n).

Leg Segments and Claw	Lengths Prothoracic	Lengths Mesothoracic	Lengths Metathoracic
Coxa	23 (21-26)	24 (21-26)	24 (21-28)
Trochanter	27 (23-33)	28 (26-33)	26 (25-30)
Femur	61 (53-65)	62 (51-67)	64 (53-70)
Tibia	36 (33-39)	39 (35-42)	40 (35-44)
Tarsus	55 (49-58)	59 (51-65)	64 (56-67)
Claw	18 (14-19)	19 (16-21)	20 (16-21)
Entire Leg	223 (204-237)	229 (206-246)	238 (216-251)

Pores associated with spiracle (fig. o). Each anterior spiracle with 4 quinquelocular pores, but sometimes with 3 pores. Each posterior spiracle with 1 quinquelocular pore.

Bilocular pores (fig. p). Located near the bases of the marginal setae. Seven - 11 along each margin.

Submedial pores on derm (fig. q). In 2 submedial longitudinal rows. Four pairs on head and thorax, 5 pairs on abdomen, mostly triloculars.

Body setae (figs. r-v). In 8 longitudinal rows on abdomen and partly on thorax: medial 11 (8-14) long, ca. 1 wide (fig. r); submedial 8 (7-10) long, ca. 1 wide (fig. s); submarginal 5 (4-7) long, ca. 1 wide (fig. t); marginal 8 (6-9) long, ca. 1 wide (fig. u). Posteriormost seta in marginal row thicker than rest in row 9 (7-11) long (fig. v).

Anal lobes and ring (figs. a,i). Sclerotized. With 1 submedial seta on each lobe, 18 (14-25) long. Ring oval, 14 (11-16) long, 21 (19-23) wide; anal ring setae 36 (30-39) long; 1 pair of thick setae at the anterior margin of anal ring 16 (14-19) long.

Additional material studied. On *Quercus alba*, **CO**, Manitou, 3(6), USNM. On *Quercus engelmannii*, **MEXICO**, Amecameca, coll. AK, 3(13), USNM; Amecameca, May 25, 1897, coll. AK, 9(55) USNM; 4(25) VPI, 3(22) UCD. On *Q. gambelii*, **CO**, Manitou, coll. TDAC, 3(15), UCD, 2(18) VPI, 1(9) USNM. On *Quercus* sp., **MEXICO**, Chivela, Claxaca, 1926, coll. GFF, 4(27) UCD; **AZ**, Young, Nov. 1, 1935, coll. NWC, 2(6), USNM; **CO**, Colorado Mts., foothills, Jul. 1909, coll. E. Bethel, 2(4) CSU; Colorado Springs, Sep. 3, 1919, coll. J. H. Pollock, 3(22) UCD; Manitou, coll. TDAC, 2(13) PANS; Manitou, Apr. 13, 1904, coll. TDAC, 4(32) USNM; Manitou, Oct. 10, 1923, coll. Beetrel, 4(6) UCD; Palmer Lake, 4(13) UCD; **FL**, Gainesville, Jan. 22, 1964, coll. JMA, 1(3) VPI; Jacksonville, Jul. 5, 1881, 2(4) USNM; Miami, Dec. 27, 1974, coll. CHR, 3(7), AU 2(6) VPI; **TX**, Cuero, May 21, 1976, coll. DRM, 2(4), VPI; Davis Mts., Mt. Livermore, Jul. 1921, coll. GFF, 1(2), UCD.

Remarks. The first instars of *A. gillettei* cannot be distinguished from *A. grandis* Cockerell (1898d) and *Lecanium tubuliferum* Cockerell (1898b). *A. gillettei* is closely allied with the *A. galliformis* group. All species in this group have 2 rows of trilocular pores on the venter and relatively small, setaceous dorsal marginal setae.

A. gillettei can be distinguished by the following characters: 1) 1 pair of dorsal marginal setae on each abdominal segment; 2) setaceous dorsal marginal setae 9-22 long; 3) usually 4 quinquelocular pores laterad of each anterior spiracle; 4) 4 -11 ventral bilocular pores along each body margin; and 5) usually 5 pairs of submedial trilocular pores on the abdominal venter.

This species is found on *Quercus alba*, *Q. engelmanni*, *Q. gambelii*, and *Q. undulata* in Florida, Colorado, Texas and Mexico.

ALLOKERMES GILLETTEI (COCKERELL), SECOND INSTAR FEMALE

Plate 11

Kermes gillettei Cockerell, 1895b:101.

Type material studied. Paralectotypes from *Quercus undulata*, CO, Manitou, (no date mentioned), coll. CPG, 2(2) USNM.

Description. Body (fig. a) length 974 (921-1026), width 559 (513-604).

Dorsum

Marginal setae (fig. b). Thick, slightly curved at middle, ca. 48, these 49 (35-59) long, ca. 7 wide.

Submedial setae (fig. c). In 2 longitudinal rows, 8 pairs, several other pairs located medially to these rows, ca. 5 long, ca. 1 wide.

Simple pores (fig. d). One - 5 distributed on derm.

Tubular ducts. Absent.

Anal lobes. Sclerotized. One seta on inner margin of each lobe ca. 28 long, another at posterior end ca. 26 long; apical seta ca. 171 long.

Venter

Antennae. Total length 148 (144-153). Scape 15 (14-16) long, 34 (33-35) wide. Segments II to VI: 20 (19-21), 51 (49-53), ca. 16, 17 (16-19), 29 (28-31) long, respectively.

Clypeolabral shield. Length ca. 148, width 130 (106-153).

Labium. Length 109 (94-124), width 91 (77-106).

Legs. See chart below.

Leg Segments and Claw	Lengths Prothoracic	Lengths Mesothoracic	Lengths Metathoracic
Coxa	34 (33-35)	41 (35-46)	41 (35-46)
Trochanter	41 (39-42)	43 (42-44)	41 (37-44)
Femur	94 (93-95)	ca. 93	93 (91-95)
Tibia	65 (63-67)	60 (58-63)	65 (63-67)
Tarsus	87 (86-89)	87 (86-88)	89 (88-91)
Claw	17 (14-21)	17 (14-21)	ca. 21
Entire leg	337 (332-343)	341 (339-343)	349 (348-350)

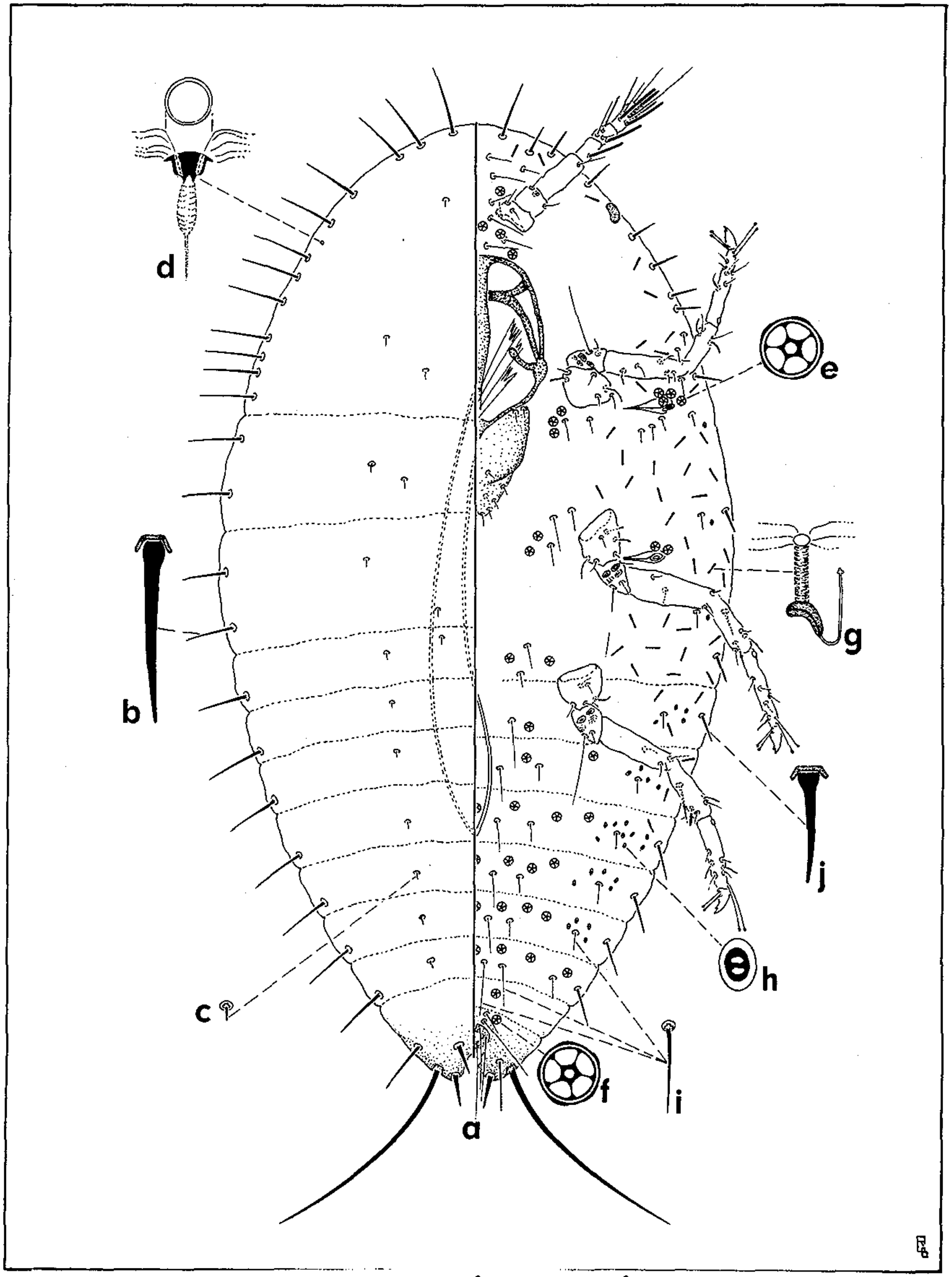


Plate II. - *Allokermes gillettei* (Cockerell), second instar female

Pores associated with spiracle (fig. e). Each anterior spiracle with 4 quinquelocular pores. Each posterior spiracle with 2 quinquelocular pores.

Quinquelocular pores on derm (fig. f). Ca. 34 on abdomen, ca. 2-4 near each coxal and antennal base.

Tubular ducts (fig. g). Distributed in derm, mainly along submargin and coxal areas, ca. 86.

Bilocular pores (fig. h). Located near the bases of the submarginal setae, ca. 16-54.

Body setae (figs. i,j). In 8 longitudinal rows on abdomen and partly on thorax and head: medial 33 (21-44) long (fig. i); submedial 16 (12-21) long (fig. i); submarginal 12 (7-19) long (fig. i); marginal 25 (19-33) long (fig. j). All ca. 2 wide.

Anal lobes and ring. Sclerotized. With 1 submedial seta on each lobe, 46 (44-49) long. Ring oval, ca. 30 long, 43 (39-46) wide; anal ring setae 73 (70-77) long.

Remarks. *A. gillettei* second instar females can be distinguished from other *Allokermes* species by the following characters: 1) tubular ducts absent from dorsum; 2) 1 pair of dorsal marginal setae on each abdominal segment; 3) 1 - 5 simple pores on dorsal derm; and 4) ventral quinquelocular pores on abdomen not arranged in definite rows.

ALLOKERMES KOSZTARABI (BAER), FIRST INSTAR

Plate 12

Kermes kosztarabi Baer, 1980:20.

Type material studied. Holotype and paratype series from *Quercus nigra*, **GA**, Tifton, Nov. 22, 1899, colls. W. M. Scott and ALQ, 3(14) USNM, 3(10) UGA, 3(14) CSU, 2(7) UCD, 2(9) VPI, 1(3) BM.

Description. Body (fig. a) length 393 (347-531), width 166 (166-287).

Dorsum

Marginal setae (fig. b). Short and stout, ca. 44-48, these 12 (8-14) long, 3 (2-5) wide.

Marginal setae on anal lobe (fig. c). Longer and thicker than other marginal setae, 14 (12-16) long.

Submedial setae on head and thorax (fig. d). Fusiform shaped setae on abdominal segments, 4 pairs, 10 (8-12) long, ca. 2 wide.

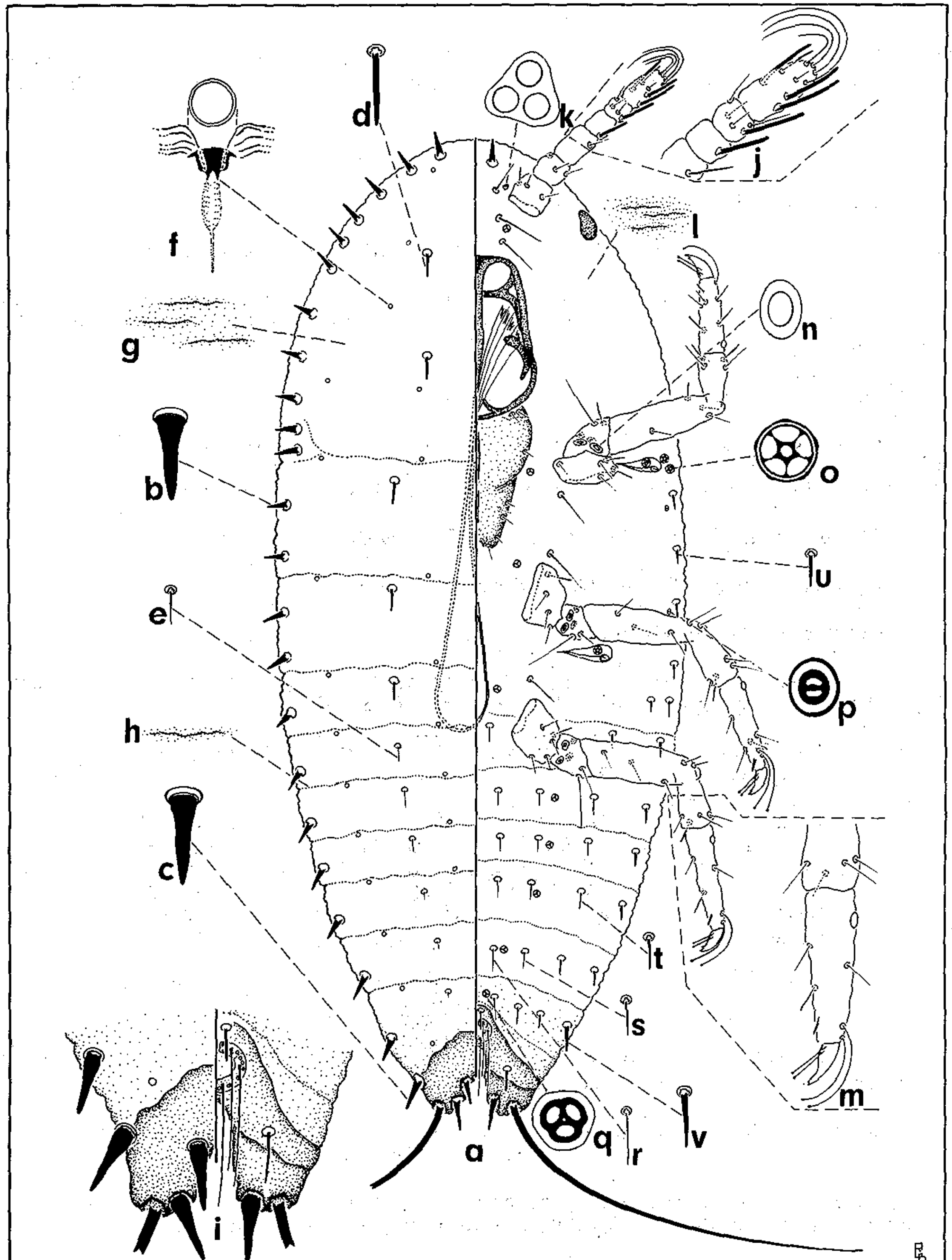


Plate 12. - *Allokermes kosztarabi* (Baer), first instar

Submedial setae on abdomen (fig. e). First pair similar to those on head and thorax, ca. 8 long, ca. 2 wide. Six remaining pairs, thin setaceous, 5 (2-8) long, ca. 1 wide.

Simple pores (fig. f). In 4 longitudinal rows, ca. 44-48.

Derm (fig.g). Simple, membranous.

Intersegmental membrane (fig. h). Apparent due to type of derm.

Anal lobes (figs. a,i). Sclerotized. One thick seta on inner margin of each lobe, ca. 12 long, another at posterior end, 14 (12-16) long; apical seta 136 (84-151) long.

Venter

Antennae (fig. j). Total length 86 (74-88). Scape 12 (9-14) long, 23 (21-23) wide. Segments II to VI: 14 (11-14), 19 (16-21), 9 (7-12), 12 (7-12), 21 (19-23) long respectively. Trilocular pore at scape base (fig. k).

Clypeolabral shield. Length 67 (60-74), width 51 (49- 63).

Labium. Length 53 (49-65), width 39 (35-44).

Derm (fig. l). Membranous.

Legs (fig. m). See enlargement of tibia, tarsus and claw of metathoracic leg. Four sensory pores on each trochanter (fig. n).

Leg Segments and Claw	Lengths Prothoracic	Lengths Mesothoracic	Lengths Metathoracic
Coxa	19 (19-23)	21 (19-23)	23 (19-23)
Trochanter	26 (23-28)	23 (21-26)	26 (23-26)
Femur	51 (46-51)	46 (46-51)	51 (49-53)
Tibia	28 (26-30)	28 (23-30)	30 (28-35)
Tarsus	44 (42-49)	46 (44-51)	51 (44-51)
Claw	14 (12-16)	14 (12-16)	16 (12-19)
Entire leg	181 (179-188)	179 (174-197)	197 (179-202)

Pores associated with spiracle (fig. o). Each anterior spiracle with 3 quinquelocular pores. Each posterior spiracle with 1 quinquelocular pore.

Bilocular pores (fig. p). Located near the bases of the marginal setae. Usually associated with the anterior setae. Two or 3 along each margin.

Submedial pores on derm (fig. q). In 2 submedial longitudinal rows. Four pairs on head and thorax, 5 pairs on abdomen, mostly triloculars.

Body setae (figs. r-v). In 8 longitudinal rows on abdomen and partly on thorax: medial 7 (5-10) long, ca. 1 wide (fig. r); submedial 5 (5-8) long, ca. 1 wide (fig. s); submarginal 4 (3-5) long, 1 (1-2) wide (fig. t); 5 (5-7) long, 1 (1-2) wide (fig. u). Posteriormost seta in marginal row thicker than rest in row 9 (7-12) long (fig. v).

Anal lobes and ring (figs. a,i). Sclerotized. With 1 submedial seta on each lobe, 9 (7-12) long. Ring oval, 19 (9-19) long, 19 (16-19) wide; anal ring setae 23 (23-33) long; 1 pair of thick setae at the anterior margin of anal ring 9 (9-12) long.

Additional material studied. On *Q. laurifolia*, **AL**, Auburn, Gay Str., Gay Manor, Jun. 8, 1976, colls. MLW and MK, 2(3) VPI; **FL**, Marion Co., Heagy Burry Pk., Sep. 17, 1976, colls. CHR and L. R. Ray, 2(7) VPI. On *Q. myrtifolia*, **FL**, Carabelle, Nov. 2, 1929, 1(3), USNM. On *Quercus* sp., **FL**, Bradenton, Jun. 28, 1917, coll. F. Poos, Jr., 1(3) USNM; Fort Pierce, Jul. 27, 1917, coll. F. F. Bibby, 2(4) USNM; Levy Co., Rt. 24, Aug. 4, 1977, colls. SWB and F. L. Carle, 4(12) VPI; **LA**, New Orleans, Spanish Ft., Mar. 9, 1919, colls. HFD and ERS, 1(2) USNM; **SC**, Charleston, Magnolia Cemetery, Jul. 10, 1923, colls. ERS and Rogers, 1(1) USNM.

Remarks. This species is closely allied to the *K. galliformis* group. All species included in this group have relatively short setaceous dorsal marginal setae and trilocular pores on the venter.

A. kosztarabi can be distinguished by: 1) 1 pair of dorsal marginal setae on each abdominal segment; 2) setaceous dorsal marginal setae 8-14 long; 3) 3 quinquelocular pores laterad of each anterior spiracle; 4) 2 - 3 bilocular pores along each body margin; and 5) dorsal submedial setae on head, thorax and first abdominal segment thicker than those on rest of abdomen.

This species is found on *Quercus laurifolia*, *Q. myrtifolia* and *Q. nigra* in Alabama, Florida, Georgia, Louisiana and South Carolina.

According to the study by Bullington and Kosztarab (1985) on adult females, *A. kosztarabi* cannot be distinguished. However, through first instar morphology, *A. kosztarabi* was determined to be a valid new species.

KERMES COCKERELLI EHRHORN, FIRST INSTAR

Plate 13

Kermes cockerelli Ehrhorn, 1898:185.

Type material studied. Paralectotypes from *Quercus lobata*, **CA**, Mountain View, (no date or collector mentioned), 8(48) USNM; 4(22) VPI; 3(16) UCD.

Description. Body (fig. a) length 530 (438-589), width 233 (196-257).

Dorsum

Marginal setae (fig. b). Long, thick, setaceous, ca. 40-48, these 25 (19-37) long, 4 (2-7) wide.

Marginal setae on anal lobe (fig. c). Longer and thicker than other marginal setae, 35 (26-46) long.

Submedial setae on head and thorax (fig. d). Thick, setaceous, on head, pro- and mesothorax, similar to dorsal marginal setae, 3 pairs, 22 (19-26) long, 2 (1-3) wide. Metathoracic setae thin, setaceous, similar to submedial setae on abdomen, 1 pair, 11 (10-13) long.

Submedial setae on abdomen (fig. e). Thin, setaceous, 7 pairs, 9 (5-12) long, ca. 1 wide.

Simple pores (fig. f). In 4 longitudinal rows, ca. 44-50.

Derm (fig. g). Simple, membranous.

Intersegmental membrane (fig. h). Apparent due to type of derm.

Anal lobes (figs. a,i). Sclerotized. One thick seta on inner margin of each lobe, 29 (23-31) long, another at posterior end, 30 (26-42) long; apical seta 146 (76-211) long.

Venter

Antennae (fig. j). Total length 111 (103-117). Scape 18 (14-23) long and 30 (28-33) wide. Segments II to VI: 16 (14-19), 25 (23-28), 12 (9-14), 12 (12-14), 25 (23-33) long respectively. Trilocular pore at scape base (fig. k).

Clypeolabral shield. Length 90 (81-97), width 70 (63-81).

Labium. Length 86 (79-97), width 53 (46-60).

Derm (fig. l). Membranous.

Legs (fig. m). See enlargement of tibia, tarsus and claw of metathoracic leg. Four sensory pores on each trochanter (fig. n).

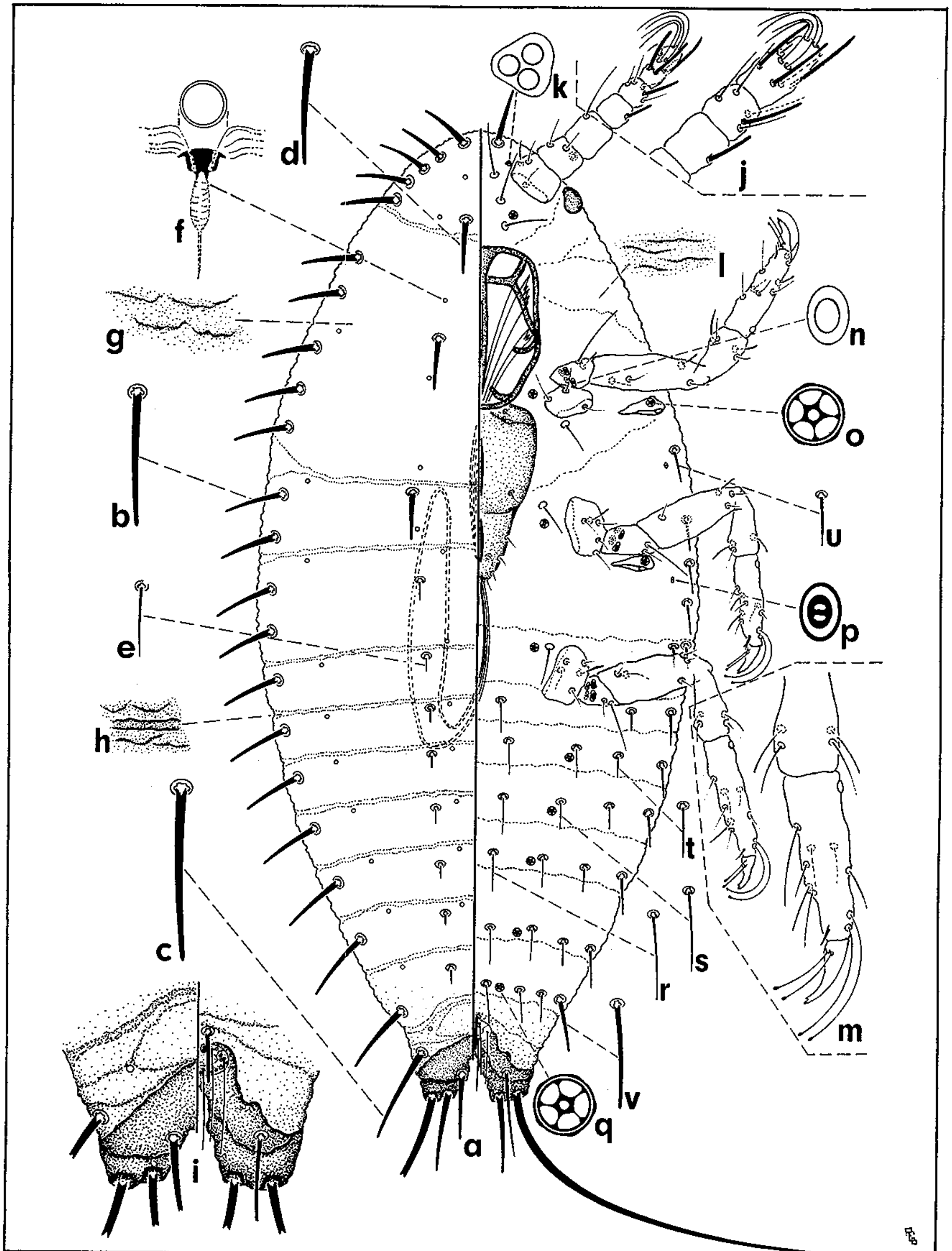


Plate 13. - *Kermes cockerelli* Ehrhorn, first instar

Leg Segments and Claw	Lengths Prothoracic	Lengths Mesothoracic	Lengths Metathoracic
Coxa	25 (21-28)	25 (23-28)	25 (23-28)
Trochanter	33 (30-35)	28 (23-30)	29 (26-33)
Femur	66 (58-72)	65 (56-74)	68 (60-72)
Tibia	36 (33-39)	38 (30-42)	40 (28-46)
Tarsus	52 (51-56)	56 (51-65)	62 (56-65)
Claw	20 (16-21)	21 (16-23)	22 (21-23)
Entire leg	226 (206-234)	235 (207-253)	246 (218-260)

Pores associated with spiracle (fig. o). Each anterior and posterior spiracle with 1 quinquelocular pore.

Bilocular pores (fig. p). Located near the bases of the marginal setae, usually associated with the 5 anteriormost setae. Usually 2-3 along each margin.

Submedial pores on derm (fig. q). In 2 submedial longitudinal rows. Four pairs on head and thorax; mostly 5 pairs on abdomen, usually quinquelocular pores but sometimes triloculars.

Body setae (figs. r-v). In 8 longitudinal rows on abdomen and thorax: medial 18 (12-30) long, ca. 1 wide (fig. r); submedial 14 (12-35) long, ca. 1 wide (fig. s); submarginal 8 (7-9) long, ca. 1 wide (fig. t); marginal 13 (7-28) long, ca. 1 wide (fig. u). Posteriormost seta in marginal row thicker than the rest in the row 22 (16-26) long (fig. v).

Anal lobes and ring (figs. a,i). Sclerotized. With 1 submedial seta on each lobe, 39 (19-53) long. Ring oval, 15 (12-17) long, 24 (23-26) wide; anal ring setae 28 (19-44) long; 1 pair of thick setae at the anterior margin of anal ring, each 22 (16-28) long.

Additional material studied. On *Quercus chrysolepis*, **CA**, Mammoth Lakes, Jun. 29, 1976, coll. MK, 1(2) VPI. On *Q. douglasii*, Tulare Co., E Orange Cove, Apr. 28, 1964, coll. HM, 2(8) CDA, 1(4) USNM, 1(4) VPI. On *Q. durata*, Napa Co., Mt. St. Helena, Oct. 12, 1967, coll. JWB, 1(3) JWB, 1(3) VPI. On *Q. garryana*, **OR**, Jackson Co., 9.2 mi. E of Ashland, Jun. 1-5, 1977, coll. R. L. Penrose, 2(3) VPI. On *Q. kelloggii*, **CA**, Yolo, 1910, 1(2) AMNH. On *Q. lobata*, **CA**, near Escalon, Sep. 19, 1967, coll. JWB, 1(3) JWB; Sacramento Co., American River, "Governors Mansion," Oct. 19, 1977, coll. RJG, 1(1) VPI, 1(1) CDA; Stanford University, Apr. 1914, coll. GFF, 2(8) UCD and Oct. 28, 1914, coll. A. F. Swain, 3(5) USNM; Walnut Creek, Aug. 20, 1911, coll. (JCB), 1(10) UCD, 1(11) USNM, 1(11) VPI. On *Quercus* sp., **CA**, Trinity Natl. Forest, Feb. 25, 1918, coll. R. Headley, 2(7) USNM.

Remarks. The original description included no useful information on the first instar. However, Ferris (1920) redescribed and illustrated the first instar and mentioned it as having 2 or 3 large setae on the cephalothorax. This character is important in species recognition. *Kermes cockerelli* is closely allied with species in the *Kermes concinnulus* group. All species in this group have relatively long setaceous or parallel-sided setae and quinquelocular pores in rows on the venter.

Kermes cockerelli can be distinguished by the following characters: 1) 1 pair of dorsal marginal setae on each abdominal segment; 2) setaceous dorsal marginal setae 19-48 long; 3) dorsal submedial setae on head, pro- and mesothorax thickened and similar to the dorsal marginal setae; and 4) 1 quinquelocular pore laterad of each anterior spiracle.

Kermes cockerelli is found in California and Oregon on *Quercus douglasii, Q. durata, Q. garryana, Q. kelloggii* and *Q. lobata.*

Bullington and Kosztarab (1980) do not recognize *K. cockerelli* as a valid species on the basis of the adult female. They synonymize *K. cockerelli* with *K. rimarum.* However, through the first instars, both species are valid because of paralectotypes used in both descriptions.

KERMES COCKERELLI EHRHORN, SECOND INSTAR MALE

Plate 14

Kermes cockerelli Ehrhorn, 1898:185.

Material studied. On *Quercus douglasii,* **CA,** 3 mi. E of Monticello Dam, Putah Creek, Dec. 6, 1967, coll. JWB, 1(3) JWB. *Quercus lobata,* **CA,** Seursville Lake, Mar. 4, 1937, 1(1) UCD.

Description. Body (fig. a) length 1351 (1117-1827), width 532 (438-604).

Dorsum

Marginal setae (fig. b). Very thin, setaceous, ca. 52, these 46 (30-59) long, ca. 2 wide.

Submedial setae (fig. c). In 4 longitudinal rows, 3-4 pairs in medial row, 11 pairs in submedial row, these 28 (18-41) long, ca. 2 wide.

Quinquelocular pores (fig. d). Scattered over derm, ca. 100.

Simple pores. Absent.

Tubular ducts (fig. e). Distributed throughout derm, ca. 200-250, 20 (19-21) long.

Anal lobes. Sclerotized. One seta on inner margin of each lobe, 25 (21-28) long, another at posterior end, 23 (21-28) long; apical seta 144 (106-166) long.

Venter

Antennae. Total length 175 (166-186). Scape 21 (18-26) long, 46 (42-51) wide. Segments II to VII: 18 (16-19), 36 (35- 37), 28 (26-30), 20 (18-23), 21 (18-26), 32 (30-35) long respectively.

Clypeolabral shield. Length 124 (118-130), width ca. 123.

Labium. Length 85 (77-94), width 75 (71-77).

Legs. See chart below.

Leg Segments and Claw	Lengths Prothoracic	Lengths Mesothoracic	Lengths Metathoracic
Coxa	41 (30-47)	49 (41-53)	49 (47-51)
Trochanter	48 (46-51)	43 (35-47)	49 (47-53)
Femur	89 (86-94)	85 (81-89)	91 (88-94)
Tibia	59 (58-60)	68 (65-71)	69 (65-71)
Tarsus	86 (82-89)	88 (82-94)	93 (88-97)
Claw	22 (14-26)	21 (14-23)	22 (14-26)
Entire Leg	344 (341-350)	354 (328-371)	372 (363-385)

Pores associated with spiracle (fig. f). Each anterior and posterior spiracle with 4-6 quinquelocular pores.

Quinquelocular pores on derm (fig. g). Scattered over derm.

Tubular ducts (fig. h). Less numerous than on dorsum, ca. 125, about the same size and shape as those on dorsum.

Bilocular pores (fig. i). Located near the bases of the submarginal and marginal setae, about 15 along each margin.

Body setae (figs. j,k). In 8 longitudinal rows on abdomen and partly on head and thorax: medial 63 (51-77) long, ca. 2 wide (fig. j); submedial 39 (35-46) long, ca. 2 wide (fig. j); submarginal 21 (14-26) long, ca. 2 wide (fig. j); marginals, similar to dorsal marginals, 44 (37-51) long, ca. 3 wide (fig. k).

Anal lobes and ring. Sclerotized. With 1 submedial seta on each lobe, 48 (30-65) long. Ring oval, 31 (28-35) long, 35 (33-37) wide; anal ring setae 41 (26-53) long.

Remarks. The first instars of *Kermes cockerelli* were placed in the *K. concinnulus* group. Also, the second instar males were found to be morphologically similar to other second instar males of different species in the

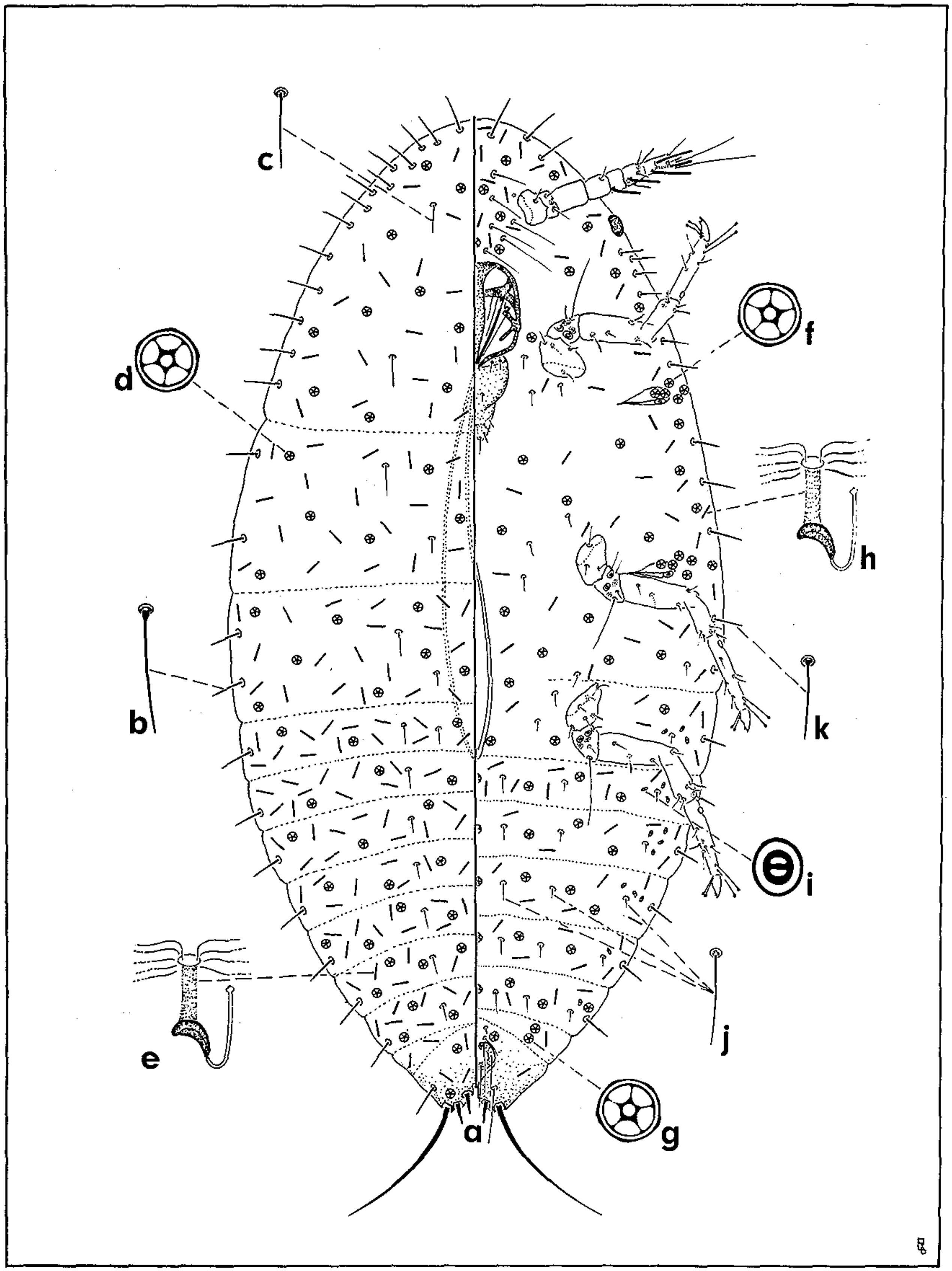


Plate 14. - *Kermes cockerelli* Ehrhorn, second instar male

Kermes concinnulus group. All species in this group have long, thin dorsal marginal setae and quinquelocular pores on the dorsum.

Kermes cockerelli second instar males can be distinguished by the following characters: 1) quinquelocular pores scattered over entire dorsal and ventral derm; 2) dorsal and ventral marginal setae thin, setaceous; 3) without simple pores on dorsum; and 4) dorsal marginal setae 30-59 long.

KERMES COCKERELLI EHRHORN, SECOND INSTAR FEMALE

Plate 15

Kermes cockerelli Ehrhorn, 1898:185.

Material studied. On *Quercus lobata* CA, Stanford University, Mar. 1, 1918, coll. GFF, 3(3) UCD, 1(1) USNM, 1(1) VPI.

Description. Body (fig. a) length 1505 (1419-1640), width 717 (604-830).

Dorsum

Marginal setae (fig. b). Thick, slightly curved at middle, 2 pairs on each abdominal segment, ca. 68, these 63 (58-71) long, ca. 4 wide.

Submedial setae (figs. c,d). In 2 longitudinal rows, usually head, pro- and mesothoracic regions with 1 pair of setae each which are similar morphologically to marginal setae 45 (44- 47) long, ca. 4 wide (fig. c), 7 other pairs on metathorax and abdomen short, ca. 5 long, ca. 1 wide (fig. d), several other pairs located medially to these rows, ca. 5 long.

Simple pores (fig. e). One - 5 distributed on derm, sometimes absent.

Tubular ducts. Absent.

Anal lobes. Sclerotized. One seta on inner margin of each lobe, 33 (30-35) long, another at posterior end 26 (23-30) long; apical seta 170 (151-181) long.

Venter

Antennae. Total length 172 (166-177). Scape ca. 24 long, 43 (40-46) wide. Segments II to VI: 21 (18-24), 50 (48-53), ca. 24, ca. 24, 30 (29-33) long respectively.

Clypeolabral shield. Length 138 (123-147), width 112 (106-118).

Labium. Length 118 (112-123), width 85 (83-89).

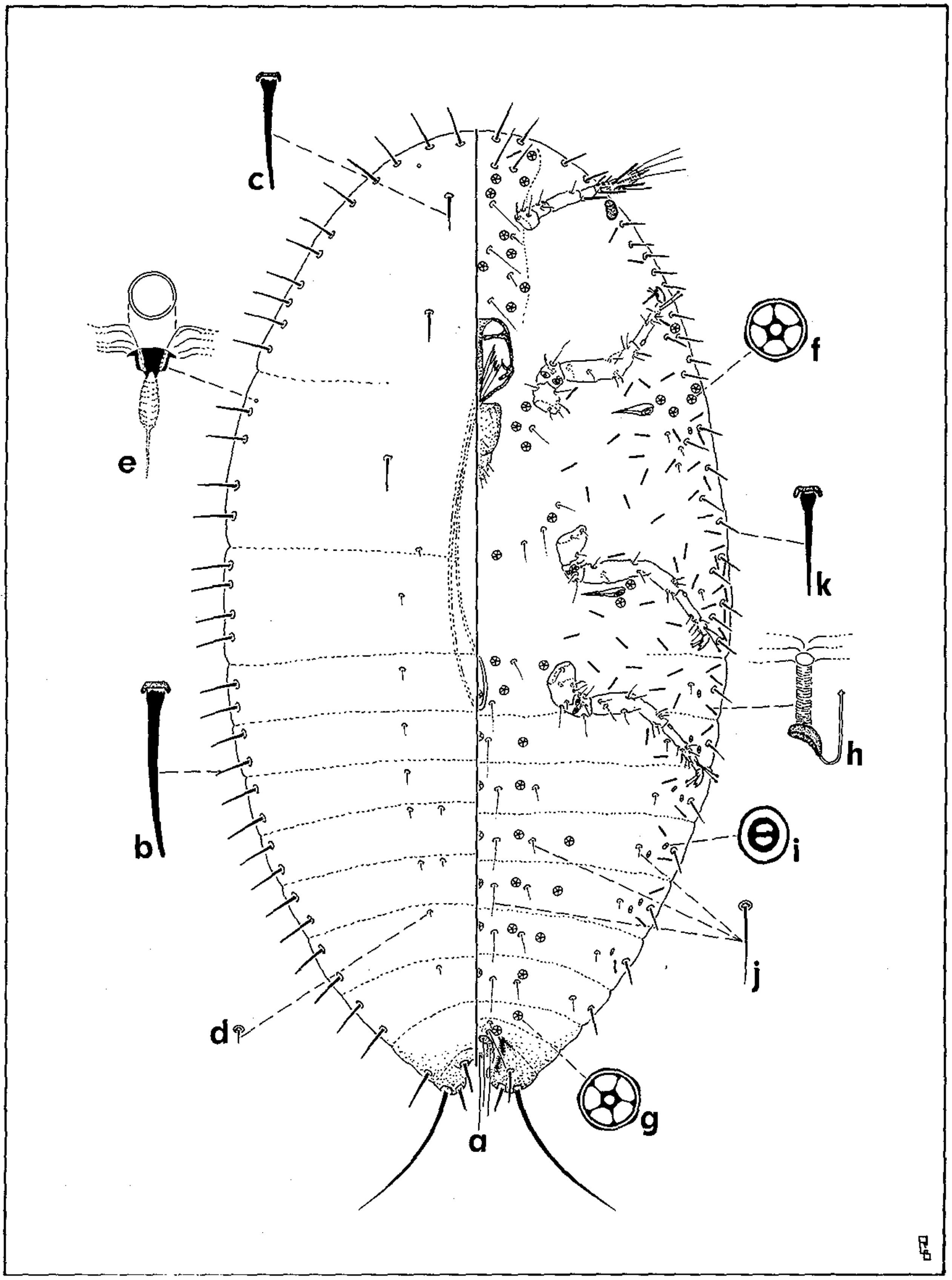


Plate 15. - *Kermes cockerelli* Ehrhorn, second instar female

Legs. See chart below.

Leg Segments and Claw	Lengths Prothoracic	Lengths Mesothoracic	Lengths Metathoracic
Coxa	50 (48-53)	51 (49-53)	52 (48-53)
Trochanter	46 (44-49)	45 (41-49)	45 (41-49)
Femur	95 (93-97)	98 (95-100)	98 (95-100)
Tibia	64 (62-67)	64 (62-67)	70 (67-72)
Tarsus	86 (83-91)	94 (93-95)	96 (95-100)
Claw	20 (18-24)	21 (17-24)	21 (17-24)
Entire leg	362 (359-366)	373 (365-378)	381 (375-384)

Pores associated with spiracle (fig. f). Each anterior spiracle with 3 - 4 quinquelocular pores. Each posterior spiracle with 2 quinquelocular pores.

Quinquelocular pores on derm (fig. g). In 5 longitudinal rows on abdomen, ca. 25; also ca. 35 near coxal and antennal scape bases.

Tubular ducts (fig. h) Mainly along submargin and coxal areas, ca. 120.

Bilocular pores (fig. i). Located near the bases of the submarginal setae, ca. 5 - 10.

Body setae (figs. j,k). In 8 longitudinal rows on abdomen and partly on thorax and head: medial 56 (47-65) long, ca. 2 wide (fig. j); submedial 25 (23-30) long, ca. 2 wide (fig. j); submarginal 5 (4-7) long, ca. 1 wide (fig. j); marginal, similar morphologically to dorsal marginal setae 13 (12-14) long, ca. 2 wide (fig. k).

Anal lobes and ring. Sclerotized. With 1 submedial seta on each lobe, 54 (49-58) long. Ring oval 31 (30-33) long, ca. 41 wide; anal ring setae 64 (58-67) long.

Additional material studied. On *Quercus douglasii*, **CA**, Putah Creek, 3 mi. E Monticello Dam, Dec. 6, 1967, coll. JWB, 2(3), JWB. On *Q. garryana*, **OR**, Jackson Co., 9.2 mi. NE Ashland, Apr. 26, 1977, coll. RLP, 1(4), Jackson Co., 1 mi. NE Central Point, Apr. 26, 1977, coll. RLP, 2(3) VPI. On *Quercus* sp., **CA**, Danville, Mar. 28, 1958, colls. Seeley and Danielson, 1(1) CDA; San Mateo, 1(1) UCD.

Remarks. Ferris (1920) illustrated and briefly described the second instar female. The description lacked the important morphological characters needed for species recognition.

Kermes cockerelli second instar females can be distinguished by the following characters: 1) tubular ducts absent from dorsum; 2) abdominal venter with quinquelocular pores but absent along body margin; 3) 2 pairs of dorsal marginal setae on each abdominal segment; 4) with few or no simple pores on dorsal derm; 5) dorsal submedial setae on head, pro- and mesothorax thickened and similar to dorsal marginal setae; and 6) ventral seta on inner margin of anal lobe 49-58 long.

KERMES CONCINNULUS COCKERELL, FIRST INSTAR

Plate 16

Kermes concinnulus Cockerell, in Bogue 1898: 172.

Type material studied. Paralectotypes from *Quercus macrocarpa,* **KS,** Manhattan, (no date mentioned), coll. JBN, 1(1), USNM, 1(1) VPI.

Description. Body (fig. a) length 521 (438- 604), width 227 (211-242).

Dorsum

Marginal setae (fig. b). Long, thick, setaceous, ca. 42-48, these 27 (26-28) long, 3 (2-4) wide.

Marginal setae on anal lobe (fig. c). Longer and thicker than other marginal setae, ca. 33 long.

Submedial setae on head and thorax (fig. d). Thin, setaceous, similar to abdominal submedial setae, 4 pairs, 10 (9-12) long, ca. 1 wide.

Submedial setae on abdomen (fig. e). Thin, setaceous, 7 pairs, 8 (6-10) long, ca. 1 wide.

Simple pores (fig. f). In 4 longitudinal rows, ca. 40-46.

Derm (fig. g). Simple, membranous.

Intersegmental membrane (fig. h). Apparent due to type of derm.

Anal lobes (figs. a,i). Sclerotized. One thick seta on inner margin of each lobe, 31 (30-33) long; another at posterior end, 34 (33-35) long; apical seta ca. 166 long.

Venter

Antennae (fig. j). Total length 107 (104-109). Scape 20 (19-21) long, ca. 26 wide. Segments II to VI: 17 (16-19), 24 (23-26), 10 (9-12), ca. 12, ca. 23, long respectively. Trilocular pore at scape base (fig. k).

Clypeolabral shield. Length 91 (88-93), width 68 (65-72).

Labium. Length 63 (60-65), width 44 (42-46).

Derm (fig. l). Membranous.

Legs (fig. m). See enlargement of tibia, tarsus and claw of metathoracic leg. Four sensory pores on each trochanter (fig. n).

Leg Segments and Claw	Lengths Prothoracic	Lengths Mesothoracic	Lengths Metathoracic
Coxa	ca. 23	23 (21-26)	20 (19-21)
Trochanter	28 (26-30)	ca. 26	27 (26-28)
Femur	60 (58-63)	ca. 58	60 (58-63)
Tibia	30 (28-33)	ca. 33	34 (33-35)
Tarsus	45 (44-46)	ca. 49	ca. 51
Claw	20 (19-21)	ca. 19	ca. 21
Entire leg	207 (202-211)	ca. 205	212 (211-213)

Pores associated with spiracle (fig. o). Anterior spiracle, mostly with quinquelocular pores, occasionally a 7- locular pore, usually 3 associated with each spiracle. Each posterior spiracle with 1 pore, usually quinquelocular but sometimes 7-locular.

Bilocular pores (fig. p). Located near the bases of the submarginal and marginal setae. Usually associated with the anterior setae. Between 4-7 along each margin.

Submedial pores on derm (fig. q). In 2 submedial longitudinal rows. Four pairs on head and thorax, 5 pairs on abdomen, usually quinquelocular pores, sometimes triloculars.

Body setae (figs. r-v). In 8 longitudinal rows on abdomen and partly on thorax: medial 15 (14-16) long, ca. 1 wide (fig. r); submedial 8 (7-9) long, ca. 1 wide (fig. s); submarginal 9 (7-12) long, ca. 1 wide, (fig. t); marginal 15 (7-23) long, ca. 1 wide (fig. u). Posteriormost seta in marginal row thicker than rest in the row, 21 (19-23) long (fig. v).

Anal lobes and ring (figs. a,i). Sclerotized. With 1 submedial seta on each lobe, 24 (23-26) long. Ring oval, 12 (9-14) long, ca. 23 wide; anal ring setae ca. 24 (23-26) long; 1 pair of thick setae at the anterior margin of anal ring, each ca. 12 (11-13) long.

Additional material studied. On *Quercus alba*, **AL,** Madison Co., Huntsville, Jun. 7, 1975, coll. CHR, 2(6) AU; **IN,** Vincennes, Jul. 13, 1913, coll. HFD, 1(1) USNM; **MA,** Lawrence, Sep. 9, 1899, 2(10) AMNH; **MD,** Hagerstown, Greenhill Gardens, Jun. 7, 1972, coll. MLW, 2(6) AU; **PA,** Trappe, Jun. 12, 1946, coll. G. B. Sleesman, 2(6) USNM; **VA,** Montgomery Co., Becky Thompson's Riding Academy, Jun. 20, 1975, colls. RGB and ABH, 6(38) VPI; Christiansburg, May 22, 1963, colls. D. Carl and J. Holcomb, 2(6) VPI. On *Q. borealis*, **MA,** Lawrence, Sep. 9, 1899, 2(13) AMNH; Lawrence, coll. GBK,

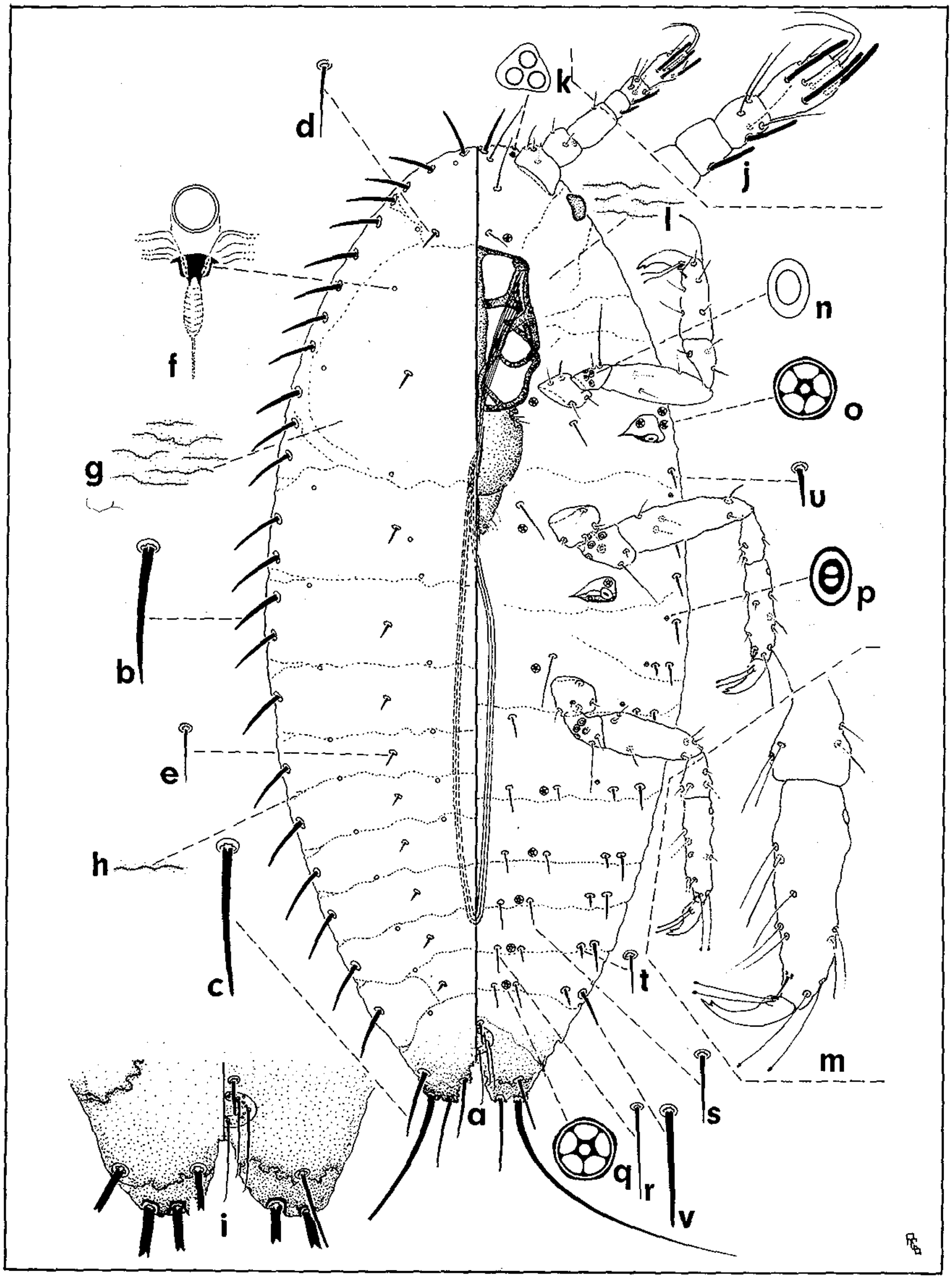


Plate 16. - *Kermes concinnulus* Cockerell, first instar

2(4) CAS. On *Q. lyrata*, **AL**, Auburn University, Comer Hall area, Jun. 8, 1976, colls. MLW and MK, 2(5) AU. On *Q. macrocarpa*, **OH**, Plain City, Jul. 9, 1960, coll. MK, 2(8) VPI. On *Q. nigra*, **OK**, Stillwater, Jun. 23, 1897, coll. EEB, 1(1) USNM. On *Q. prinus*, **OH**, Columbus, coll. JGS, 2(9) AMNH; **VA**, Craig Co., S. of Newcastle, Rt. 42, Overlook, Jun. 4, 1977, colls. MMK, 3(19) VPI. On *Q. stellata*, **GA**, Experiment, Jun. 8, 1976, colls. JOH, RB and MK, 2(5) VPI. On *Quercus* sp., **AL**, Birmingham, May 12, 1925, coll. E. E. Ellis, 2(5) USNM; **AZ**, near Flagstaff, Walnut Creek Canyon, coll. EME, 4(4) USNM; **GA**, Atlanta, coll. W. M. Scott, 7(48) USNM, 3(18) VPI, 2(12) UCD; **IN**, Noglesville, May 22, 1916, coll. HM, 5(54) USNM, 3(23) VPI, 1(7) UCD.

Remarks. The first instars of *Kermes concinnulus* Cockerell cannot be differentiated from *Kermes andrei* (King 1900a) and *K. ceriferus* (Ehrhorn 1899a). The type descriptions of the latter two species contained no useful morphological characters in species recognition. *K. concinnulus* is designated here to represent a group of species including *K. cockerelli*, *K. prinus*, *K. rimarum* and *K. shastensis*. All these species have relatively long or parallel sided dorsal marginal setae and quinquelocular pores in rows on the venter.

Kermes concinnulus can be distinguished by the following characters: 1) 1 pair of dorsal marginal setae on each abdominal segment; 2) setaceous dorsal marginal setae 19-48 long; 3) dorsal submedial setae on head, pro- and mesothorax slender, small and different from the dorsal marginal setae; 4) 3 pores laterad of each anterior spiracle; 5) 4 - 7 bilocular pores along each ventral body margin; 6) terminal antennal segment 21-25 long.

Kermes concinnulus is found in central and eastern U.S. on *Quercus alba*, *Q. borealis*, *Q. lyrata*, *Q. macrocarpa*, *Q. nigra*, *Q. prinus* and *Q. stellata*.

Bullington and Kosztarab (1985) were not able to separate *K. concinnulus* adult females from other species, and they included this species in the unplaced species category because the specimens available to them were all distorted, sclerotized, post- reproductive females. Based on the available paralectotypes first and second instars, *K. concinnulus* appears to be a valid species.

KERMES CONCINNULUS COCKERELL, SECOND INSTAR MALE

Plate 17

Kermes concinnulus Cockerell, in Bogue 1898:172.

Material studied. On *Quercus alba*, VA, Montgomery Co., Radford, Dec. 12, 1970, coll. MK, 1(1), USNM.

Description. Body (fig. a) ca. 1148 long, ca. 606 wide.

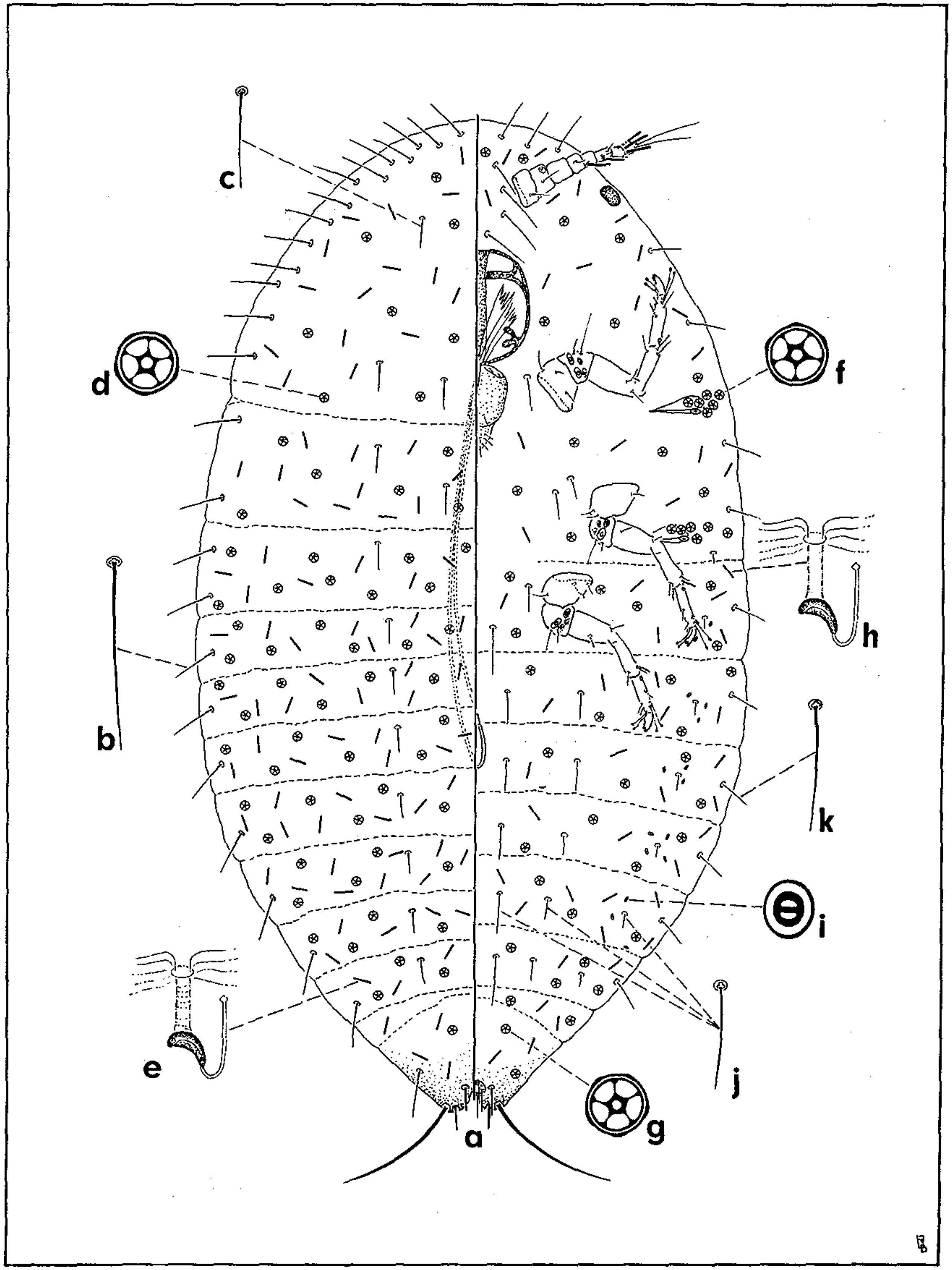


Plate 17. - *Kermes concinnulus* Cockerell, second instar male

Dorsum

Marginal setae (fig. b). Very long thin, setaceous, ca. 52, these ca. 83 long, ca. 2 wide.

Submedial setae (fig. c). In 4 longitudinal rows, 2-4 pairs in medial row, 11 pairs in submedial row, these ca. 47 long, ca. 2 wide.

Quinquelocular pores (fig. d). Scattered over derm, ca. 100.

Simple pores. Absent.

Tubular ducts (fig. e). Distributed throughout derm, ca. 150-225; ca. 22 long.

Anal lobes. Sclerotized. One seta on inner margin of each lobe, ca. 33 long, another at posterior end, ca. 28 long; apical seta ca. 123 long.

Venter

Antennae. Total length ca. 135. Scape ca. 23 long, ca. 49 wide. Segments II to VII: ca. 19, 28, 12, 16, 14, 23 long respectively.

Clypeolabral shield. Length ca. 144, width ca. 116.

Labium. Length ca. 102, width ca. 90.

Legs. See chart below.

Leg Segments and Claw	Lengths Prothoracic	Lengths Mesothoracic	Lengths Metathoracic
Coxa	ca. 47	ca. 47	ca. 47
Trochanter	ca. 53	ca. 47	ca. 47
Femur	ca. 77	ca. 77	ca. 83
Tibia	ca. 71	ca. 65	ca. 71
Tarsus	ca. 65	ca. 70	ca. 71
Claw	ca. 20	ca. 20	ca. 20
Entire leg	ca. 333	ca. 326	ca. 339

Pores associated with spiracle (fig. f). Each anterior and posterior spiracle with 5-7 quinquelocular pores.

Quinquelocular pores on derm (fig. g). Scattered over derm, ca. 100.

Tubular ducts (fig. h). Less numerous than on dorsum, ca. 100, about the same size and shape as those on dorsum.

Bilocular pores (fig. i) Located near the bases of the submarginal and marginal setae, ca. 15 along each margin.

Body setae (figs. j,k). In 8 longitudinal rows on abdomen and partly on head and thorax: medial ca. 71 long (fig. j); submedial ca. 35 long (fig. j); marginal ca. 20 long (fig. j); marginal ca. 70 long (fig. k). All ca. 2 wide.

Anal lobes and ring. Sclerotized. With 1 submedial seta on each lobe, ca. 42 long. Ring oval, ca. 21 long, ca. 35 wide; anal ring setae ca. 30 long.

Remarks. The first instars of *K. concinnulus* were designated to represent a group of species allied to *K. cockerelli*, *K. prinus*, *K. rimarum* and *K. shastensis*. Existing second instar males are also similar in morphology. All have quinquelocular pores on their dorsum.

Kermes concinnulus second instar males can be distinguished by the following characters: 1) quinquelocular pores scattered over entire dorsal and ventral derm; 2) dorsal and ventral marginal setae thin, setaceous; 3) without simple pores on the dorsum; 4) dorsal marginal setae 63-100 long; 5) antenna ca. 135 long; and 6) anal ring setae ca. 30 long.

KERMES CONCINNULUS COCKERELL, SECOND INSTAR FEMALE

Plate 18

Kermes concinnulus Cockerell, in Bogue 1898:172.

Material studied. On *Quercus prinus*, CT, Portland, Portland Country Club, Nov. 21, 1975, colls. M. McClure and K. Welch, 2(8), CAES, 1(4) USNM, 1(5) VPI. On *Q. stellata*, VA, Radford, Becky Thompson's Riding Academy, Jan. 13, 1976, colls. RGB, ABH and MK, 1(1) VPI.

Description. Body (fig. a) length 941 (755-1223), width 434 (317-498).

Dorsum

Marginal setae (fig. b). Thickened, 2 pairs on each abdominal segment, ca. 68-72 total pairs, these 35 (30-47) long, 6 (5-7) wide.

Submedial setae (fig. c). In 2 longitudinal rows, 11 pairs, reduced to small rounded setae, ca. 2 long, ca. 1 wide.

Simple pores (fig. d). Randomly distributed on derm, ca. 100-150, dia. ca. 2.

Tubular ducts Absent.

Anal lobes. Sclerotized. One seta on inner margin of each lobe, 23 (18-29) long, another at posterior end 22 (18-23) long; apical seta 123 (105-151) long.

Venter

Antennae. Total length 157 (140-177). Scape 18 (16-24) long, 44 (40-53) wide. Segments II to VI: 17 (16-19), 53 (47-71), 17 (16-19), 17 (16-19), 34 (28-37) long respectively.

Clypeolabral shield. Length 138 (120-166), width 123 (91-151).

Labium. Length 107 (91-123), width 81 (60-91).

Legs. See chart below.

Leg Segments and Claw	Lengths Prothoracic	Lengths Mesothoracic	Lengths Methathoracic
Coxa	38 (33-44)	40 (33-44)	40 (33-47)
Trochanter	40 (39-44)	41 (39-44)	44 (41-46)
Femur	82 (74-88)	84 (76-88)	89 (85-93)
Tibia	59 (56-63)	58 (53-63)	62 (56-65)
Tarsus	77 (74-79)	83 (76-88)	94 (90-97)
Claw	16 (14-19)	16 (14-19)	16 (13-19)
Entire leg	312 (300-318)	323 (298-338)	345 (334-359)

Pores associated with spiracle (fig. e). Each anterior spiracle with 5 quinquelocular pores; each posterior spiracle with 1 quinquelocular pore.

Quinquelocular pores on derm (fig. f). Arranged in 7 longitudinal rows on abdomen, ca. 35; also ca. 200 near coxal areas and along body margin and submargin.

Tubular ducts (fig. g). Along submargin and near coxal areas, ca. 70.

Bilocular pores (fig. h). Located near the bases of the submarginal setae, ca. 12 along each margin.

Body setae (figs. i,j). In 6 longitudinal rows on abdomen and partly on thorax: medial 29 (21-44) long, ca. 2 wide (fig. i); submedial 14 (12-16) long, ca. 2 wide (fig. i); submarginal 9 (7-14) long, ca. 2 wide (fig. i). Several marginal setae from mesothorax to head region, ca. 8 pairs, similar morphologically to dorsal marginal setae, 20 (18-24) long, ca. 4 wide (fig. j).

Anal lobes and ring. Sclerotized. With 1 submedial seta on each lobe, 51 (44-56) long. Ring oval 30 (23-37) long, 35 (28-41) wide; anal ring setae 49 (41-56) long.

Remarks. *Kermes concinnulus* second instar females can be distinguished by the following characters: 1) tubular ducts absent from dorsum; 2) abdominal venter and ventral body margin with quinquelocular pores; 3) 2 pairs of dorsal

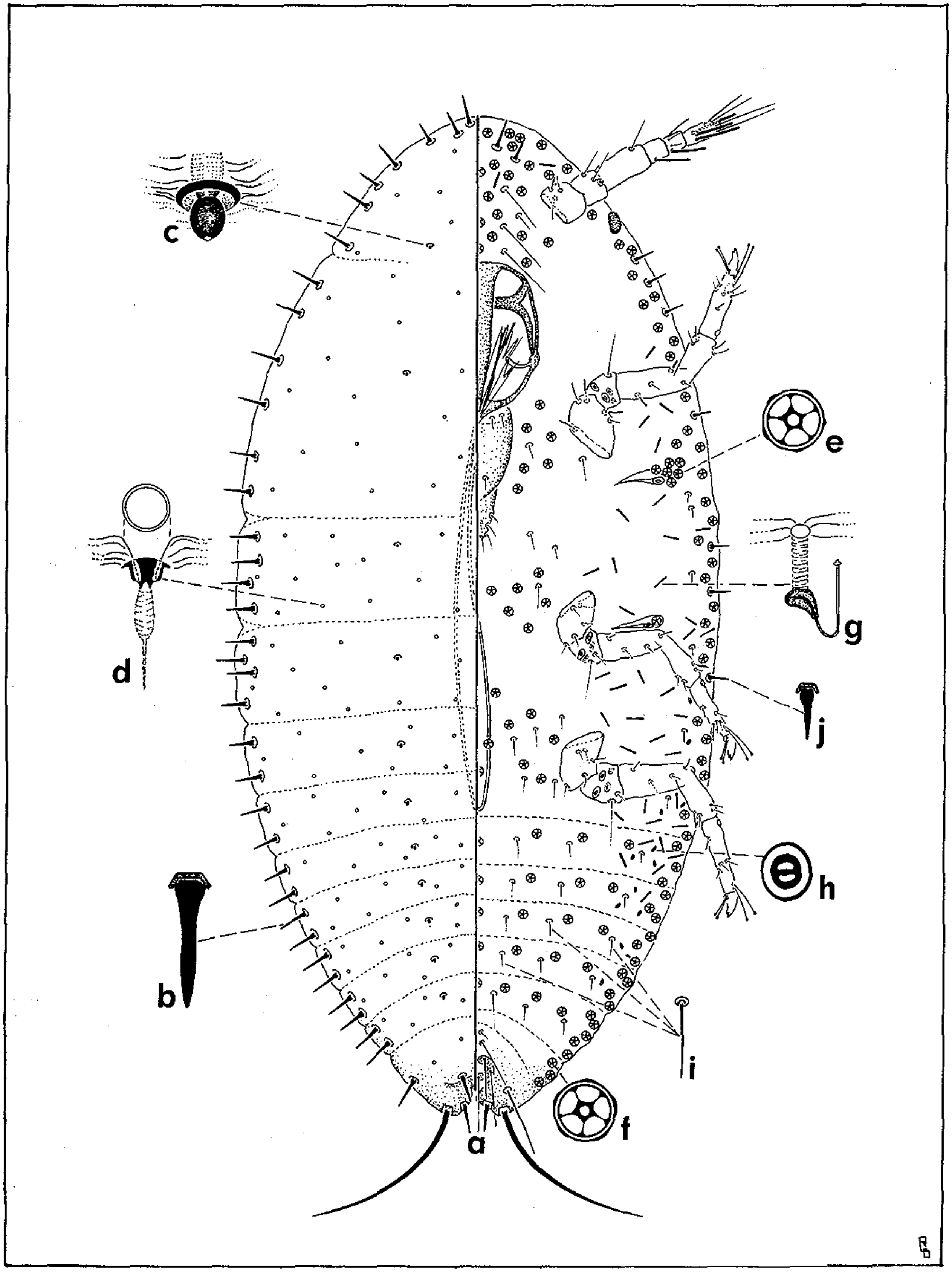


Plate 18. - *Kermes concinnulus* Cockerell, second instar female

marginal setae on each abdominal segment; and 4) with 100-150 pores on dorsal derm.

KERMES PRINUS BAER & KOSZTARAB, FIRST INSTAR

Plate 19

Kermes prinus Baer & Kosztarab, 1981: 226.

Type material studied. Holotype and paratype series from twigs near bud regions of *Quercus prinus*, WV, Pipestem State Park, June 27, 1978, colls. M., M., and E. Kosztarab and D. and M. Suhayda, 5(18) USNM, 4 (13)BM, 4(16) UCD, 4(12) VPI.

Description. Body (fig. a). Oblong, widest at mesothorax. Length 550 (513-563), width 250 (225-263).

Dorsum

Marginal setae (fig. b). Long, thick, setaceous, ca. 42-48, 26 (23-33) long, 4 (3-4) wide. Each abdominal segment with 1 pair of dorsal marginal setae.

Marginal setae on anal lobe (fig. c). Longer and thicker than other marginal setae, 37 (28-39) long; 5 (4-5) wide.

Submedial setae on head and thorax (fig. d). Thick, setaceous, similar to abdominal submedial setae, 4 pairs, 25 (15-26) long, 3 (3-4) wide.

Submedial setae on abdomen (fig. e). Thick, setaceous, 7 pairs, 22 (17-26) long, ca. 1 wide.

Simple pores (fig. f). Composed of sclerotized ring, opening into a membranous duct, arranged in 4 longitudinal rows, 34-46 pores.

Derm (fig. g). Simple, membranous.

Intersegmental membrane (fig. h). Apparent due to type of derm.

Anal lobes (figs. a,i). Sclerotized. One thick seta on inner margin of each lobe, 32 (27-33) long. Another of posterior end, 36 (32-37) long; apical seta 166 (125-168) long.

Venter

Antennae (fig. j). Total length 101 (88-106). Scape 13 (12-15) long, 37 (27-37) wide. Segments II to VI: 15 (15-19), 25 (23-25), 9 (9-12), 13 (12-14), 26 (24-28) long respectively. Trilocular pore at scape base (fig. k). Segment I with 3 slender setae, II with 2 slender setae and one sensory pore, III with

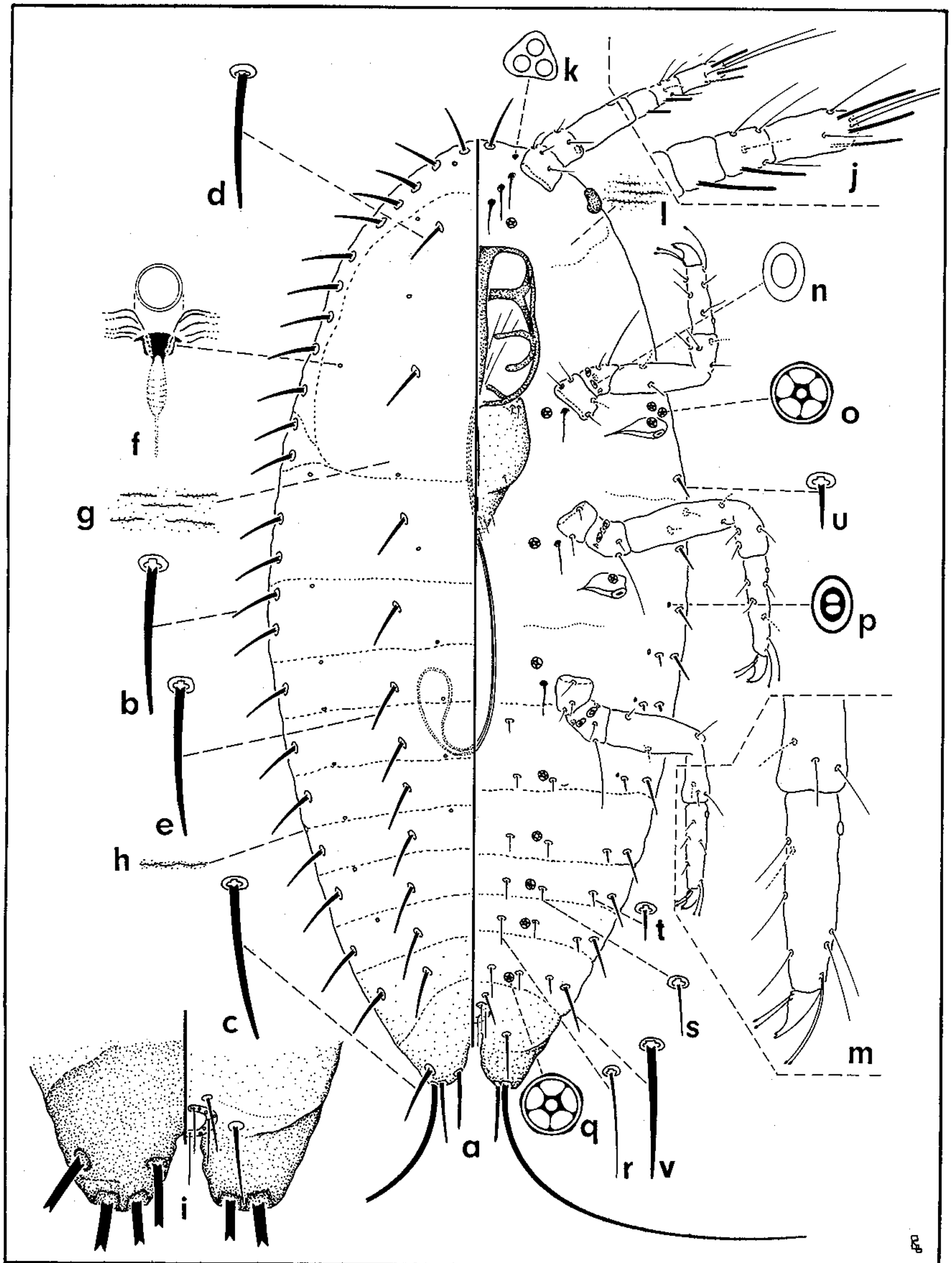


Plate 19. - *Kermes prinus* Baer and Kosztarab, first instar

1 slender seta, IV with 1 fleshy seta, V with 4 slender setae and 1 fleshy seta and VI with 4-5 slender setae and 3 fleshy setae.

Clypeolabral shield. Length 101 (97-110), width 71 (68-72). Looped stylets extending to the first or second abdominal segments.

Labium. Triangular shaped, composed of 3 distinct parts. The anterior part with 2 pairs of setae, the middle part with 1 pair of setae and the posterior part with 4 pairs of setae. Length 81 (78-83), width 58 (48-62).

Derm (fig. l). Membranous.

Legs (fig. m). Sclerotized. Numerous, slender setaceous setae on each segment. Sensory pore on lateral margin of each tarsus. See enlargement of tibia, tarsus and claw of metathoracic leg (fig. m). Four sensory pores on each trochanter (fig. n).

Leg Segments and Claw	Lengths Prothoracic	Lengths Mesothoracic	Lengths Metathoracic
Coxa	26 (24-30)	26 (23-27)	26 (22-27)
Trochanter	26 (24-29)	30 (24-30)	31 (26-32)
Femur	70 (64-70)	68 (58-70)	70 (64-71)
Tibia	37 (30-37)	35 (32-39)	39 (34-40)
Tarsus	52 (47-53)	54 (53-58)	57 (56-59)
Claw	19 (19-20)	23 (19-23)	23 (19-23)
Entire leg	230 (210-237)	236 (215-245)	243 (231-253)

Pores associated with spiracles (fig. o). Each anterior spiracle with 3 quinquelocular pores, occasionally a trilocular pore. Each posterior spiracle with 1 quinquelocular pore. Dia. ca. 4. Anterior spiracle 15 (13-16) long, 5 (4-6) wide, atrium ca. 2 wide. Posterior spiracle 14 (13-17) long, 5 (5-8) wide, atrium ca. 2 wide.

Bilocular pores (fig. p). Located near the bases of the submarginal setae. Usually associated with the anterior setae. Four to 7 along each margin.

Submedial pores on derm (fig. q). In 2 submedial longitudinal rows. Four pairs on head and thorax, 5 pairs on abdomen, usually quinqueloculars but sometimes several triloculars in each row, dia. ca.4.

Body setae (figs. r-v). In 8 longitudinal rows on abdomen and partly on thorax: medial 15 (9-19) long, ca. 1 wide (fig. r); submedial 8 (7-10) long, ca. 1 wide (fig. s); submarginal 9 (7-10) long, ca. 1 wide (fig. t); marginal 15 (12-24) long, ca. 2 wide (fig. u). Posteriormost seta in marginal row thicker than rest in the row 20 (18-26) long (fig. v). Other longer setaceous setae near coxae and antennal bases. One pair of setae similar morphologically to dorsal marginal setae on anterior margin of head.

Anal lobes and ring (figs. a,i). Sclerotized. With 1 submedial seta on each lobe 21 (13-23) long. Ring oval 12 (9-14) long, ca. 20 wide, with 14-20 translucent cells and 6 anal ring setae ca. 19 long; 1 pair of thick setae at the anterior margin of anal ring 19 (16-23) long.

Remarks. *Kermes prinus* is closely allied to *Kermes concinnulus* Cockerell, *K. cockerelli* Ehrhorn (1898), *K. shastensis* Ehrhorn (1911) and *K. rimarum* Ferris (1955b).

KERMES RIMARUM FERRIS, FIRST INSTAR

Plate 20

Kermes rimarum Ferris, 1955b:202.

Type material studied. Paralectotypes from *Quercus "utahensis,"* NM, 30 mi. from Las Vegas, Beulah, Jul. 17, 1947, coll. GFF, 9(22) UCD, 4(7) VPI, 2(2) USNM.

Description. Body (fig. a) length 538 (438-649), width 270 (227-317).

Dorsum

Marginal setae (fig. b). Long, thick, setaceous, ca. 46-48, these 25 (19-35) long, 3 (2-5) wide.

Marginal setae on anal lobe (fig. c). Longer and thicker than other marginal setae, 36 (27-42) long.

Submedial setae on head and thorax (fig. d). Thin setaceous, similar to abdominal submedial setae, 4 pairs, 12 (10-14) long, ca. 1 wide.

Submedial setae on abdomen (fig. e). Thin setaceous, 7 pairs, 9 (7-12) long, ca. 1 wide.

Simple pores (fig. f). In 4 longitudinal rows, ca. 40-44.

Derm (fig. g). Simple, membranous.

Intersegmental membrane (fig. h). Apparent due to type of derm.

Anal lobes (figs. a,i). Sclerotized. One thick seta on inner margin of each lobe 34 (30-37) long, another at posterior end, 35 (30-39) long; apical seta 136 (100-166) long.

Venter

Antennae (fig. j). Total length 104 (107-121). Scape 17 (14-21) long, 29 (26-33) wide. Segments II to VI: 15 (14-16), 29 (26-33), 12 (9-16), 14 (12-16), 28 (26-30) long respectively. Trilocular pore at scape base (fig. k).

Clypeolabral shield. Length 102 (97-107), width 69 (63-74).

Labium. Length 78 (72-88), width 52 (42-70).

Derm (fig. l). Membranous.

Legs (fig. m). See enlargement of tibia, tarsus and claw of metathoracic leg. Four sensory pores on each trochanter (fig. n).

Leg Segments and Claw	Lengths Prothoracic	Lengths Mesothoracic	Lengths Metathoracic
Coxa	21 (19-23)	22 (21-23)	23 (18-28)
Trochanter	29 (28-35)	28 (23-33)	28 (26-33)
Femur	64 (60-67)	65 (63-67)	62 (67-72)
Tibia	35 (28-39)	35 (33-39)	37 (35-39)
Tarsus	53 (49-56)	57 (53-58)	61 (58-65)
Claw	18 (16-21)	20 (19-23)	21 (19-23)
Entire leg	221 (204-234)	223 (227-236)	237 (225-246)

Pores associated with spiracle (fig. o). Each anterior spiracle usually with 3 quinquelocular pores. Each posterior spiracle with 1 quinquelocular pore.

Bilocular pores (fig. p). Located near the bases of the marginal and submarginal setae. Between 8-10 along each margin.

Submedial pores on derm (fig. q). In 2 submedial longitudinal rows. Four pairs on head and thorax, 5 pairs on abdomen, usually quinqueloculars, sometimes triloculars.

Body setae (figs. r-v). In 8 longitudinal rows on abdomen and partly on thorax: medial 15 (9-30) long, ca. 1 wide (fig. r); submedial 10 (7-16) long, ca. 1 wide (fig. s); submarginal 9 (5-12) long, ca. 1 wide (fig. t); marginal 13 (6-30) long, ca. 2 wide (fig. u). Posteriormost seta in marginal row thicker than rest in the row, 27 (21-33) long (fig. v).

Anal lobes and ring (figs. a,i). Sclerotized. With 1 submedial seta on each lobe, 33 (21-42) long. Ring oval, 18 (13-20) long, 26 (23-29) wide; anal ring setae 30 (26-33) long; 1 pair of thick setae at the anterior margin of anal ring, 18 (14-26) long.

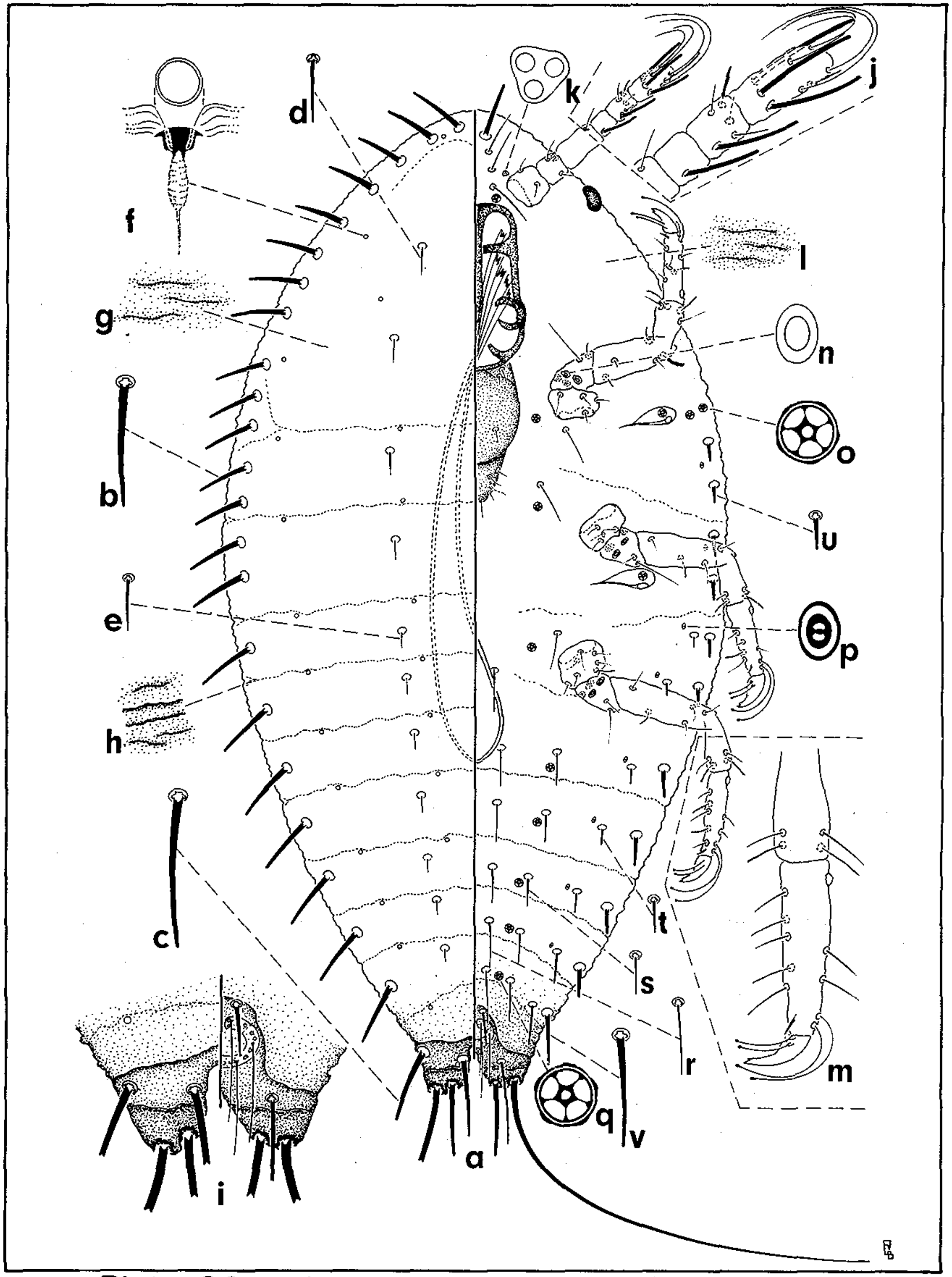


Plate 20. - *Kermes rimarum* Ferris, first instar

Additional material studied. On *Quercus gambelii*, NM, San Miguel Co., 9 mi. W of Sapello, Beulah, Jun. 2, 1976, coll. WAI, 3(14) VPI (topotypes). On *Quercus* sp., CO, LaVeta Pass, Jul. 13, 1947, coll. GFF, 3(5) UCD.

Remarks. The original species description did not mention the first instar. *K. rimarum* is closely allied to the *K. concinnulus* group. Species included in this group have relatively long setaceous or parallel-sided dorsal marginal setae and quinquelocular pores on the venter.

Kermes rimarum can be distinguished by the following characters: 1) Presence of 1 dorsal marginal seta on each abdominal segment; 2) dorsal marginal setae 19-48 long; 3) dorsal submedial setae on head, pro- and mesothorax slender, small and different from the dorsal marginal setae; 4) 8-10 bilocular pores along each ventral body margin; and 5) terminal antennal segment 26-30 long.

K. rimarum is a bark-infesting species found in Colorado and New Mexico on *Quercus "utahensis"*.

KERMES RIMARUM FERRIS, SECOND INSTAR MALE

Plate 21

Kermes rimarum Ferris, 1955b: 202.

Type material studied. Paralectotypes from *Quercus "utahensis,"* NM, 30 mi. from Las Vegas, Beulah, Jul. 15, 1947, coll. GFF, 10(23) UCD, 5(8) VPI, 2(6) USNM.

Description. Body (fig. a) length 1259 (906-1464), width 664 (558-785).

Dorsum

Marginal setae (fig. b). Thin, setaceous, ca. 52, these 79 (65-100) long, ca. 2 wide.

Submedial setae (fig. c). In 4 longitudinal rows, 3 pairs in medial row, 11 pairs in submedial row, these 35 (29-43) long, ca. 2 wide.

Quinquelocular pores (fig. d). Randomly scattered over derm, ca. 100.

Simple pores. Absent.

Tubular ducts (fig. e). Distributed throughout derm, ca. 225-300.

Anal lobes. Sclerotized. One seta on inner margin of each lobe, 31 (23-35) long, another at posterior end 23 (22-24) long; apical seta 153 (120-183) long.

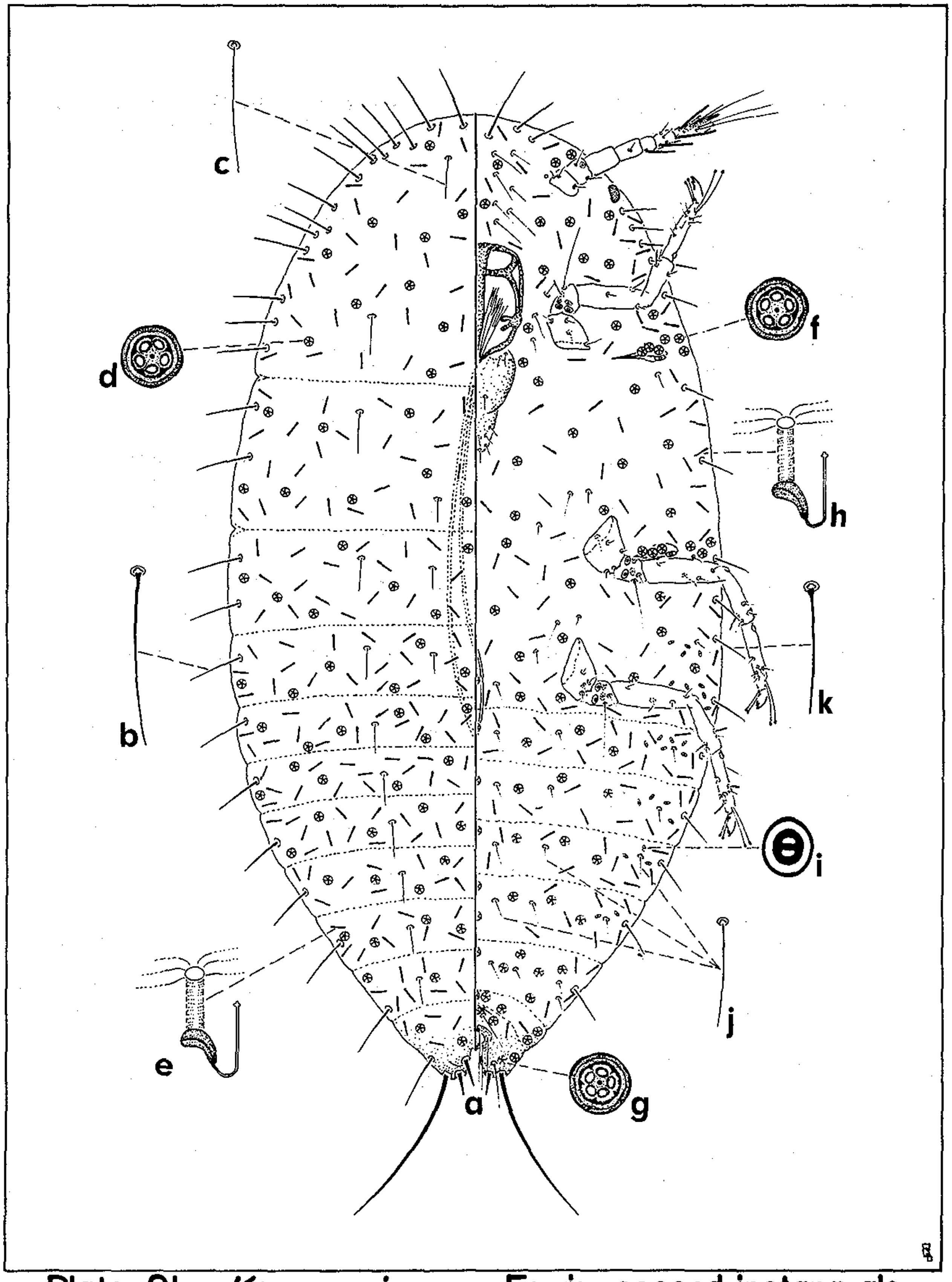


Plate 21. - *Kermes rimarum* Ferris, second instar male

Venter

Antennae. Total length 188 (179-201). Scape 27 (23-30) long, 41 (38-44) wide. Segments II to VII: 21 (18-24), 42 (35-47), 29 (26-30), 16 (14-18), 18 (16-19), 25 (23-28) long respectively.

Clypeolabral shield. Length 140 (120-149), width 123 (106-136).

Labium. Length 110 (90-136), width 89 (76-106).

Legs. See chart below.

Leg Segments and Claw	Lengths Prothoracic	Lengths Mesothoracic	Lengths Metathoracic
Coxa	47 (44-51)	48 (45-52)	49 (44-53)
Trochanter	52 (48-56)	51 (49-53)	46 (44-48)
Femur	93 (88-97)	92 (88-95)	91 (89-96)
Tibia	78 (72-84)	78 (74-86)	79 (74-84)
Tarsus	89 (86-93)	90 (86-93)	92 (88-97)
Claw	22 (19-26)	21 (19-24)	20 (19-24)
Entire leg	381 (364-388)	386 (374-396)	391 (378-401)

Pores associated with spiracle (fig. f). Each anterior and posterior spiracle with 5-7 quinquelocular pores.

Quinquelocular pores on derm (fig. q). Randomly scattered over derm, ca. 125.

Tubular ducts (fig. h). Less numerous than on dorsum, distributed throughout the derm, about the same size and shape as those on dorsum.

Bilocular pores (fig. i). Located near the bases of the submarginal and marginal setae, ca. 15 along each margin.

Body setae (figs. j,k). In 8 longitudinal rows on abdomen and partly on head and thorax: medial 66 (51-112) ca. 2 wide (fig. j); submedial 38 (35-41) long, ca. 2 wide (fig. j); submarginal 28 (22-30) long, ca. 2 wide (fig. j); marginals, similar to dorsal marginals, 48 (41-59) long, ca. 2 wide (fig. k).

Anal lobes and ring. Sclerotized. With 1 submedial seta on each lobe, 42 (37-46) long. Ring oval, 31 (28-35) long, 35 (33-37) wide; anal ring setae 44 (38-47) long.

Remarks. Second instar males were found along with second instar females and first instars in bark crevices.

Based on first instar morphology, *Kermes rimarum* was placed in the *K. concinnulus* group, which includes *K. cockerelli*, *K. concinnulus* and *K. shastensis*. The second instar males of *K. rimarum* were also morphologically similar to the included species (except *K. shastensis* where no male second instars were available). Second instar males in this group have long, thin dorsal marginal setae and quinquelocular pores on the dorsum.

Kermes rimarum second instar males can be distinguished by the following characters: 1) quinquelocular pores with small loculi, these scattered over entire dorsal and ventral derm; 2) dorsal and ventral marginal setae thin, setaceous; 3) simple pores on the dorsum absent; 4) dorsal marginal setae 63-100 long; 5) antenna 179-202 long; and 6) anal ring setae 38-47 long.

KERMES RIMARUM FERRIS, SECOND INSTAR FEMALE

Plate 22

Kermes rimarum Ferris, 1955b: 202.

Type material studied. Paralectotypes from *Quercus "utahensis,"* NM, 30 mi. from Las Vegas, Beulah, Jul. 15, 1947, coll. GFF, 3(3) UCD, 2(3) VPI, 1(1) USNM.

Description. Body (fig. a) length 1223 (1087-1434), width 722 (453-906).

Dorsum

Marginal setae (fig. b). Thick, straight, 2 pairs on each abdominal segment, ca. 70, these 62 (53-71) long, 8 (7-9) wide.

Submedial setae (fig. c). In 2 longitudinal rows, 11 pairs, 3 (2-5) long, ca. 1 wide, occasionally 1 pair located medially to those on thorax.

Simple pores. Absent.

Tubular ducts (fig. f). Few along submargin.

Anal lobes. Sclerotized. One seta on inner margin of each lobe, 13 (12-14) long, another at posterior end 14 (12-15) long; apical seta 200 (181-226) long.

Venter

Antennae. Total length 185 (178-191). Scape 30 (27-33) long, 40 (37-44) wide. Segments II to VI: 21 (19-24), 65 (62-70), 21 (18-24), 19 (18-21), 29 (26-33) long respectively.

Clypeolabral shield. Length 84 (59-147), width 61 (47-89).

Labium. Length 66 (53-118), width 50 (35-89).

Legs. See chart below.

Leg Segments and Claw	Lengths Prothoracic	Lengths Mesothoracic	Lengths Metathoracic
Coxa	40 (33-47)	46 (42-53)	46 (42-53)
Trochanter	44 (41-47)	53 (49-56)	50 (47-53)
Femur	95 (88-104)	95 (88-102)	96 (83-107)
Tibia	69 (65-74)	65 (60-67)	61 (53-67)
Tarsus	93 (88-95)	93 (89-102)	104 (89-124)
Claw	22 (19-24)	21 (19-24)	22 (19-24)
Entire leg	361 (355-369)	374 (359-386)	370 (334-425)

Pores associated with spiracle (fig. d). Each anterior spiracle with 5 or 6 quinquelocular pores. Each posterior spiracle with 3 quinquelocular pores.

Quinquelocular pores on derm (fig. e). In 5 longitudinal rows on abdomen, also, several near coxal and antennal scape bases.

Tubular ducts (fig. f). Mainly along submargin and at coxal areas, ca. 100.

Bilocular pores (fig. g). Located near the bases of the submarginal setae, ca. 7-10.

Body setae (figs. h,i). In 8 longitudinal rows on abdomen and partly on thorax and head: medial 58 (41-77) long, ca. 2 wide (fig. h); submedial 26 (18-35) long, ca. 2 wide (fig. h); submarginal 16 (12-24) long, ca. 2 wide (fig. h); marginal, similar morphologically to dorsal marginal setae, 35 (24-59) long, 7 (5-9) wide (fig. i).

Anal lobes and ring. Sclerotized. With 1 submedial seta on each lobe, 31 (30-33) long. Ring oval, 20 (19-21) long, 19 (16-21) wide; anal ring setae 33 (30-35).

Remarks. *K. rimarum* second instar females can be distinguished by the following characters: 1) tubular ducts absent from dorsum; 2) abdominal venter with quinquelocular pores, but absent along body margin; 3) 2 pairs of dorsal marginal setae on each abdominal segment; 4) with few or no simple pores on dorsal derm; 5) dorsal submedial setae on head, pro- and mesothorax reduced to small slender setae and these not similar to dorsal marginal setae; and 6) ventral seta on inner margin of anal lobe 30-33 long.

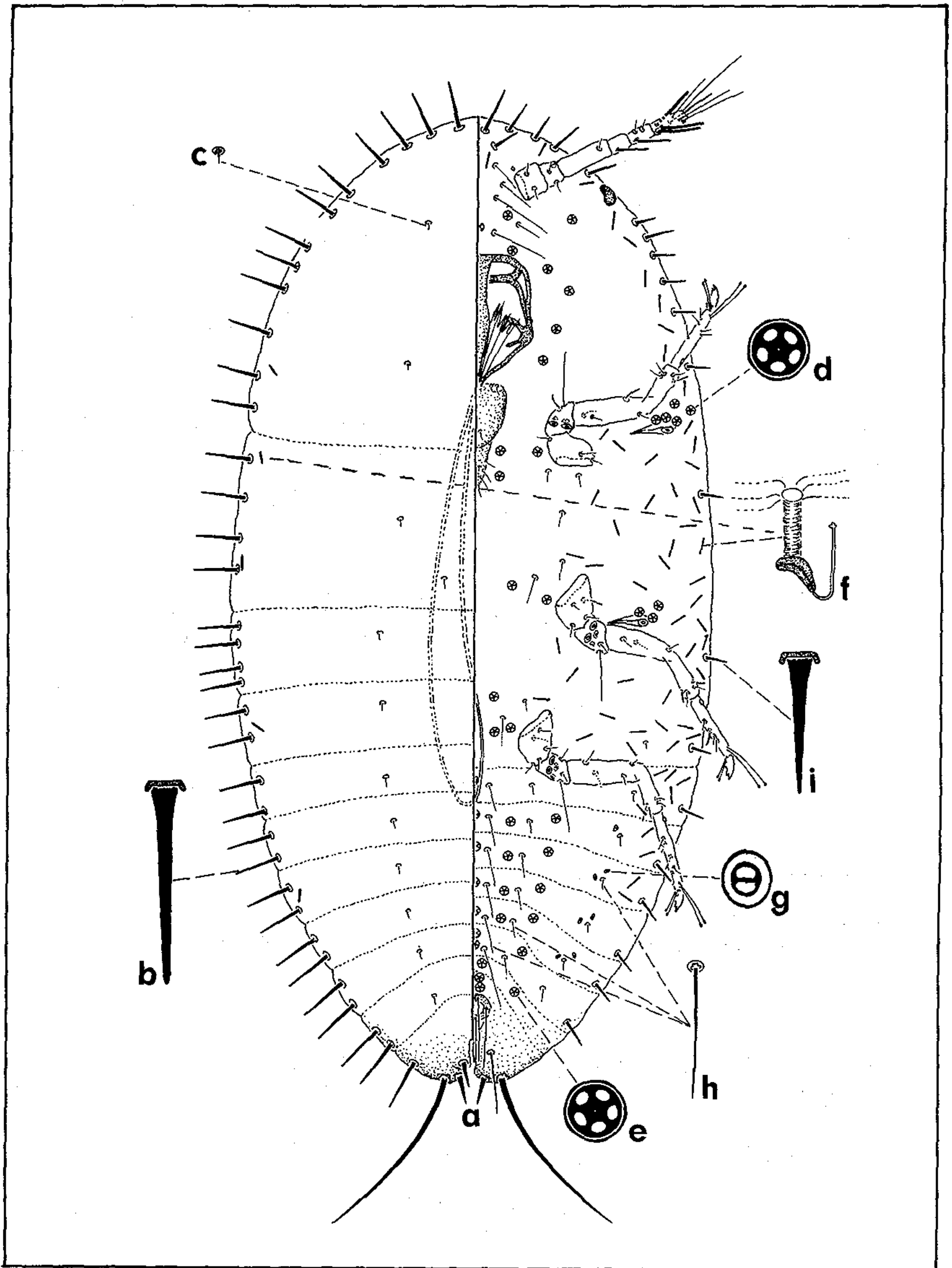


Plate 22. - *Kermes rimarum* Ferris, second instar female

KERMES SHASTENSIS EHRHORN, FIRST INSTAR

Plate 23

Kermes shastensis Ehrhorn, 1911: 275.

Type material studied. Topotypes on *Quercus chrysolepis*, **CA,** Siskiyou Co., near Shasta Springs, Colls. MMK, Jul. 7, 1976, 4(19) VPI. *Quercus* sp., Shasta Springs, May 20, 1976, coll. RJG, 5(30) CDA, 2(7) VPI, 2(19) USNM, 1(8) UCD.

Description. Body (fig. a) length 492 (468- 544), width 236 (227-242).

Dorsum

Marginal setae (fig. b). Parallel sided, blunt or slightly pointed at apex, ca. 42-48, these morphologically similar along entire body margin. Length 17 (14-24), width 3 (2-5).

Marginal setae on anal lobe (fig. c). Longer and thinner at apex than other marginal setae, 30 (26-33) long.

Submedial setae on head and thorax (fig. d). Parallel sided, blunt at apex on head, pro- and mesothorax, similar to dorsal marginal setae, 3 pairs, 15 (12-16) long, ca. 3 wide. Metathorax with 1 pair, thin, setaceous, similar to submedial setae on abdomen, ca. 12 long.

Submedial setae on abdomen (fig. e). Thin, setaceous, 7 pairs, 9 (7-11) long, ca. 1 wide.

Simple pores (fig. f). In 4 longitudinal rows, ca. 38-45.

Derm (fig. g). Simple, membranous.

Intersegmental membrane (fig. h). Apparent due to type of derm.

Anal lobes (figs. a,i). Sclerotized. One thick seta on inner margin of each lobe, 23 (21-24) long, another at posterior end, 23 (21-26) long; apical seta 127 (106-142) long.

Venter

Antennae (fig. j). Total length 114 (107-121). Scape 16 (14-19) long, 32 (28-37) wide. Segments II to VI: 18 (14-21), 27 (23-30), 12 (11-14), 14 (12-15), 29 (28-33) long, respectively. Trilocular pore at scape base (fig. k).

Clypeolabral shield. Length 97 (84-103), width 70 (67-74).

Labium. Length 85 (72-95), width 55 (51-63).

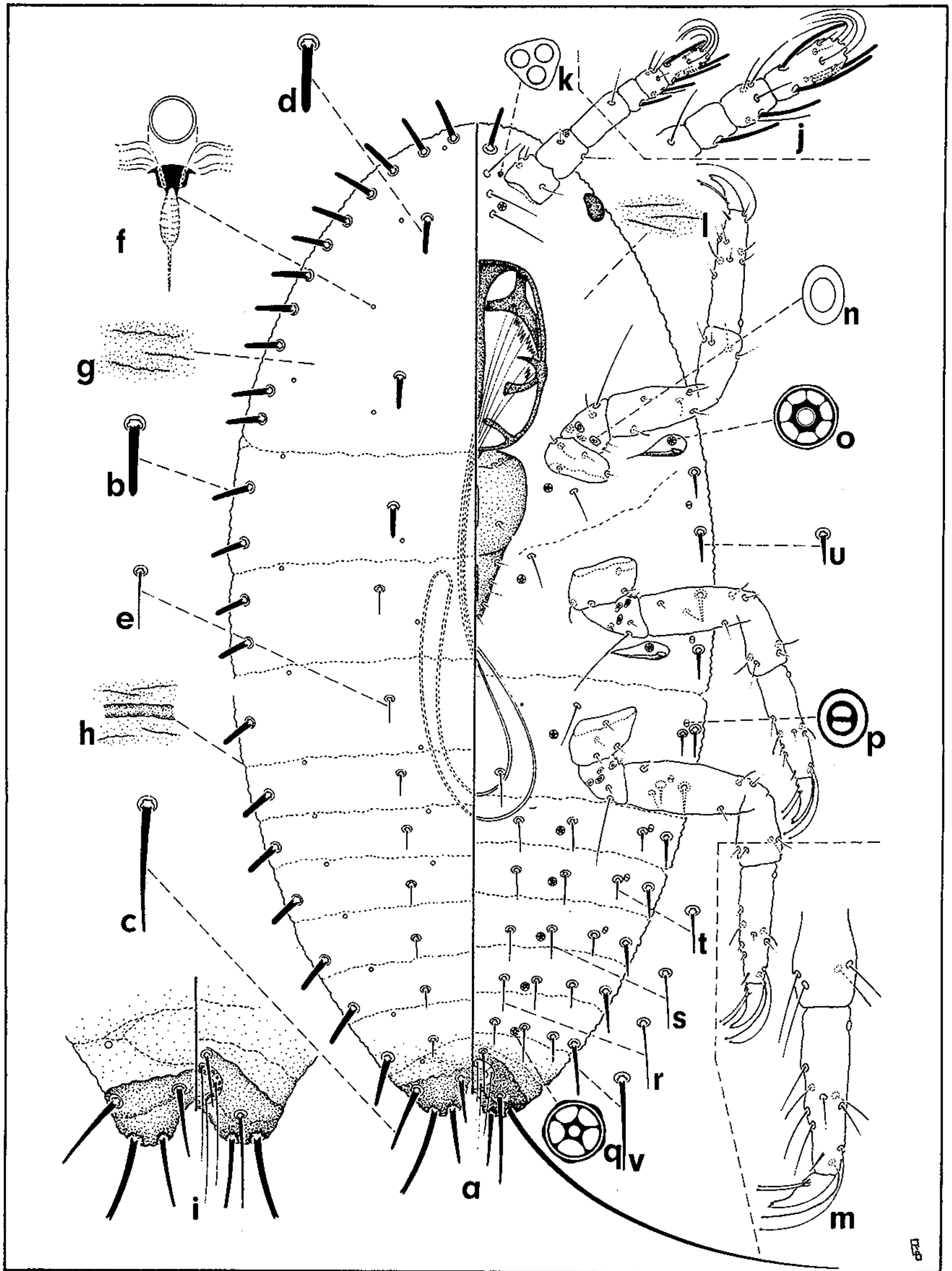


Plate 23. - *Kermes shastensis* Ehrhorn, first instar

Derm (fig. l). Membranous.

Legs (fig. m). See enlargement of the tibia, tarsus and claw of metathoracic leg. Four sensory pores on each trochanter (fig. n).

Leg Segments and Claw	Lengths Prothoracic	Lengths Mesothoracic	Lengths Metathoracic
Coxa	23 (19-28)	25 (23-28)	24 (21-28)
Trochanter	32 (26-35)	27 (23-35)	31 (23-35)
Femur	68 (63-74)	65 (58-72)	69 (60-74)
Tibia	35 (28-39)	38 (33-39)	37 (30-42)
Tarsus	57 (53-60)	59 (53-63)	63 (53-70)
Claw	20 (19-23)	19 (18-21)	20 (19-23)
Entire leg	236 (223-246)	236 (209-248)	246 (216-269)

Pores associated with spiracle (fig. o). Each anterior and posterior spiracle usually with 1 7-locular pore, occasionally a 5-, 6-, or 10-locular pore.

Bilocular pores (fig. p). Located near the bases of the submarginal and marginal setae. Between 6-8 along each margin.

Submedial pores on derm (fig. q). In 2 submedial longitudinal rows. Four pairs on head and thorax, 5 pairs on abdomen, most quinqueloculars, rarely a 7-locular pore.

Body setae (figs. r-v). In 8 longitudinal rows on abdomen and partly on thorax: medial 13 (8-24) long, ca. 1 wide, (fig. r); submedial 10 (8-17) long, ca. 1 wide (fig. s); submarginal 8 (5-12) long, ca. 1 wide (fig. t); marginal 11 (9-22) long, ca. 2 wide (fig. u). Posteriormost seta in marginal row thicker than rest in row, 20 (14-26) long.

Anal lobe and ring (figs. a,i). Sclerotized. With 1 submedial seta on each lobe, 34 (16-44) long. Ring oval, 13 (9-16) long, 28 (26-30) wide; anal ring setae 39 (30-46) long; 1 pair of thick setae at the anterior margin of anal ring, each 17 (9-26) long.

Additional material studied. On *Chrysolepis sempervirens*, **CA**, Mono Co., Mammoth, Earthquake Fault, Jul. 4, 1976, colls. RJG and R. F. Gill, 5(30) CDA; Sierra Co., 6 mi. E Independence Lake, Jul. 15, 1966, coll. DRM, 1(3) USNM. On *Quercus vaccinifolia*, **CA**, Fallen Leaf Lake, Aug. 1920, coll. (JMC), 3(8) UCD, 1(3) VPI; Lake Tahoe, 1916, coll. G. Bently, 3(5) UCD, 1(2) USNM, 1(3) VPI. On *Q. wislizenii*, **CA**, Kings Canyon, National Pk., Aug. 7, 1968, coll. JWB, 1(5), JWB.

Remarks. The original description contained no morphological characters on the first instars for species recognition.

Kermes shastensis is closely allied to the *K. concinnulus* group. Species included in this group have relatively long, setaceous or parallel-sided dorsal marginal setae and quinquelocular pores on the venter.

Kermes shastensis can be distinguished by the following characters: 1) 1 pair of dorsal marginal setae on each abdominal segment; 2) parallel sided and blunt dorsal marginal setae; 3) dorsal submedial setae on head, pro- and mesothorax thickened and similar to the dorsal marginal setae; and 4) 1 7-locular pore laterad of each anterior spiracle.

K. shastensis can be found on twigs near the bud region on *Quercus chrysolepis*, *Q. vaccinifolia*, *Q. wislizenii* and *Chrysolepis sempervirens* in California.

NANOKERMES ISELINI (BAER & KOSZTARAB), FIRST INSTAR

Plate 24

Kermes iselini Baer and Kosztarab, 1981: 226.

Type material studied. Holotype and paratype series from *Quercus mohriana*, NM, Otero Co., 15 mi. N of El Paso Gap, Jun. 15, 1976, coll. WAI, 5(25) USNM, 3(16) BM, 3(17) UCD, 3(12) VPI, 1(2) CDA.

Description. Body (fig. a) length 423 (408-544), width 181 (166-227).

Dorsum

Marginal setae (fig. b). Long, conical, ca. 66-70, these 16 (12-23) long, 8 (5-9) wide.

Marginal setae on anal lobe (fig. c). Slightly longer and thicker than other marginal setae, 16 (16-24) long.

Submedial setae on head and thorax (fig. d). Long, conical, 4 pairs on head and thorax, similar to marginal setae. Length 14 (12-16), width 9 (6-9).

Submedial setae on abdomen (fig. e). Thin, setaceous, 7 pairs, 4 (4-6) long, ca. 1 wide.

Simple pores (fig. f). In 2 longitudinal rows along submargin of abdomen, ca. 16, and 12 pores on the thoracic and head regions.

Derm (fig. g). Composed of overlapping platelike areas.

Intersegmental membrane (fig. h). Pronounced due to type of derm.

Anal lobes (figs. a,i). Sclerotized. One thick seta on inner margin of each lobe 16 (16-23) long, another at posterior end, 19 (16-21) long; apical seta 106 (91-196) long.

Venter

Antennae (fig. j). Total length 84 (80-102). Scape 12 (12-14) long, 26 (23-33) wide. Segments II to VI: 16 (16-21), 16 (16-19), 9 (9-12), 12 (9-14), 19 (16-26) long, respectively. Trilocular pore at scape base (fig. k).

Clypeolabral shield. Length 74 (74-95), width 58 (51-70).

Labium. Length 65 (58-86), width 46 (44-53).

Derm (fig. l). Membranous.

Legs (fig. m). See enlargement of tibia, tarsus and claw of metathoracic leg. Four sensory pores on each trochanter (fig. n).

Leg Segments and Claw	Lengths Prothoracic	Lengths Mesothoracic	Lengths Metathoracic
Coxa	19 (19-23)	19 (16-23)	19 (16-23)
Trochanter	19 (19-30)	23 (23-30)	23 (23-35)
Femur	44 (44-53)	44 (37-53)	46 (44-58)
Tibia	33 (23-35)	33 (26-35)	30 (26-37)
Tarsus	49 (35-49)	39 (39-46)	42 (42-53)
Claw	9 (9-19)	9 (9-21)	14 (9-21)
Entire leg	171 (160-200)	167 (162-202)	174 (167-218)

Pores associated with spiracle (fig. o). Each anterior and posterior spiracle with 1 quinquelocular pore.

Bilocular pores (fig. p). Located near the bases of the submarginal setae. Seven-10 along each margin.

Submedial pores on derm (fig. q). In 2 submedial longitudinal rows. Four pairs on head and thorax, 4 pairs on abdomen, mostly triloculars.

Body setae (figs. r-t). In 6 longitudinal rows on abdomen and partly on thorax: medial 6 (5-11) long, ca. 1 wide (fig. r); submedial 7 (5-9) long, ca. 1 wide (fig. s); submarginal 6 (5-9) long, ca. 2 (1-2) wide (fig. t).

Anal lobes and ring (figs. a,i). Sclerotized. With 1 submedial seta on each lobe, 11 (9-12) long. Ring oval, 14 (9-19) long, 16 (16-21) wide, anal ring setae 16 (14-23) long; 1 pair of thick setae at the anterior margin of anal ring 7 (7-14) long.

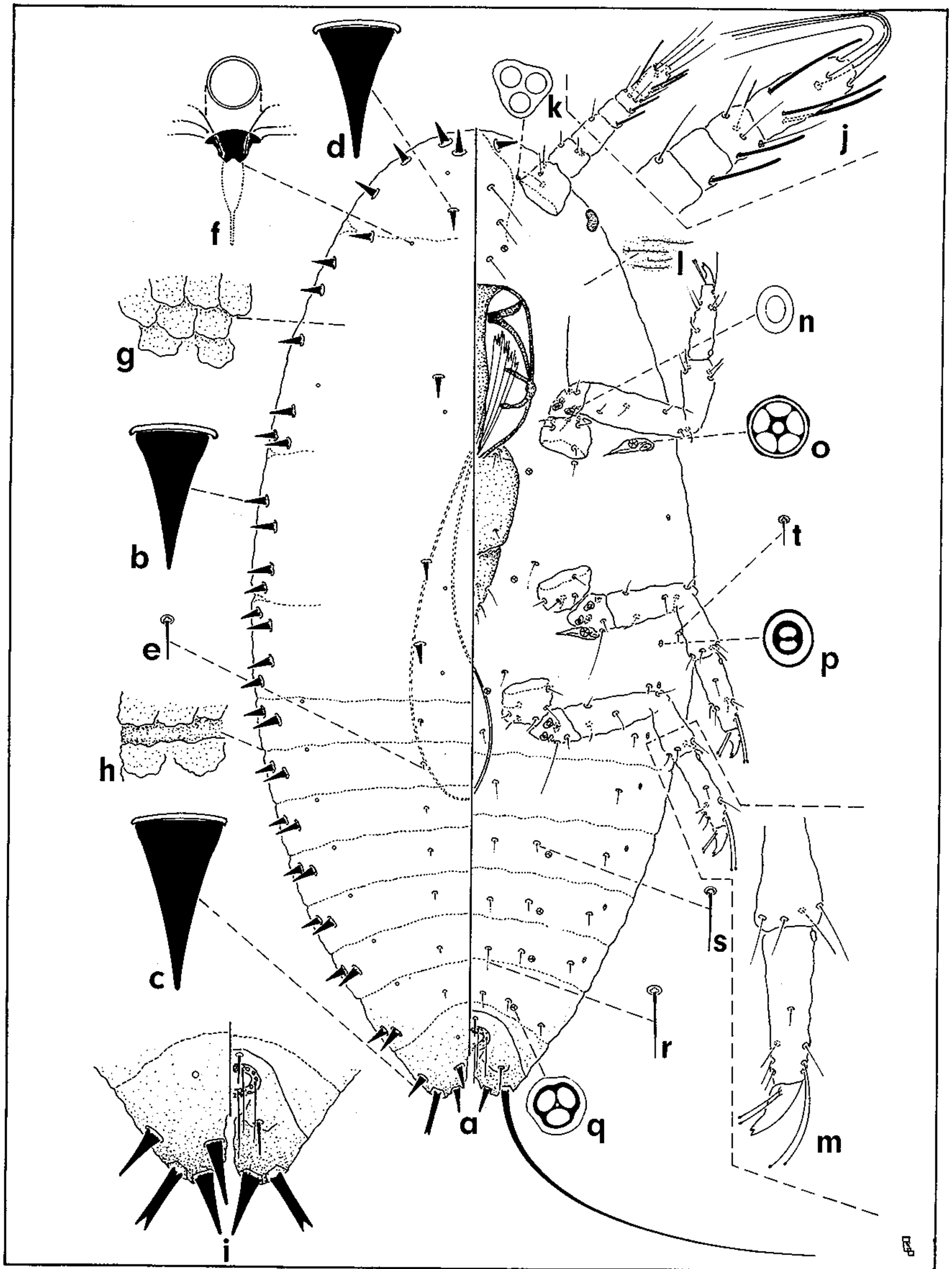


Plate 24.-*Nanokermes iselini* (Baer and Kosztarab), first instar

Additional material studied. On *Quercus grisea*, AZ, Tex Canyon, about 18 mi. N from Rt. 80, Jun. 20, 1976, colls. MMK, 1(3) VPI. On *Q. rugosa*, AZ, near Portal, 1.5 mi. up on S Fork Rd., Jun. 19, 1976, colls. MK, D. Hanna, and I. Storks, 1(3) VPI; NM, Coronado Natl. Forest, Jun. 20, 1976, colls. MMK, 1(3) VPI, 1(2) UCD.

Remarks. *Nanokermes iselini* is closely allied with the *N. pubescens* group. The species in this group have conical dorsal marginal setae and quinquelocular pores on the venter.

N. iselini can be distinguished by having the following characters: 1) 2 pairs of dorsal marginal setae on each abdominal segment; 2) conical shaped dorsal marginal setae; 3) only first 4 pairs of dorsal submedial setae similar to dorsal marginal setae; and 4) 1 quinquelocular pore laterad of each anterior spiracle.

This species is found in Arizona and New Mexico on the leaves, petioles and buds of *Quercus grisea*, *Q. mohriana* and *Q. rugosa*.

Etymology. *Nanokermes iselini* was named in honor of William A. Iselin who provided this study with many valuable specimens from the southwestern United States.

NANOKERMES ISELINI (BAER & KOSZTARAB), SECOND INSTAR FEMALE

Plate 25

Kermes iselini Baer and Kosztarab 1981: 226.

Type material studied. Paratypes from *Quercus mohriana*, NM, Otero Co., 15 mi. N of El Paso Gap, Jun. 15, 1976, coll. WAI, 1(3) VPI.

Description. Body (fig. a) length 901 (800-1087), width 503 (392-709).

Dorsum

Marginal setae (fig. b). Thick, slightly curved at middle, 2 pairs on each abdominal segment, ca. 74, these 28 (14-42) long, ca. 5 wide.

Submedial setae (fig. c). In two longitudinal rows, 11 pairs, 22 (5-47) long, ca. 4 wide.

Simple pores (fig. d). Randomly distributed over derm, these bilocular, ca. 50.

Tubular ducts (fig. e). Distributed through derm, wider than those on venter, ca. 120-150, ca. 33 long, ca. 9 wide.

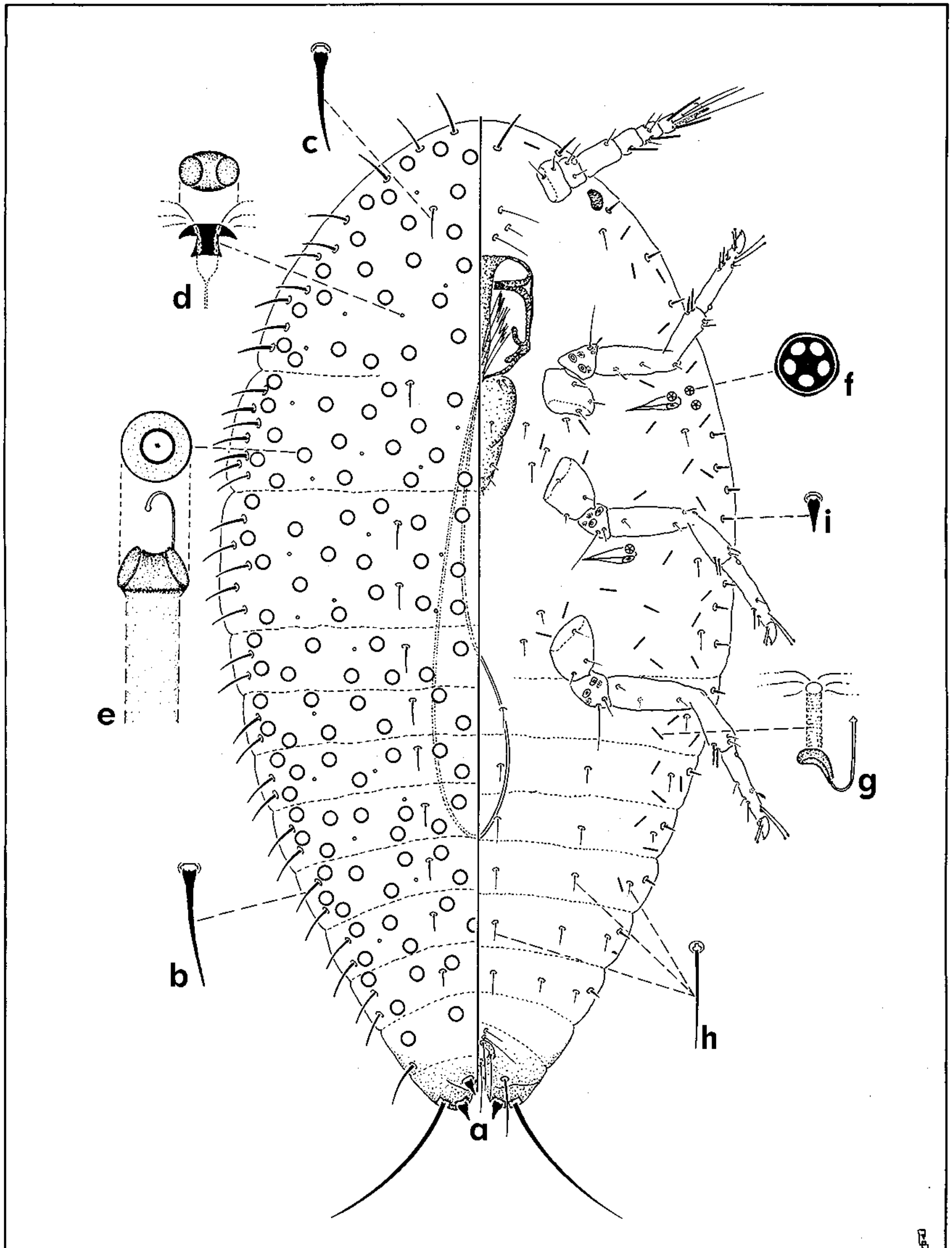


Plate 25.- *Nanokermes iselini* (Baer and Kosztarab), second instar female

Anal lobes. Sclerotized. One seta on inner margin of each lobe 13 (12-14) long, another at posterior end ca. 12 long; apical seta not able to be measured.

Venter

Antennae. Total length 138 (130-146). Scape 21 (18-23) long, 40 (35-46) wide. Segments II to VI: 19 (18-21), 36 (33-39), 19 (18-21), 19 (18-21), 25 (24-26) long respectively.

Clypeolabral shield. Length 112 (104-118), width 88 (83-93).

Labium. Length 77 (71-89), width 58 (47-65).

Legs. See chart below.

Leg Segments and Claw	Lengths Prothoracic	Lengths Mesothoracic	Lengths Metathoracic
Coxa	39 (37-41)	43 (39-47)	42 (37-47)
Trochanter	39 (37-41)	39 (37-41)	40 (39-41)
Femur	79 (77-83)	77 (74-83)	78 (74-84)
Tibia	51 (49-53)	52 (51-53)	57 (56-59)
Tarsus	65 (63-67)	69 (65-72)	74 (71-77)
Claw	20 (18-24)	20 (18-24)	20 (18-24)
Entire leg	293 (285-301)	300 (293-313)	310 (305-314)

Pores associated with spiracle (fig. f). Each anterior spiracle with 3, sometimes 4 quinquelocular pores. Each posterior spiracle with 1 quinquelocular pore.

Quinquelocular pores on derm. Absent.

Tubular ducts (fig. g). Mainly restricted to submargin, thinner than those on dorsum, ca. 60, ca. 19 (20-23) long, ca. 3 (2-4) wide.

Bilocular pores. Absent.

Body setae (figs. h,i). In 8 longitudinal rows on abdomen and partly on thorax and head: medial 27 (19-35) long, ca. 2 wide (fig. h); submedial 16 (12-21) long, ca. 2 wide (fig. h); submarginal 15 (9-21) long, ca. 2 wide (fig. h); marginal 12 (9-14) long, ca. 4 wide (fig. i).

Anal lobes and ring. Sclerotized. With 1 submedial seta on each lobe, 34 (33-35) long. Ring oval, 23 (21-26) long, 20 (19-21) wide; anal ring setae 52 (51-53) long.

Remarks. *Nanokermes iselini* second instar females can be separated by having: 1) 120-150 tubular ducts on the dorsum; and 2) 3-4 quinquelocular pores laterad of each anterior spiracle.

NANOKERMES PUBESCENS (BOGUE), FIRST INSTAR

Plate 26

Kermes pubescens Bogue, 1898: 172.

Type material studied. Paralectotypes from *Quercus macrocarpa*, KS, Manhattan (June 11, 1898), coll. JBN, 7(33) USNM, 3(17) UCD, 3(16) VPI, 2(9) CDA, 1(5) BM.

Description. Body (fig. a) length 477 (464-512), width 214 (197-228).

Dorsum

Marginal setae (fig. b). Short, conical, 2 pairs on each abdominal segment, ca. 73-75, these 8 (6-12) long, 5 (4-6) wide.

Marginal setae on anal lobe (fig. c) Longer and thicker than other marginal setae, 11 (9-13) long.

Submedial setae on head and thorax (fig. d). Short, conical, similar to marginal setae, 4 pairs on head and thorax, 8 (7-9) long, 5 (4-6) wide.

Submedial setae on abdomen (fig. b). Short, conical, similar to submedial setae on head and thorax, 7 pairs, 7 (6-8) long, 5 (4-6) wide.

Simple pores (fig. e). In 4 longitudinal rows, ca. 38-42.

Derm (fig. f). Composed of overlapping platelike areas.

Intersegmental membrane (fig. g.). Pronounced due to type of derm.

Anal lobes (figs. a,h). Partially sclerotized. One conical seta on inner margin of each lobe 11 (10-14) long, another at posterior end, 11 (10-12) long; apical seta 125 (110-134) long.

Venter

Antennae (fig. i). Total length 106 (99-115). Scape 17 (12-21) long, 29 (25-33) wide. Segments II to VI: 17 (16-19), 20 (18-21), 14 (10-16), 16 (12-18), 23 (20-27) long respectively. Trilocular pore at scape base (fig. j).

Clypeolabral shield. Length 88 (80-95), width 66 (58-70).

Labium. Length 67 (58-76), width 43 (39-49). Koteja (1974a) noted on basal segment 1 or 2 pairs of setae, 1 pair on medial segment and 4 pairs on apical segment. The structure of the labium was similar to that of the adult female.

Derm (fig. k). Membranous.

Legs (fig. l). See enlargement of tibia, tarsus and claw of metathoracic leg. Four sensory pores on each trochanter (fig. m).

Leg Segments and Claw	Lengths Prothoracic	Lengths Mesothoracic	Lengths Metathoracic
Coxa	25 (19-29)	24 (18-29)	24 (19-29)
Trochanter	29 (27-33)	28 (23-35)	27 (25-29)
Femur	51 (49-54)	49 (43-52)	51 (47-56)
Tibia	30 (25-33)	32 (31-35)	35 (33-39)
Tarsus	39 (35-41)	42 (39-45)	45 (41-47)
Claw	17 (13-19)	18 (14-19)	18 (14-19)
Entire leg	188 (181-198)	192 (181-208)	202 (196-212)

Pores associated with spiracle (fig. n). Each anterior spiracle with usually 2, sometimes 3 quinquelocular pores. Each posterior spiracle with 1, sometimes with 2 quinquelocular pores. Rarely 2, 4- or 7-locular pores.

Bilocular pores (fig. o). Located near the bases of the submarginal setae. Six - 8 along each margin.

Submedial pores on derm (fig. p). In 2 longitudinal rows. Four pairs on head and thorax, 5 pairs on abdomen, mostly triloculars, occasionally quinqueloculars.

Body setae (figs. q-s). In 6 longitudinal rows on abdomen and partly on thorax: medial 8 (6-12) long, ca. 1 wide (fig. q); submedial 7 (5-13) long, ca. 1 wide (fig. r); submarginal 5 (4-8) long, ca. 1 wide (fig. s).

Anal lobes and ring (figs. a,h). Partially sclerotized. With 1 submedial seta on each lobe 8 (7-11) long. Ring oval, ca. 16 long, 19 (12-20) wide; anal ring setae 11 (8-12) long; 1 pair of thick setae at the anterior margin of anal ring 7 (6-10) long.

Additional material studied. On *Quercus alba*, **AL**, Vinemont, Jun. 16, 1904, coll. H. O. Sargent, 2(5), USNM; **DC**, Jun. 30, 1906, coll. F. Baker, 1(2), DSIR; Jun. 17, 1916, coll. JK, 2(6), USNM; Jun. 16, 1927, coll. P. Bissett, 2(6), USNM; Jun. 10, 1938, coll. C. A. Bolgiano, 2(5), USNM; Cleveland Pk., Feb. 18, 1917, coll. JK, 2(7), USNM; St. Elizabeth Hosp., Jun. 8. 1918, coll. JK, 2(7), USNM; U.S. Zool. Pk., Jun. 30, 1906, coll. F. Baker, 3(8), USNM; **DE**, Wilmington, Jul. 3, 1927, coll. H. L. Dozier, 2(6), USNM;

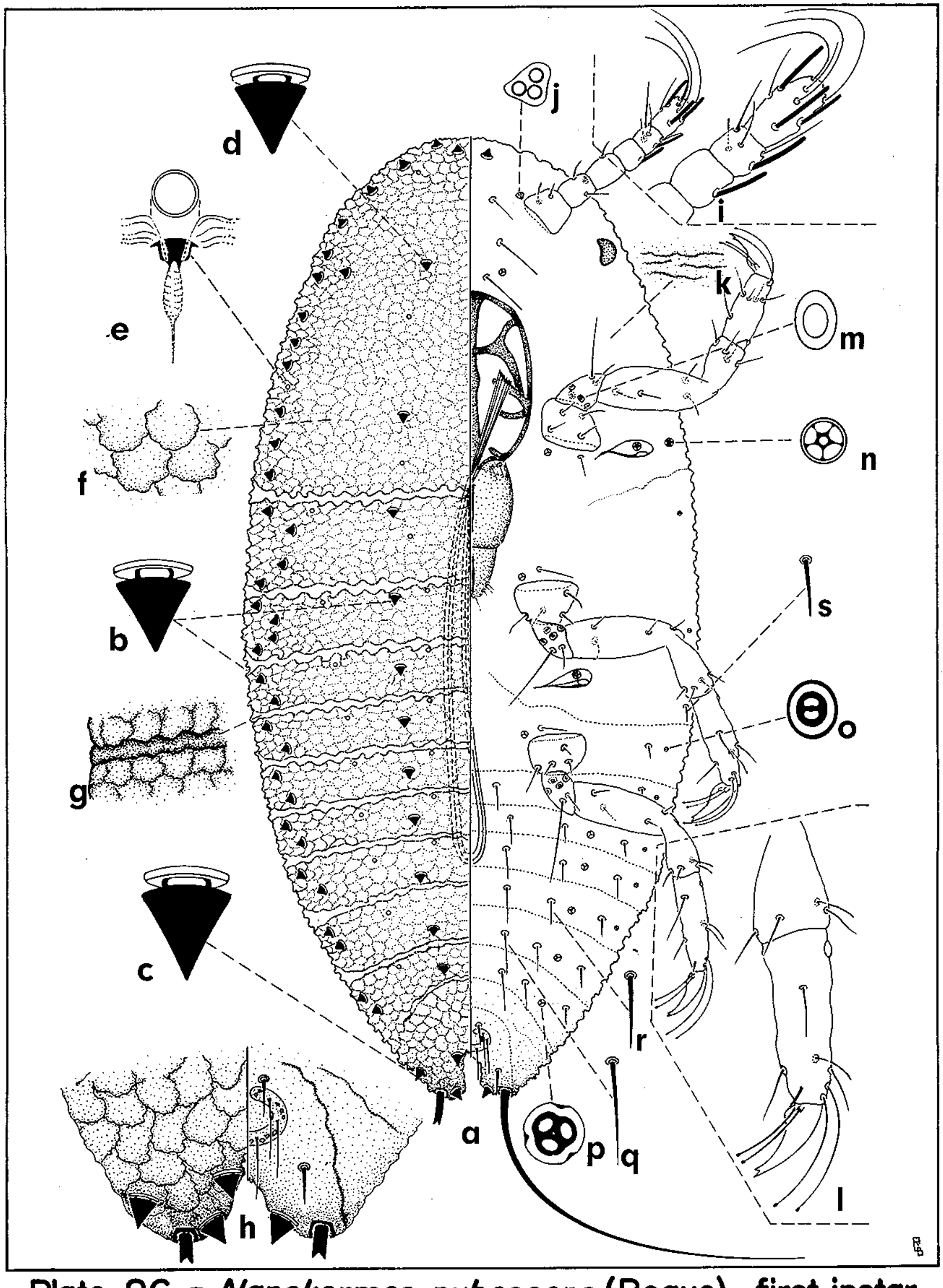


Plate 26. - *Nanokermes pubescens* (Bogue), first instar

GA, Experiment, Georgia, Agricultural Experiment Station, Jun. 8, 1976, colls. MK, RB and JOH, 2(6), VPI; **IL**, Kankakee, Jun. 16, 1908, coll. S. A. Forbes, 2(6), USNM; **IN**, Marion Co., Jul. 1, 1913, coll. HFD, 2(6), UCD; Noblesville, Jul. 4, 1913, coll. HM, 1(1), UCD; **KS**, Lawrence, Mar. 1898, coll. OEB, 4(13), UCD; **MA**, Lawrence, 1898, coll. GBK, 2(5), SEM; **MD**, Belaire, 213 Red Pump Rd., Jun. 18. 1971, coll. C. W. McCombs, 2(5), AU; College Park, Jun. 1, 1956, coll. H. S. McCounce, 1(3), VPI; College Park, Sep. 23, 1958, 1(3), VPI; College Park, Univ. of Maryland Campus, Jun. 18, 1974, coll. MLW, 2(8), AU; La Plata, Jul. 5, 1905, coll. ERS, 2(6), USNM; **MN**, Alexandria, Jul. 9, 1941, coll. W. C. Hanson, 2(6), UMN; **NC**, Chapel Hill, Jun. 4, 1941, coll. J. N. Couch, 1(3), USNM; **NH**, Concord, Jul. 29, 1940, coll. T. J. Parr, 2(8), USNM; **NJ**, Holly Beach, Jul. 2, 1906, coll. C. F. Naegle, 2(6), USNM; Madison, Jul. 7, 1925, coll. FMS, 2(5), USNM; Red Bank, Jun. 12, 1919, coll. H.W. Lutz, 2(5), USNM; **NY**, Cornell Univ., Ithaca, Jul. 6, 1972, coll. D. Williams, 2(8), VPI; **PA**, Cedar Grove, May 26, 1926, coll. S. F. Bailey, 2(7), USNM; Norristown, Jun. 29, 1937, coll. M. C. VanHorn, 2(6), USNM; Philadelphia, Sep. 27, 1919, coll. S. N. Baxter, 2(6), USNM; **SC**, Clemson College, Jun. 18, 1917, coll. J. A. Berly, 3(8), USNM; **VA**, Arlington, Aug. 1945, coll. S. B. Detweiler, 4(12), USNM; Arlington, Jul. 22, 1963, coll. L. T. Froney, 2(8), VPI; Blacksburg, VPI&SU Campus, Jun. 20, 1977, coll. RGB, 2(8), VPI; Charlottesville, Univ. VA Campus, Oct. 5, 1973, coll. MK, 1(1), VPI; Fairfax, R. F. Kennedy Estate, May 28, 1975, coll. B. Zirrilli, 3(43) VPI; Radford, Becky Thompson's Riding Academy, Jan. 13, 1976, colls. RGB, MK, and ABH, 5(13), VPI. On *Q. falcata*, **TN**, Smokey Mts. Natl. Pk., Rt. 73, 3 mi. before Metcalf Bottom Picnic Ground, Jun. 6, 1976, colls. MMK, 2(4), VPI. On *Q. lyrata*, **AR**, near Helena, 1925, coll. WJB, 2(5), USNM; **LA**, Tallulah, May 21, 1907, coll. A. H. Rosenfeld, 2(7), USNM. On *Q. macrocarpa*, **IL**, Chicago, Sep. 22, 1903, 1(1), USNM; **IN**, Indianapolis, Jun. 17, 1912, coll. H. H. Fall, 2(6), USNM; Lafayette, Jun. 16, 1931, coll. J. J. Davis, 2(6), USNM; Lafayette, Sep. 26, 1931, coll. JMA, 1(1), USNM; W Lafayette, 1931, coll. JMA, 1(2), VPI; **KS**, Iola, City Pk., Aug. 17, 1976, colls. MMK, 2(4), VPI; Manhattan, Aug. 6, 1976, colls. MMK, 2(7), VPI; Wichita, Aug. 3, 1976, coll. H. E. Thompson, 2(7), VPI; **OH**, Cincinnati, Aug. 4, 1913, coll. JSH, 2(4), OHSU; **PA**, Sharon Hill, Jul. 20, 1918, coll. FMT, 4(13), UCD. On *Q. prinus*, **AR**, near Helena, 1925, coll. JWB, 2(7), USNM; **DC**, Cleveland Pk., Jul. 8, 1906, coll. JGS, 2(6), USNM. On *Q. stellata*, **AL**, Baldwin Co., Jun. 15, 1975, coll. R. Self, 4(13), VPI; Fruitdale, May 3, 1905, coll. W. F. Fiske, 2(6), USNM; **AR**, Ft. Smith, Jun. 8, 1937, coll. WJB, 2(4), USNM; Texarkana, Jun. 7, 1919, coll. W. C. McCallister, 1(3), USNM; **GA**, Atlanta, Jun. 17, 1911, coll. H. C. Lewis, 2(7), USNM; Demorest, Rt. 441, Jun. 7, 1976, colls. MMK, 2(6), VPI; **MO**, St. Louis, Jul. 12, 1912, coll. C. W. Fullgraf, 2(7), USNM; Webster Groves, Jun. 11, 1920, coll. AFS, 1(3) USNM; Webster Groves, Jun. 18, 1928, coll. F. P. Westcott, 2(5) USNM; Webster Groves, Jun. 27, 1931, coll. JSH, 2(5), USNM; **MS**, Jackson, May 12, 1919, coll. S. M. Thomas, 2(5), USNM; Jackson, May 23, 1919, coll. J. B. Harris, 2(4), USNM; **NC**, Oteen, Jul. 10, 1941, coll. C. H. Hoffman, 1(3), USNM. *Quercus* sp., **AL**, Birmingham, Jul. 17, 1914, coll. L. W. Wright, 2(7), USNM; Birmingham, Jun. 10, 1924, coll. S. Harris, 2(6), USNM; Birmingham, May 12, 1925, coll. E. E. Ellis, 1(3), USNM; **AR**, Russellville, May 23, 1938, coll. EJB, 2(6), USNM; Texarkana, Jun. 25, 1919, coll. E. Holland, 2(6), USNM; **DC**, Aug. 2, 1907, 1(1), UCD; Jul. 11, 1916, coll. N. P. Sedaley, 1(3), USNM; Jun. 4, 1927, 2(11), USNM; Capitol Grounds, Jun. 6, 1910, coll. E. Woode, 2(6), USNM; Cleveland Pk., Jul. 16, 1923, 2(4), USNM; near Zool. Pk., May 28, 1918, coll. Kootz, 4(15), USNM; **GA**, Spelman, Oct. 31, 1934, coll. H. T. Albro, 1(2), USNM; Kirkwood, May 11, 1919, coll. W. F. Turner, 2(3), USNM; Augusta, Jun. 21, 1901, 2(4), USNM; **IA**, Ames, Jun. 17, 1938, coll. C. J. Drake, 2(6), USNM; Des Moines, Sep. 3, 1937, coll. C. J. Drake, 2(6) USNM; Des Moines, Jun. 13, 1938, coll. C. H. Richardson, 2(5), USNM; Marshaltown, Jun. 28, 1923, coll. C. J. Drake, 2(7), USNM; **IL**, Glenville, Jul. 6, 1915, coll. R. Redfield, Jr., 2(6), USNM; Godfrey, Jun. 17, 1919, coll. RWD, 8(29), UCD; **IN**, Indianapolis, Oct. 18, 1911, coll HM, 2(7), UCD; **KS**, Manhattan, 1(1), USNM; Manhattan, coll. EEB, 2(5), USNM; Manhattan, Apr. 23, 1906, coll. G. A. Dean, 2(7), USNM; Manhattan, Jun. 1, 1915, 4(13), KSU; Riley Co., 1899, coll. P. J. Parrott, 5(27), SEM; Scandia, coll. S. Shivvers, Jun. 13, 1904, 2(7), KSU; **MA**, Lawrence, 4(15), UCD; **MD**, Chevy Chase, Jun. 14, 1912, coll. W. Law, 2(6), USNM; College Park, Jun. 16, 1974, coll. CHR, 3(12), AU; College Park, Univ. of Maryland, Jun. 24, 1974, coll. CHR, 2(8), AU; Ellicott City, Jul. 11, 1958. coll. MK, 2(5), VPI; Waldorf, Jul. 9, 1926, coll. P. Simmons, 1(4), USNM; **MN**, Bemidji, coll. E. J. Olin, 3(11), USNM; **MO**, St. Louis, Aug. 16, 1920, coll. J. L. Wentworth, 2(4), USNM; St. Louis, Jun. 23, 1913, coll. J. M. Greenman, Jun. 23, 1913, 1(3), USNM; Webster Groves, Jun. 7, 1930, coll. J. W. Freudenberg, 2(4), USNM; **MS**, Jackson, Elon Dairy Farm, Jun. 16, 1925, coll. H. H. Wedgworth, 2(7); USNM; **NJ**, New Brunswick, Sep. 20, 1904, coll. J. B. Smith, 2(6), USNM; Trenton, Jul. 7, 1926, coll. E. J. Matthews, 2(7), USNM; **NY**, Pelham, Apr. 20, 1932, coll. E. P. Felt, 2(5), USNM; Rochester, Jul. 30, 1931, coll. C. R. Crosby, 2(4), USNM; **OH**, Cincinnati, Nov. 8, 1914, colls. JSH and GBK, 2(6), OHSU; Cincinnati, Jun. 22, 1916, coll. R. M. Lenise, 1(3), OHSU; Cincinnati, Nov. 1918, coll. F. P. Atkins, 2(6), USNM; Columbus, Jul. 8. 1931, coll. R. C. Hall, 2(6), USNM; Oberlin, Jul. 1915, coll. E. A. Barrett, 2(4), OHSU; Toledo, Jul. 6, 1910, coll. W. M. Brooker, 2(6), USNM; **RI**, Kingston, Jul. 3, 1915, coll. A. E. Stone, 2(7), USNM; Providence, Apr. 7, 1883, coll. A. S. Packard, 2(5), USNM; **TN**, Memphis, Jun. 11, 1924, coll. C. W. Herskell, 2(7), USNM; Nashville, Jun. 6, 1925, coll. R. S. Maddox, 1(1), USNM; **TX**, Dallas, May 8., 1916, coll. F. H. McGinnis, 2(6), USNM; Gregg Co., Longview, May 7, 1938, coll. R. K. Fletcher, 2(4), USNM; **VA**, Frys Springs, Jun. 24, 1910, coll. M. W. Minor, 2(5), USNM; Lyon Farm, May 31, 1941, coll. F. Andre, 2(5), USNM; Norfolk area, Newport News, Jul. 6, 1942, coll. H. G. Walker, 2(6), USNM; Portsmouth, Pinecrest Baptist Church, Jun. 26, 1967, coll. W. F. Tate, 4(10), VPI.

Remarks. The original description contained no information on the first instar of *Nanokermes pubescens*. King (1900b) and Sanders (1904) mentioned that the first instars differ from other species by having 6 rows of short conical spines and short caudal setae. These characters undoubtedly refer to the conical dorsal marginal and dorsal submedial setae. The redescription and illustration by McConnell and Davidson (1959) provided some characters for species recognition, but according to Bullington and Kosztarab (1985), the specimens studied by them belong to an undescribed new species based on an adult female study. We were not able to separate first instars of *N. folium* from *N. pubescens*.

Nanokermes pubescens is designated to represent a group of species including *N. pubescens*, *N. iselini* and presumably *N. folium*. The first two species have 2 rows of trilocular pores on the venter and conical dorsal marginal setae.

N. pubescens can be distinguished by the following characters: 1) 2 pairs of dorsal marginal setae on each abdominal segment; 2) dorsal marginal setae conical; 3) entire row of dorsal submedial setae similar to the dorsal marginal setae; and 4) 2-3 quinquelocular pores laterad of each anterior spiracle.

This species is found on *Quercus alba*, *Q. falcata*, *Q. lyrata*, *Q. macrocarpa*, *Q. prinus* and *Q. stellata* in central and eastern U.S.

NANOKERMES PUBESCENS (BOGUE), SECOND INSTAR FEMALE

Plate 27

Kermes pubescens Bogue, 1898: 172.

Material studied. On *Quercus alba*, MD, College Park, May 4, 1956, coll. H. S. McConnell, 1(3), USNM.

Description. Body (fig. a) length 755 (664-830), width 448 (377-513).

Dorsum

Marginal setae (fig. b). Thick, slightly curved at middle, 2 pairs on each abdominal segment, ca. 64-68, these 28 (23-32) long, ca. 4 wide.

Submedial setae (figs. c,d). In 4 longitudinal rows, 8-9 pairs of slender setaceous setae in medial row, these 7 (6-7) long, ca. 2 wide; 11 pairs of setae, similar to dorsal marginal setae, 23 (21-26) long, 3 (2-4) wide.

Simple pores (fig. e). Randomly distributed throughout derm, usually bilocular, ca. 100-120.

Tubular ducts (fig. f). Distributed throughout derm, wider than those on the venter, ca. 70-100, ca. 19 long, ca. 9 wide.

Anal lobes. Sclerotized. One seta on inner margin of each lobe, ca. 14 long, another at posterior end 15 (14-16) long; apical seta ca. 83 long.

Venter

Antennae. Total length 131 (128-136). Scape 22 (19-24) long, 35 (33-37) long. Segments II to VI: 18 (17-19), 34 (33-35), 17 (16-18), 18 (17-19), 24 (23-25) long respectively.

Clypeolabral shield. Length 100 (94-106), width 87 (83-94).

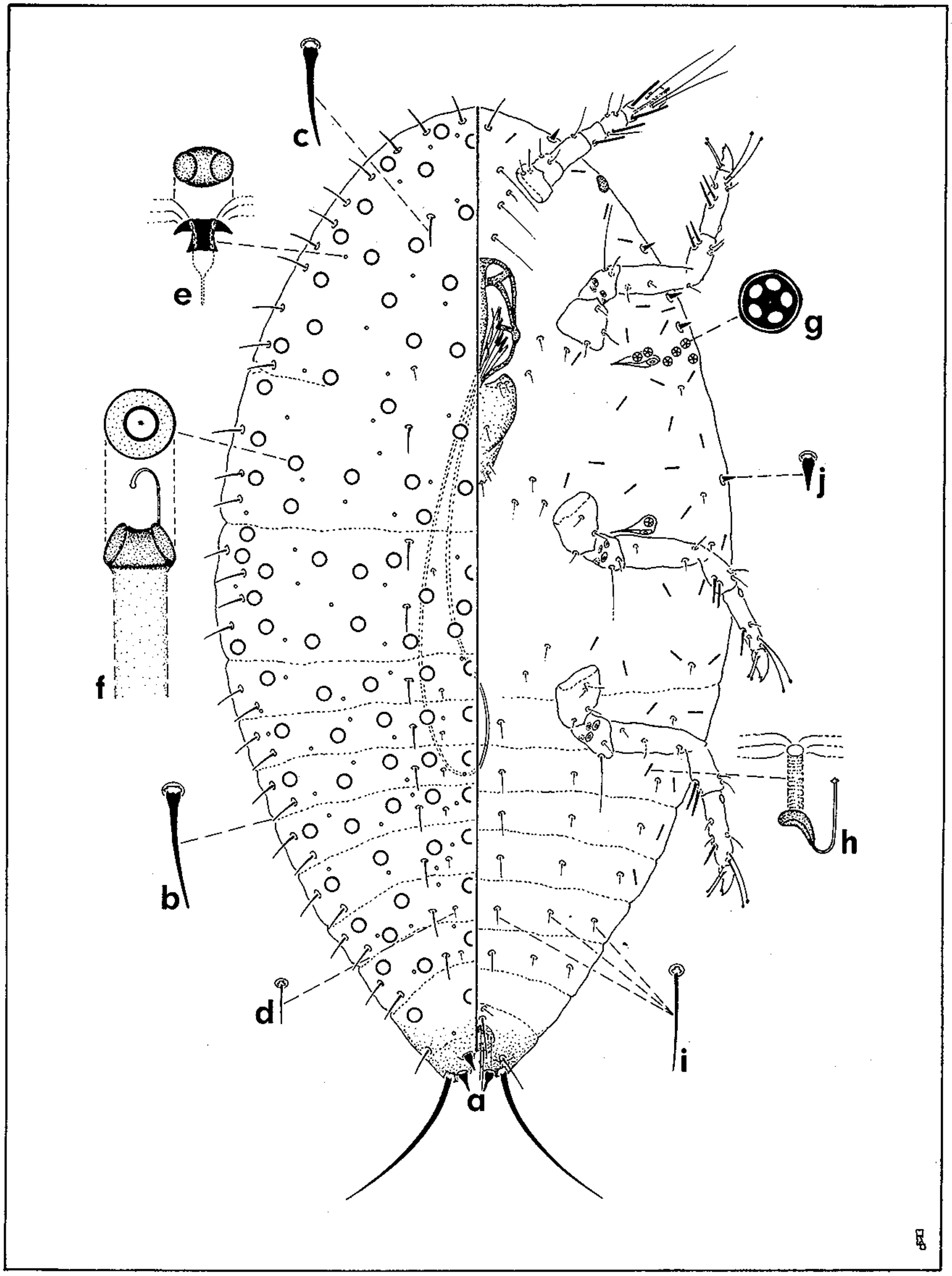


Plate 27. - *Nanokermes pubescens* (Bogue), second instar female

Labium. Length 77 (71-83), width 61 (59-65).

Legs. See chart below.

Leg Segments and Claw	Lengths Prothoracic	Lengths Mesothoracic	Lengths Metathoracic
Coxa	37 (35-41)	37 (30-41)	40 (35-44)
Trochanter	40 (39-41)	38 (35-41)	42 (41-44)
Femur	76 (74-77)	75 (74-77)	78 (77-79)
Tibia	39 (35-44)	51 (49-53)	56 (53-58)
Tarsus	56 (53-58)	57 (56-59)	63 (62-65)
Claw	18 (17-19)	18 (17-19)	18 (17-19)
Entire leg	265 (261-269)	276 (271-280)	297 (289-302)

Pores associated with spiracle (fig. g). Each anterior spiracle with 4-7 quinquelocular pores. Each posterior spiracle with 1 quinquelocular pore.

Quinquelocular pores on derm. Absent.

Tubular ducts (fig. h). Less numerous than on dorsum, mainly restricted to submargin, thinner than those on dorsum, ca. 20-30, ca. 25 long, ca. 5 wide.

Bilocular pores. Absent.

Body setae (figs. i,j). In 6 longitudinal rows on abdomen and partly on thorax: medial 20 (16-28) long, ca. 2 wide (fig. i); submedial 42 (35-53) long, ca. 2 wide (fig. i); submarginal 7 (6-8) long, ca. 2 wide (fig. i). Several pairs of short thickened setae (fig. j), between anterior and posterior spiracles and between anterior spiracle and apex of head, ca. 9 long.

Anal lobes and ring. Sclerotized. With 1 submedial seta on each lobe, ca. 33 long. Ring oval, 22 (21-23) long, 26 (23-28) wide; anal ring setae 40 (37-41) long.

Remarks. McConnell and Davidson (1959) adequately described and illustrated the second instar female for species recognition. However, the material they used in their study was determined to be a new species, closely related to *Nanokermes pubescens* (Bullington & Kosztarab, 1985).

N. pubescens second instar females can be distinguished by the following characters: 1) 70-100 tubular ducts on the dorsum; and 2) 4-7 quinquelocular pores laterad of each anterior spiracle.

OLLIFFIELLA CRISTICOLA COCKERELL, FIRST INSTAR

Plate 28

Olliffiella cristicola Cockerell, 1896c:299.

Material studied. On *Quercus emoryi*, AZ, Portal, Southwest Research Station, Jun. 24, 1976, coll. MK, 4(31) VPI.

Description. Body (fig. a) oblong, widest at mesothorax, tapering posteriorly, antennae, legs, and anal lobes well developed, with one apical seta on each lobe; body 525 (483-559) long, 208 (196- 226) wide.

Dorsum

Marginal setae (fig. b). Parallel-sided, blunt at apex, ca. 44-48. Those anterior to the anterior spiracles thinner than the rest of the marginal setae, 16 (12-17) long, 3 (2-4) wide.

Marginal setae on anal lobe (fig. c). Slightly longer and thicker than other marginal setae, ca. 17 long.

Submedial setae on head and thorax (fig. d). Parallel-sided, similar to marginal setae, 2 pairs on head, 1 pair on each thoracic region, 16 (14-18) long, ca. 5 wide.

Submedial setae on abdomen (fig. e). Parallel-sided similar to submedial setae on head and thorax, 7 pairs, ca. 15 long, ca. 5 wide.

Simple pores (fig. f). Each with a sclerotized ring opening to a membranous duct, in 4 longitudinal rows, ca. 46-50, ca. 1 wide.

Derm (fig. g). Membranous, composed of overlapping platelike areas.

Intersegmental membrane (fig. h). Pronounced due to type of derm.

Anal lobes (figs. a,i). Sclerotized. One parallel-sided seta on inner margin of each lobe 19 (16-21) long, another at posterior end, 19 (16-21) long; apical seta 187 (166-196) long.

Venter

Antennae (fig. j). Six-segmented. Total length 98 (94-102). Scape 15 (14-16) long, 26 (23-33) wide. Segments II to VI: 15 (12-16), 21 (19-23), 12 (11-13), 12 (11-14), 24 (22-27) long respectively. Numerous slender setaceous setae on segments of antenna, fleshy setae on segments IV-VI. Sensory pore on segment II. Trilocular pore at scape base (fig. k).

Clypeolabral shield. Length 79 (71-89), width 58 (53-63).

Labium. Triangular, length 81 (71-89), width 42 (37-45). Eight labial setae, ca. 14 long.

Derm (fig. l). Simple membranous.

Legs (fig. m). See enlargement of tibia, tarsus, and claw of metathoracic leg. Four sensory pores on each trochanter (fig. n). Also, a sensory pore on the proximal lateral margin of each tarsal segment. Numerous thin setaceous setae on the different segments of each leg. Tarsal and claw digitules extending beyond apex of claw. Claws with a denticle.

Leg Segments and Claw	Lengths Prothoracic	Lengths Mesothoracic	Lengths Metathoracic
Coxa	16 (14-19)	17 (14-23)	20 (19-23)
Trochanter	27 (26-33)	31 (30-33)	29 (23-33)
Femur	59 (56-63)	60 (58-63)	67 (65-70)
Tibia	36 (35-37)	36 (35-37)	39 (35-42)
Tarsus	55 (53-58)	56 (51-58)	63 (60-65)
Claw	18 (16-21)	18 (14-21)	19 (17-21)
Entire leg	205 (169-215)	218 (213-227)	237 (230-246)

Pores associated with spiracle (fig. o). Each anterior spiracle with 2 quinquelocular pores. Each posterior spiracle with 1 quinquelocular pore. Anterior spiracle ca. 21 long, ca. 7 wide, atrium ca. 2 wide. Posterior spiracle ca. 21 long, ca. 7 wide, atrium 2 wide.

Bilocular pores (fig. p). Located near the bases of the submarginal and marginal setae. Nine - 11 along each margin, ca. 2 wide.

Submedial pores on derm (fig. q). In 2 longitudinal rows. Four pairs on head and thorax, 5 pairs on abdomen; mostly quinqueloculars, occasionally triloculars.

Body setae (figs. r-t). In 8 longitudinal rows on abdomen and partly on thorax; medial row with 6 pairs; submedial row with 5 pairs; submarginal row with 7 pairs; marginal row with 10 pairs. All setae in these rows are slender and setaceous, 9 (5-23) long, ca. 2 wide (figs. r,s). Posteriormost seta in marginal row similar to dorsal marginals, ca. 16 long (fig. t). Other long setaceous setae near coxal and antennal scape bases. One pair of setae similar to dorsal marginal setae near scape base.

Anal lobe and ring (figs. a,i). Sclerotized. With 1 submedial seta on each lobe, 30 (21-33) long. Ring oval, 13 (7-14) long, 22 (21-23) wide; with ca. 22 transparent cells and 6 anal ring setae, each 30 (26-31) long. A pair of setae on the anterior margin of anal ring, each 16 (14-17) long.

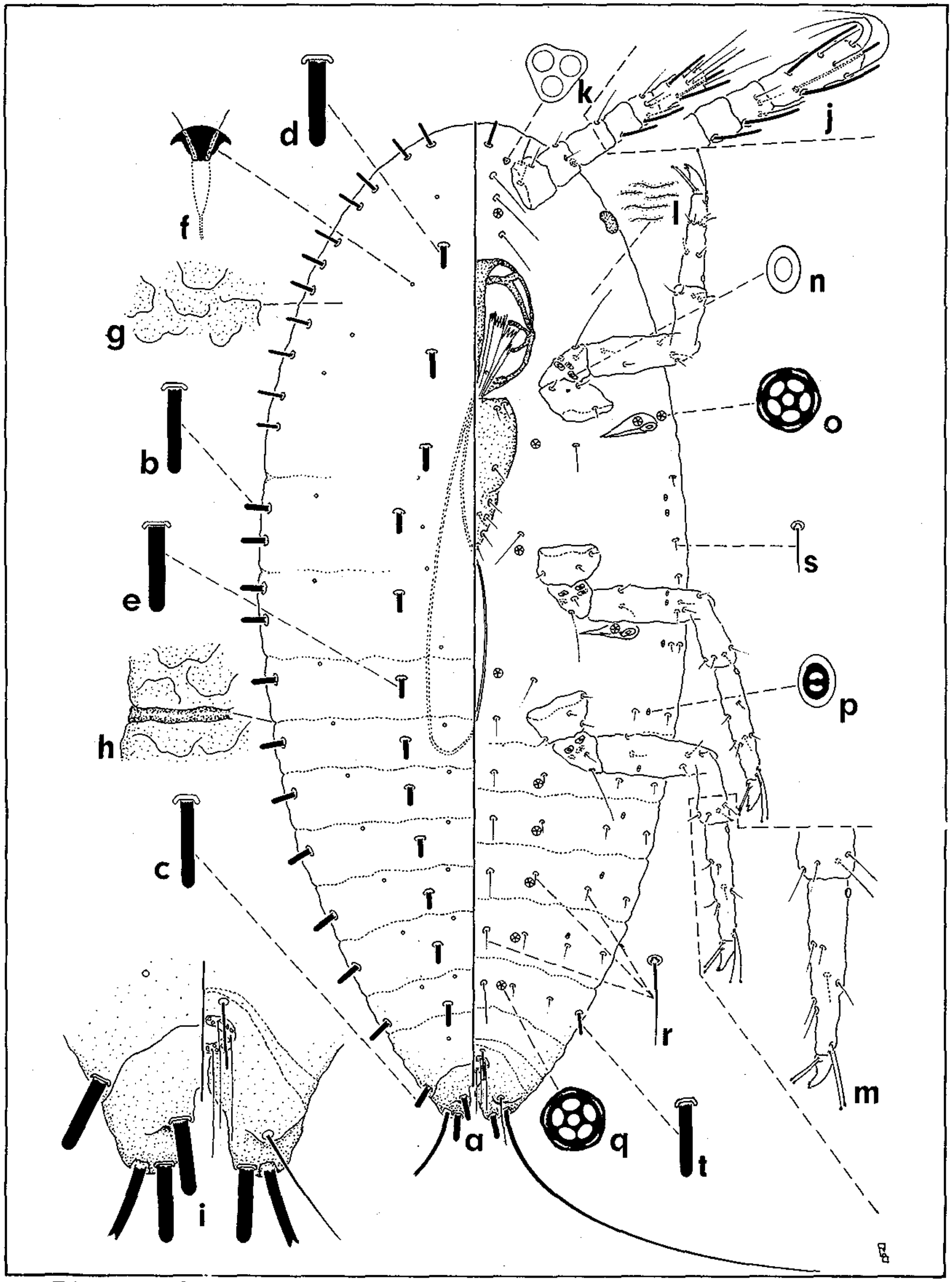


Plate 28. - *Olliffiella cristicola* Cockerell, first instar

Additional material studied. On *Quercus emoryi*, AZ, Bisbee, Jul. 11, 1918, coll. L. H. Weld, 1(7) USNM; Dragoon Pass, Jul. 6, 1940, coll. GFF, 1(16) USNM; Pine, Oct. 1939, coll. NWC, 1(2) USNM; near Portal, Southwest Research Station, Mar. 22, 1977, coll. R. Morse, 1(1) VPI; Wolf Creek, Sep. 26, 1945, coll. L. H. Weld, 1(8) USNM. On *Q. undulata* var. *pungens*, NM, Pinos Altos, 1896, 1(5) PANS.

Remarks. The original description contained no morphological information useful for first instar recognition. Ferris (1919) mentioned that the first instars may be inseparable generically from the corresponding stages of certain species of *Kermes*. However, the redescriptions (Ferris 1919, Sternlicht 1974) provided adequate morphological characters and illustrations for species recognition.

The major distinguishing character of this North American species is the presence of parallel-sided dorsal submedial setae on the abdominal segments. Also, the dorsal marginal setae anterior to the anterior spiracle are thinner than the rest of the marginal setae along the margin.

This leaf gall-former is found in Arizona and New Mexico on *Quercus emoryi* and *Q. undulata* var. *pungens*.

OLLIFFIELLA "SECUNDA" FERRIS, SECOND INSTAR FEMALE

Plate 29

Olliffiella secunda Ferris, 1955a: 21.

Type material studied. Paralectotypes from *Quercus* sp., MEXICO, State of Guerrero, 30 mi. E of Acapulco, La Providencia, Mar. 15, 1926, coll. GFF, 4(7) USNM, 3(8) VPI, 1(3) UCD.

Description. Body (fig. a) oblong, derm membranous, tubular ducts present on venter only, antennae, legs, and anal lobes well developed, body 906 (845-981) long, 480 (422-528) wide.

Dorsum

Marginal setae (fig. b). Setaceous, slightly curved at middle, ca. 45-47, these 33 (30-35) long, 3 (2-4) wide.

Submedial setae (figs. c,d). In 2 distinct longitudinal rows, 12 pairs, several other pairs on thorax and several abdominal segments, 28 (23-33) long, 3 (2-4) wide.

Quinquelocular pores (fig. e). In 2 submarginal longitudinal rows, ca. 9 pairs, dia. ca. 5.

Simple pores (fig. f). In 2 submedial longitudinal rows, 11 pairs, each with a sclerotized margin and shaped like a campaniform sensillum, ca. 2 long.

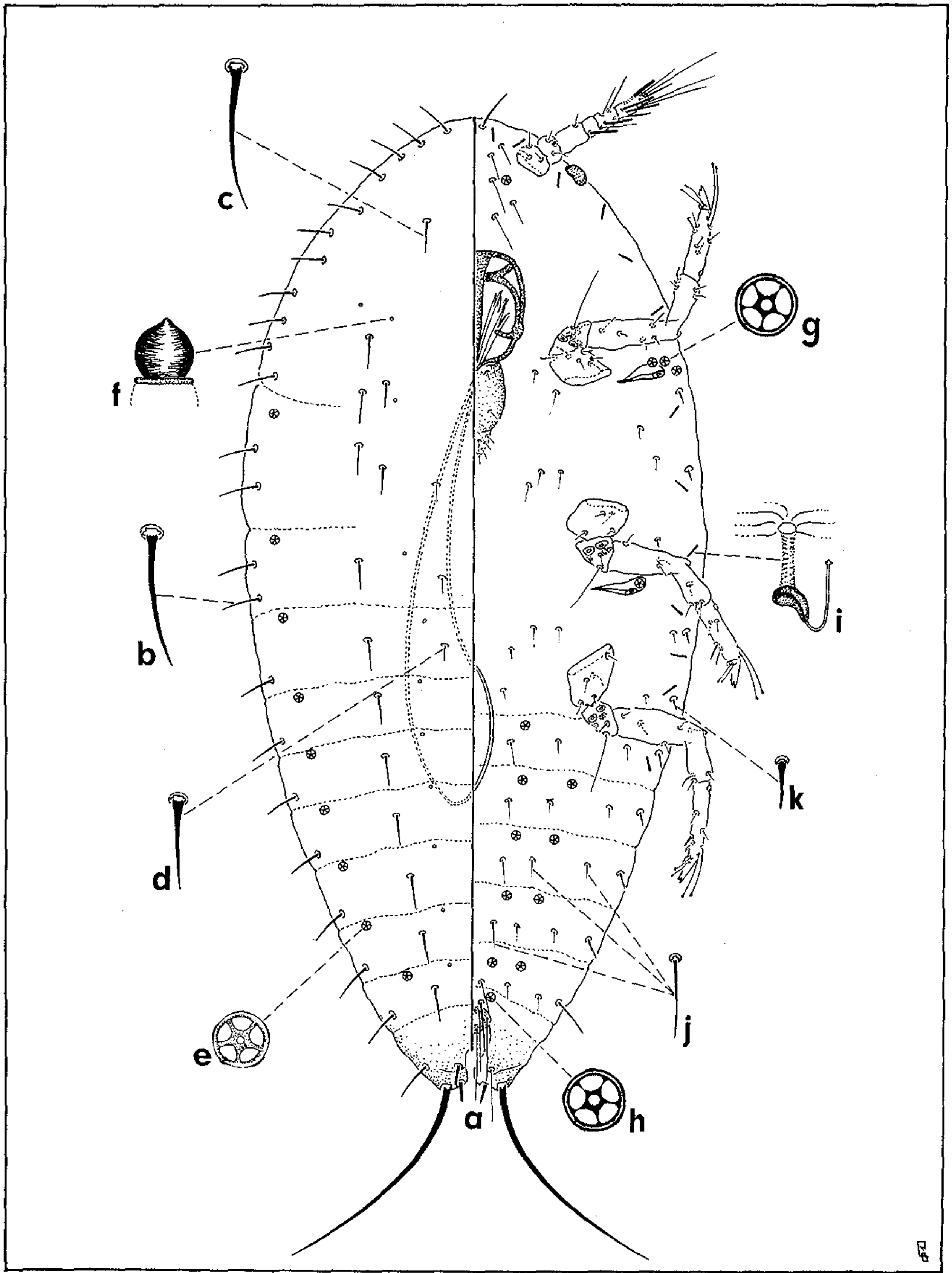


Plate 29. - *Olliffiella secunda* Ferris, second instar female

Tubular ducts. Absent.

Anal lobes. Sclerotized. One seta on inner margin of each lobe, 17 (16-19) long, another at posterior end 14 (12-16) long; apical seta 157 (135-166).

Venter

Antennae. Six-segmented. Total length 104 (95-109). Scape length 16 (14-19), width 38 (35-42). Segments II to VI: 14 (12-16), 26 (23-28), 11 (9-14), 11 (9-12), 26 (23-28) long respectively. Numerous slender setaceous setae on segments. Segments IV and V each with 1 fleshy seta, and 3 fleshy setae on segment VI. Sensory pore on segment II.

Clypeolabral shield. Sclerotized, length 91 (77-106), width 88 (71-106).

Labium. Sclerotized, triangular, length 85 (71- 94), width 66 (53-71); with 8 pairs of setae, each 11 (9-14) long.

Legs. Sclerotized, with numerous setaceous setae on each segment. Sensory pore on proximal lateral margin of each tarsus. Four sensory pores on each trochanter. Tarsal and claw digitules extending beyond apex of claw. Claws with a denticle.

Leg Segments and Claw	Lengths Prothoracic	Lengths Mesothoracic	Lengths Metathoracic
Coxa	31 (28-33)	31 (28-35)	31 (28-39)
Trochanter	30 (28-33)	33 (27-39)	39 (37-44)
Femur	81 (79-83)	81 (76-86)	81 (81-86)
Tibia	47 (41-51)	44 (39-49)	50 (48-53)
Tarsus	69 (67-72)	79 (72-83)	81 (78-86)
Claw	24 (19-28)	25 (19-28)	24 (23-28)
Entire leg	281 (273-288)	293 (282-300)	305 (294-322)

Pores associated with spiracle (fig. g). Each anterior spiracle with 3 quinquelocular pores. Each posterior spiracle with 1 quinquelocular pore.

Quinquelocular pores on derm (fig. h). In 4 longitudinal rows on abdomen, 1 pore associated with each antennal scape, ca. 5 dia.

Tubular ducts (fig. i). Along submargin, ca. 30, 20 (19-22) long, 3 (2-4) wide.

Bilocular pores. Absent.

Body setae (figs. j,k). In 8 longitudinal rows on abdomen and partly on thorax: medial row with 6 pairs, each 33 (23-49) long, ca. 2 wide (fig. j); submedial row with 5 pairs, each 10 (7-19) long, ca. 2 wide (fig. j); submarginal row with 7 to 8 pairs, each 9 (7-14) long, ca. 2 wide (fig. j); marginal row with 10 to 11 pairs, each 12 (7-30) long, ca. 3 wide (fig. k). Other setae near coxal and antennal bases. One pair of setae similar to dorsal marginal setae near scape base.

Anal lobes and ring. Sclerotized. With 1 submedial seta on each lobe 37 (33-42) long, ring oval, ca. 30 long, 32 (30-33) wide; with 18 pairs of translucent rings and 6 anal ring setae, 46 (42-51) long.

Remarks. The original description contained no information on the first or second instar. Ferris (1955b) mentioned that *O. secunda* nymphs were not available for study. The first author feels that *O. secunda* is probably a valid species and not a synonym of *O. cristicola*. Therefore, we included here its description because no second instar female of *Olliffiella* species was ever described. In addition, if *secunda* is synonymized, the description will apply to *cristicola*. Because of the uncertainty of its taxonomic status, we included the species name "secunda" in quotation marks. This species can be separated from *Kermes* second instar females by having 12 pairs of dorsal submedial setae and the presence of dorsal submarginal rows of quinquelocular pores.

FULBRIGHTIA GALLICOLA FERRIS, FIRST INSTAR

Plate 30

Fulbrightia gallicola Ferris, 1950:7.

Type material studied. Paralectotypes from *Quercus delavayi*, **CHINA**, Yunnan Province, near Kunming, An-lin-wen-chian (Hot Springs), Apr. 28, 1949, GFF, 1(1) UCD, 1(1) VPI.

Description. Body (fig. a) oblong, widest at mesothorax, tapering posteriorly, antennae, legs and anal lobes well developed, with 2 long apical setae on each lobe; body 612 (604-619) long, 192 (188-196) wide.

Dorsum

Marginal setae (fig. b). Acorn-shaped, 3 pairs on each abdominal segment, ca. 98-102, these 12 (9-14) long, 9 (7-12) wide.

Marginal setae on anal lobe (fig. c). Similar to other dorsal marginal setae.

Submedial setae on head and thorax (fig. d). Short, setaceous, 2 pairs on head, 1 pair on each thoracic region, 4 (2-5) long, ca. 1 wide.

Submedial setae on abdomen (fig. e). Short, setaceous, similar to submedial setae on head and thorax, 6 pairs, 3 (2-4) long, ca. 1 wide.

Simple pores (fig. f). Each with a sclerotized ring opening to a membranous duct, in 4 longitudinal rows, ca. 43-45, ca. 1 wide.

Derm (fig. g). Simple, membranous.

Intersegmental membrane (fig. h). Apparent due to type of derm.

Anal lobes (figs. a,i). Sclerotized. One acorn-shaped seta on inner margin of each lobe 13 (12-14) long, another at posterior end, 13 (12-14) long; apical seta 327 (325-330) long.

Venter

Antennae (fig. j). Six-segmented. Total length 153 (149-157). Scape 23 long, 34 (30-37) wide. Segments II to VI: 15 (14-16), 42 (39-44), 20 (19-21), 21 (19-23), 35 (30-39) long respectively. Numerous, slender setaceous setae on segments of antenna, fleshy setae on segments IV-VI. Sensory pore on antennal segment II. Trilocular pore at scape base (fig. k).

Clypeolabral shield. Measurements not available.

Labium. long triangular, length 128 (116-139). Eight labial setae, 16 (14-27) long.

Derm (fig. l). Simple membranous.

Legs (fig. m). See enlargement of tibia, tarsus, and claw of metathorcic leg. Four sensory pores on each trochanter (fig. n). Also 1 sensory pore on the proximal lateral margin of each tarsal segment. Numerous thin, setaceous setae on the different segments of each leg. Numerous thick setae on the tibia and tarsus of each leg. Tarsal and claw digitules extending beyond apex of claw. Claws with a denticle.

Leg Segments and Claw	Lengths Prothoracic	Lengths Mesothoracic	Lengths Metathoracic
Coxa	36 (35-37)	32 (28-37)	33 (32-35)
Trochanter	39 (37-42)	38 (37-39)	39 (37-42)
Femur	61 (60-63)	61 (58-65)	60 (58-63)
Tibia	52 (46-58)	48 (46-49)	50 (46-53)
Tarsus	57 (56-58)	59 (51-67)	56 (53-58)
Claw	24 (23-26)	ca. 26	ca. 26
Entire leg	270 (267-274)	264 (260-269)	264 (253-276)

Pores associated with spiracle (fig. o). Each anterior and posterior spiracle with 1 associated 7-locular pore. Anterior spiracle ca. 21 long, ca. 9 wide, atrium ca. 2 wide. Posterior spiracle ca. 21 long, ca. 7 wide; atrium ca. 2 wide.

Bilocular pores (fig. p). Located between the anterior and posterior spiracles. Two along each margin, ca. 2 wide.

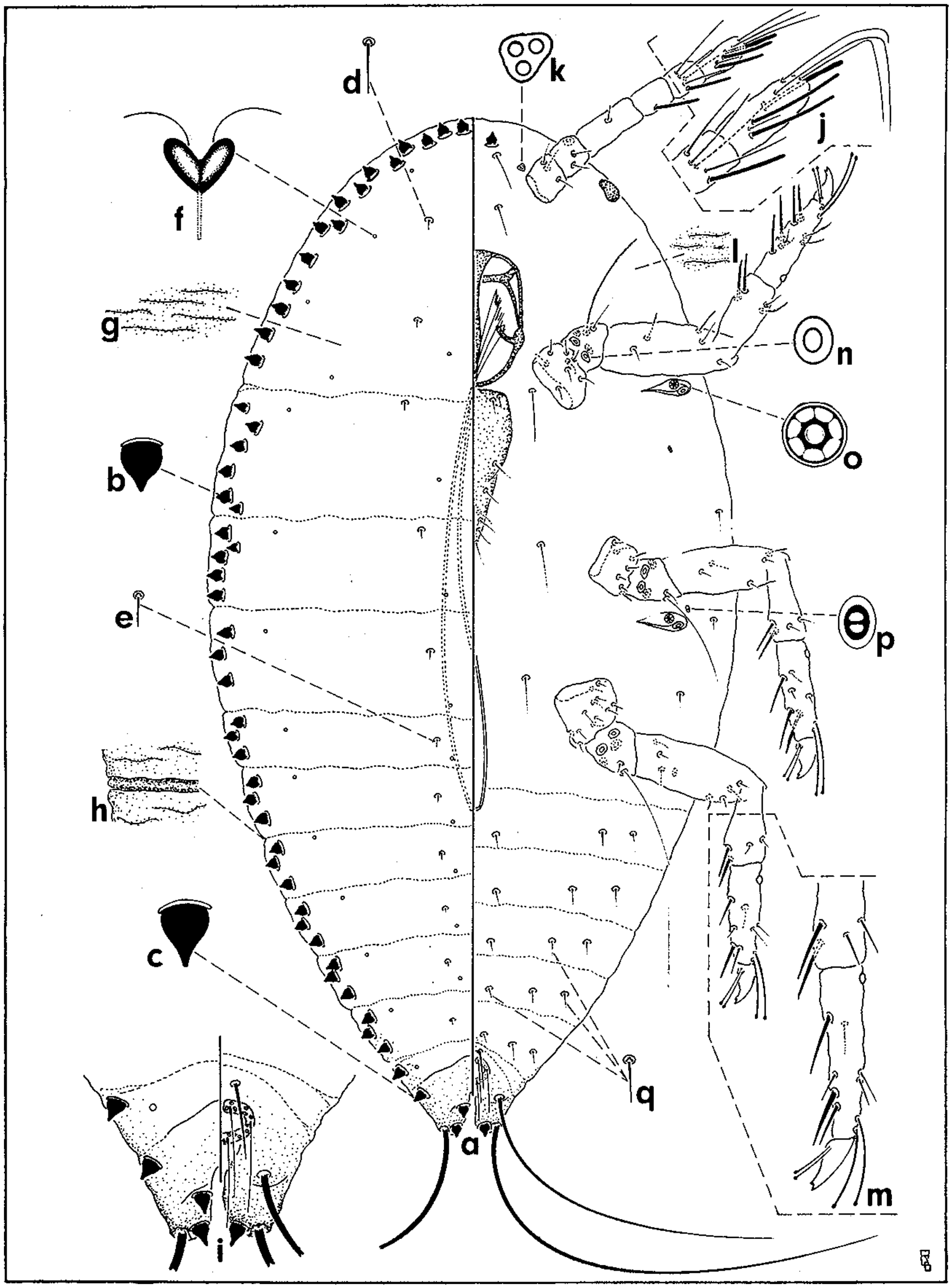


Plate 30. - *Fulbrightia gallicola* Ferris, first instar

Submedial pores on derm. Absent.

Body setae (fig. q). In 6 longitudinal rows. Thin, setaceous on abdomen and partly on thorax: medial row with 5 pairs; submedial row with 5 pairs; submarginal row with 8 pairs. Each 12 (9-14) long, ca. 2 wide. Other longer setae near coxae and antennal scape bases. One pair of acorn-shaped setae near antennal scape base.

Anal lobes and ring (figs. a,i). Sclerotized. With 1 submedial seta on each lobe 177 (171-183) long. Ring oval, ca. 23 long, ca. 26 wide; with ca. 22 transparent cells and 6 setae, each 38 (37-39) long. A pair of thick setae at the anterior margin of the anal ring, ca. 23 long.

Remarks. The type description provided adequate morphological characters and an illustration of the first instar for species recognition. The major distinguishing characters are: acorn-shaped dorsal marginal setae, 3 pairs of these setae on each abdominal segment, the ventral submedial seta on each lobe ca. 2/3 the length of the apical seta and the venter without longitudinal rows of pores.

Ferris (1950) also described the second instar female. However, according to our study, he actually described the second instar male. The 7-segmented antenna and numerous tubular ducts on the dorsum are important characters in distinguishing second instar males in the genus *Kermes* of the Nearctic Region. The presence of quinquelocular pores on the dorsum and venter may place this species in the *Kermes concinnulus* group.

However, conclusive relationships of this genus could not be established. Future studies are needed on other instars of this species. These need to be compared with corresponding stages of the genus *Kermes* from the Palearctic Region.

PHYSERIOCOCCUS CELLULOSIS BORCHSENIUS, FIRST INSTAR

Plate 31

Physeriococcus cellulosus Borchsenius, 1959: 164.

Type material studied. Paralectotypes on *Quercus* sp., **CHINA,** Yunnan Province, near Szemao and Kingtung, May 12, 1957, coll. N. S. Borchsenius, 3 (26) IZ, 1 (10) UCD, 1(8) USNM, 1(9) VPI.

Description. Body (fig. a) oblong, widest at mesothorax, tapering posteriorly, antennae, legs, and anal lobes well developed, with 1 long apical seta on each lobe; body 522 (483-634) long, 179 (166-196) wide.

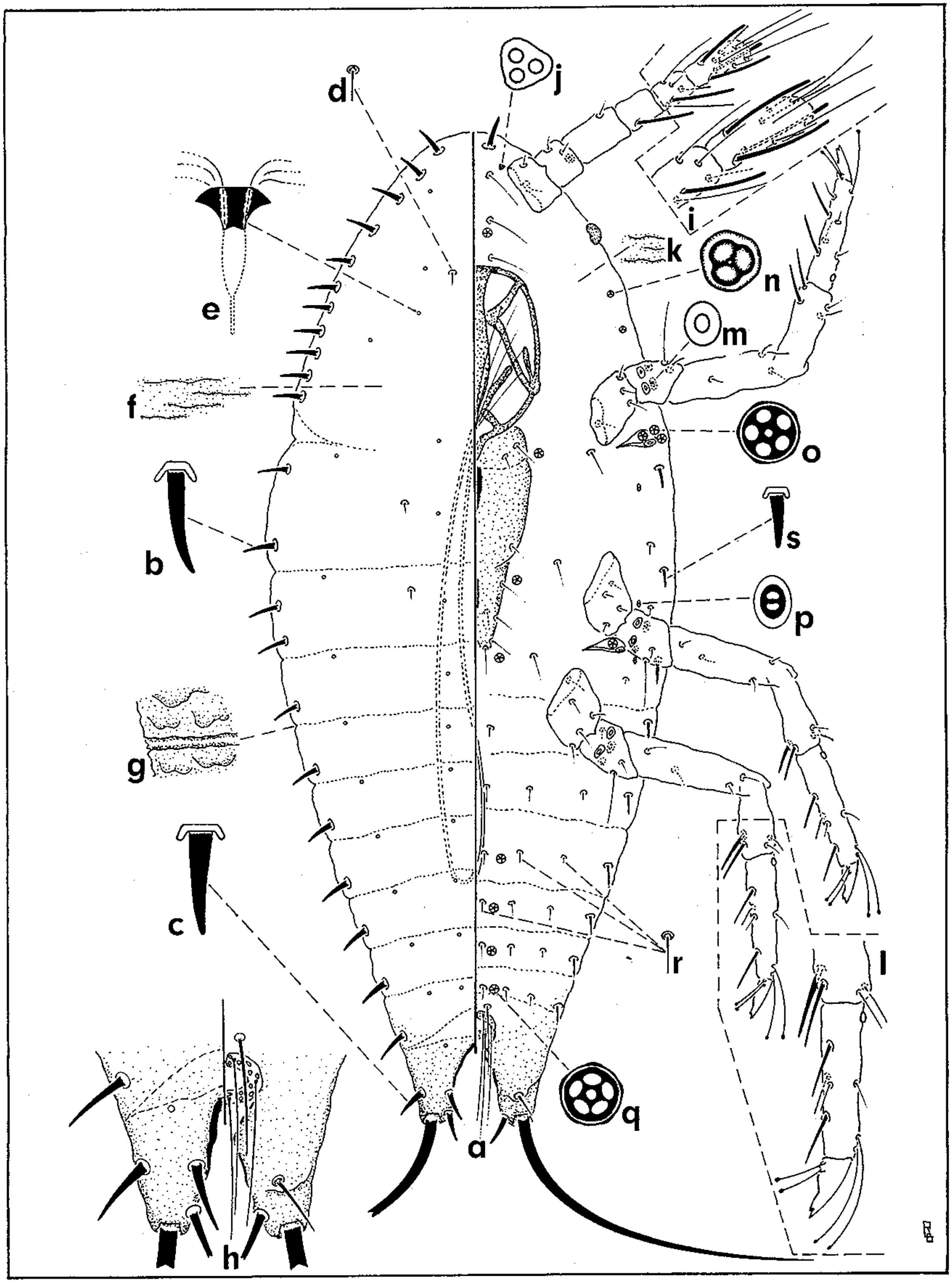


Plate 31. - *Physeriococcus cellulosus* Borchs., first instar

Dorsum

Marginal setae (fig. b). Thick, slightly curved, ca. 45-47, these 13 (12-14) long, ca. 2 wide.

Marginal setae on anal lobe (fig. c). Slightly longer and straighter than other marginal setae, ca. 14 long.

Submedial setae on head and thorax (fig. d). Short, setaceous, 1 pair each on head, pro-and mesothorax, 4 (2-5) long, ca. 1 wide.

Submedial setae on abdomen. Absent.

Simple pores (fig. e). Each with a sclerotized ring opening into a membranous tubular duct, in 4 longitudinal rows, ca. 44-48, ca. 1 wide.

Derm (fig. f) Simple, membranous.

Intersegmental membrane (fig. g). Apparent due to type of derm.

Anal lobes (figs. a,h). Sclerotized. One seta on inner margin of each lobe 12 (11-14) long, another at posterior end, 13 (12-14) long; apical seta 195 (166-211) long.

Venter

Antennae (fig. i). Six-segmented. Total length 124 (116-129). Scape 13 (12-14) long, 26 (23-28) wide. Segments II to VI; 17 (16-19), 33 (28-35), 15 (14-18), 19 (18-21), 27 (24-30) long, respectively. Numerous slender setaceous setae on segments of antenna, fleshy setae on segments IV to VI. Sensory pore on segment II. Trilocular pore at scape base (fig. j).

Clypeolabral shield. Length 88 (77-94), width 68 (59-74).

Labium. Long, triangular, 104 (93-112) long, 49 (39-53) wide. Eight labial setae, 14 (12-20) long.

Derm (fig. k). Simple membranous.

Legs (fig. 1). See enlargement of tibia, tarsus, and claw of metathoracic leg. Four sensory pores on each trochanter (fig. n). Also 1 sensory pore on the proximal lateral margin of each tarsal segment. Numerous thin, setaceous setae on the different segments of each leg. Some thick setae on the tibia and tarsus of each leg. Tarsal and claw digitules extending beyond apex of claw. Claws with a denticle.

Leg Segments and Claw	Lengths Prothoracic	Lengths Mesothoracic	Lengths Metathoracic
Coxa	25 (23-28)	28 (26-33)	26 (23-28)
Trochanter	30 (23-35)	33 (30-35)	35 (31-37)
Femur	61 (58-65)	69 (67-70)	71 (70-72)
Tibia	40 (37-42)	41 (37-46)	46 (44-48)
Tarsus	59 (56-60)	62 (60-67)	68 (67-70)
Claw	15 (12-16)	15 (12-16)	14 (12-16)
Entire leg	230 (216-246)	248 (237-260)	259 (252-265)

Pores associated with spiracle (fig. o). Each anterior spiracle with 3 quinquelocular pores. Each posterior spiracle with 1 quinquelocular pore. Anterior spiracle ca. 18 long, ca. 9 wide, atrium ca. 2 wide. Posterior spiracle ca. 23 long, ca. 9 wide, atrium ca. 2 wide.

Bilocular pores (fig. p). Located near the bases of the marginal setae. Two - 3 along each margin, ca. 2 wide.

Submedial pores on derm (fig. q). In 2 longitudinal rows. Four pairs on head and thorax, 4 pairs on abdomen, mostly quinqueloculars, occasionally triloculars.

Body setae (figs. r,s). In 8 longitudinal rows on abdomen and partly on thorax. Medial row with 6 pairs, 11 (8-16) long; submedial row with 5 pairs, each 6 (5-12) long; submarginal row with 8 pairs, each 4 (3-7) long; marginal row with 9 pairs, similar to dorsal marginal setae, 8 (7-12) long. All ca. 2 wide. Other longer setae near coxal and antennal scape bases. One pair of setae similar to dorsal marginal setae near scape base.

Anal lobes and ring (figs. a,h). Sclerotized. With 1 submedial seta on each lobe 17 (16-19) long. Ring oval, ca. 19 long, ca. 23 wide; with ca. 22 translucent cells and 6 setae, with 30 (28-35) long. A pair setae at the anterior margin of the anal ring, 12 (9-16) long.

Remarks. The original description contained no information on the first instar. The first instars of the Palearctic genus *Physeriococcus* can be separated from the 5 other genera of Kermesidae studied by the absence of dorsal submedial setae on the abdominal segments and the presence of 2 trilocular pores anterior to each anterior spiracle.

Future studies are needed on other instars. These need to be compared with species in the genus *Kermes* of the Palearctic Region.

PHYLOGENY OF THE STUDIED KERMESIDAE

This phylogenetic study of the Kermesidae is based on Hennig's (1965) method of phylogenetic systematics. In Hennig's method a character state in a series is designated as either plesiomorphic (ancestral) or apomorphic (derived). For a group of organisms to be monophyletic, its members must share certain apomorphic characters (synapotypy). This means that for two groups of organisms to be separated on a phylogenetic tree as distinct from one another, each must possess at least one apomorphic character that is plesiomorphic in the other, and both must share at least one apomorphic character.

The list of apomorphic characters and their corresponding plesiomorphic states for adult females (Table 1), and for first instar "crawlers" of both sexes (Table 2), as well as the distribution of the character states among the four North American genera (Plate 32 A), was used to deduce the probable interrelationships among the stated genera (Plate 32 B).

According to Hennig, the differentiation of two or more groups from a common ancestor must occur in a dichotomous fashion. Thus one would expect the first differentiation among the four North American kermesid genera to be either between one of the present-day genera and a group representing the ancestors of the other three genera, or between two groups, each representing the ancestors of two present-day genera. The dichotomy with the least amount of parallel evolution most likely is correct. Thus the dichotomy encompassing the most characters would most likely express the first differentiation among the four genera. Eight characters (Plate 32 A, column N, characters 8 to 3) separate N (*Nanokermes*) and the group (O, K, A) (*Olliffiella, Kermes, Allokermes*); five each separate A and (N, O, K), characters C to A, and (N, O) and (K, A), characters 13 to 10; three separate O and (N, K, A), characters G to F; and two (N, K) and (O, A), characters 15 and 14. Thus by our reasoning the split between N and (O, K, A) represents the first differentiation among the four genera.

The same reasoning is used to expose the second differentiation, which necessarily occurs in the group (O, K, A). Eight characters differentiate O and (K, A); five A from (O, K); and two separate K and (O, A). Thus the split between O and (K, A) represents the second differentiation among the four genera. The third differentiation must occur between K and A, and involves seven characters.

The resulting phylogenetic tree is shown in Plate 32 B. In the discussion above, character states that are widely distributed in the Eriococcidae are presumed to be plesiomorphic. Ferris (1955b) and Borchsenius (1960) believed the Kermesidae to be closely related to the Eriococcidae.

Table 1. Plesiomorphic (ancestral) and apomorphic (derived) character states of the adult females of North American Kermesidae (S. W. Bullington)

	Character	Plesiomorphic	Apomorphic
1.	anal lobes	anterior to anal opening	encircling anal opening
2.	circum-anal sclerotization	poorly defined	well defined, forming substitute anal ring
3.	areolate anal ring	present	absent
4.	membranous anal tube	poorly developed	well developed
5.	anal lobe setae	few, stout	many, slender
6.	anterior spiracular furrow	present	absent
7.	tubular pores	1 type	2 types
8.	lateral row of multilocular disc pores	present	absent
9.	false venter	well developed	degenerate
10.	habitat	twigs, branches, bark	leaves
11.	body size of post-reproductive adult	not larger than newly eclosed adult	several times larger than newly eclosed adult
12.	body shape of post-reproductive adult	without median incision	with median incision
13.	medial partition of postreproductive adult	triangular in cross section	parallel-sided in cross section
14.	spinescent pores	present	absent
15.	marginal setae	associated with cluster of multilocular disc pores	not associated with cluster of multilocular disc pores

Table 2. Plesiomorphic and apomorphic character states of the first instars of North American Kermesidae (R. G. Baer). All measurements are in microns.

	Character	Plesiomorphic	Apomorphic
A.	size of dorsal marginal setae	long (19-48), or parallel-sided	short (8-22), never parallel-sided
B.	ventral submedial setae on anal lobe	long (16-53)	short (7-25)
C.	type of pores on venter	trilocular	quinquelocular
D.	no. of dorsal marginal setae on each abdominal segment	2 pairs	1 pair
E.	rows of setae on abdominal venter	8 rows	6 rows
F.	shape of dorsal marginal setae	not conical	conical
G.	number of pairs of setae in dorsal submedial row	12 pairs	11 pairs
H.	dorsal marginal setae on abdomen	all thickened	all thin setaceous

The combined phylogenetic conclusions reached from separate studies on first instars and adult females, based on Hennig's (1965) method, and compiled here by S. W. Bullington and M. Kosztarab, are the following:

Members of the leaf-infesting *Nanokermes* form a distinct group morphologically, which is well separated from the other three genera present in the Nearctic Region. *Nanokermes* also share the largest number of ancestral (Plesiomorphic) character states with their eriococcid-like ancestors. *Nanokermes* appear to be most closely related to the leaf gall-inhabiting *Olliffiella*. The latter are unique among the Kermesidae by being the only group without a well-developed false venter and heavily sclerotized tergum.

Kermes and *Allokermes* appear to be closely related genera, forming the two most advanced taxa, by sharing the largest number (10) of derived (apomorphic) characters, as presented in Plate 32 A.

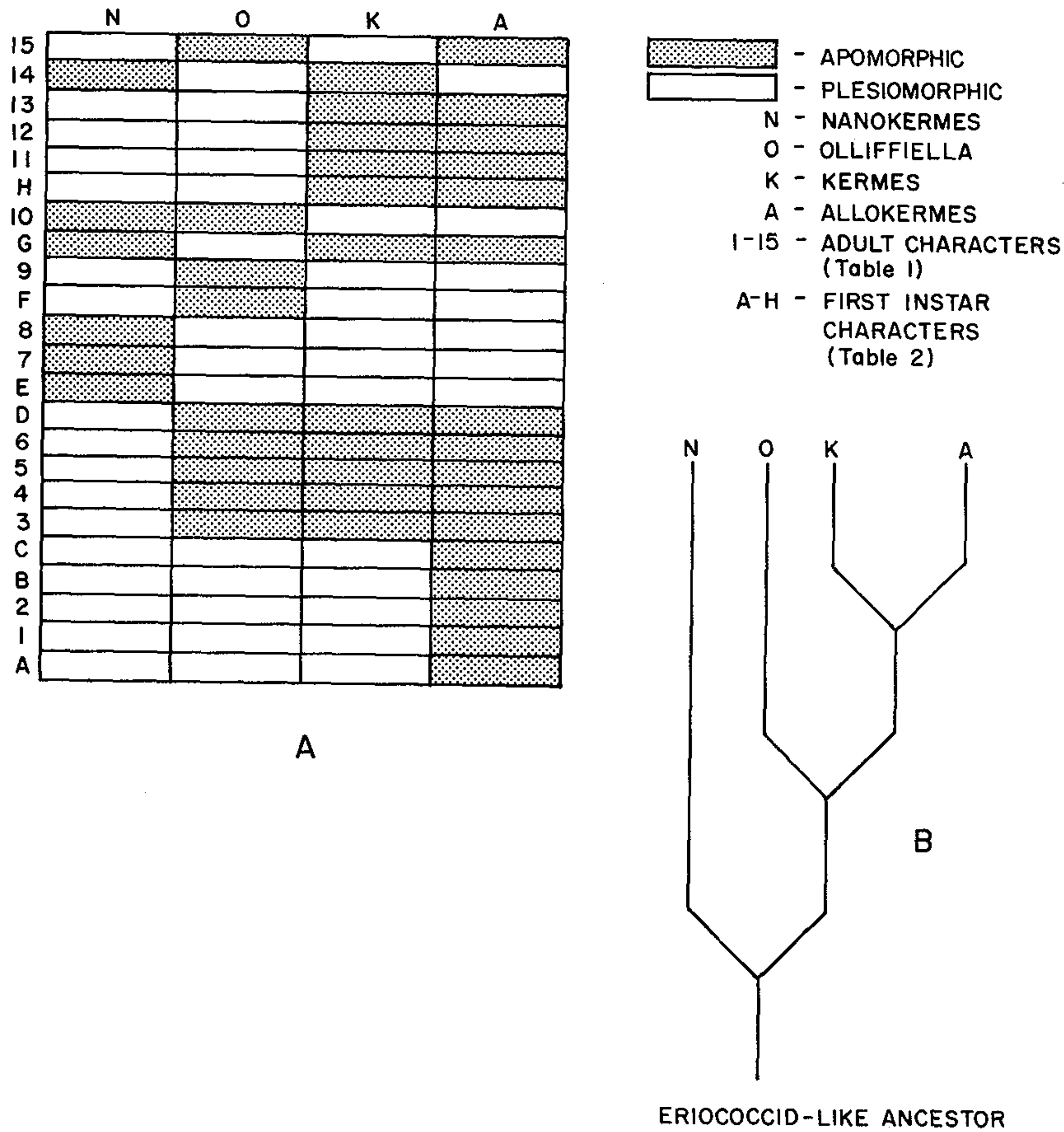


Plate 32. Phylogeny of the family Kermesidae in North America.
A. Distribution of plesiomorphic and apomorphic states for characters listed in Tables 1 and 2.
B. Hypothetical phylogenetic tree.

LITERATURE CITED

Amos, J.M. 1933. A list of the Coccidae of Tippecanoe County and their hosts (Homoptera). Proc. Ind. Acad. Sci. 42:205-211.

Baer, R.G. 1980. A new species of gall-like coccid from southeastern United States. J. Ga. Entomol. Soc. 15(1):20-25.

Baer, R.G. and M. Kosztarab. 1981. Two new species of gall-like scale insects on oaks from the Nearctic Region (Homoptera: Coccoidea: Kermesidae). Fla. Entomol. 64(2):226-234.

_________. 1985. A morphological and systematic study of the first and second instars of the Kermesidae in the Nearctic Region (Homoptera: Coccoidea). Va. Agric. Exp. Stn. Bull. 85-11:119-261.

Baerg, W.J. 1955. Notes on the biology of a post oak scale (*Kermes pubescens* Bogue, Coccidae, Homoptera). J. Kans. Entomol. Soc. 28(4):147-151.

Baker, W.L. 1972. Eastern Forest Insects. U.S. Dep. Agric. For. Serv. Misc. Publ. 1175. 642 p.

Balachowsky, A. 1942. Essai sur la classification des cochenilles (Homoptera: Coccoidea). Ann. Grignon Ecole Natl. d'Agric. (ser. 3) 3:34-48.

_________. 1948. Les cochenilles de France, d'Europe, du nord de l'Afrique, et du bassin Mediterranean. Actual. Sci. et Ind. Entomol. Appl. 1054:243-394.

_________. 1950a. Les *Kermes* (Hom. Coccoidea) des chenes en Europe et dans le bassin Mediterranean. Proc. 8th Int. Congr. Entomol. (Stockholm), 739-754.

_________. 1950b. Remarques biogeographiques sur l'aire de repartition mondiale du G. *Kermes* (Hom. Coccoidea). Proc. 8th Int. Congr. Entomol. (Stockholm), 342-346.

_________. 1953. Sur les *Kermes* Boitard (Hom. Coccoidea) des chenes du bassin oriental de la Mediterranee. Rev. Pathol. Veg. et d'Entomol. Agric. de France. 32(3):181-189.

Balduf, W.V. 1939. The Bionomics of Entomophagous Insects. J.S. Swift Co., Inc., N.Y. 384 p.

Barber, T.C. 1911. The Coccidae of Louisiana. J. Econ. Entomol. 4:448-451.

Barrows, E.M. 1979. *Polistes* wasps (Hymenoptera: Vespidae) show interference competition with other insects for *Kermes* scale insect (Homoptera: Kermesidae) secretions. Proc. Entomol. Soc. Wash. 81(4):570-575.

Beardsley, J.W. 1983. The family Kermesidae. Manuscript for a book in preparation. Unpublished.

Bogue, E.E. 1898. Two new species of *Kermes* from Kansas. Can. Entomol. 30:172.

__________. 1900. A new species of *Kermes*. Can. Entomol. 32:205-206.

Boitard, P. 1828. Les gallinsectes. *In* Manuel d'Entomologie ou Historie Naturelle des Insectes. 2:169-172.

Borchsenius, N.S. 1959. Notes on the Coccoidea of China. VI. Descriptions of some new genera and species of Eriococcidae and Coccidae (Homoptera, Coccoidea). Entomol. Obozr. 38(1):164-175.

__________. 1960. Fauna of USSR, Coccoidea, Families Kermococcidae, Asterolecaniidae, Lecanodiaspididae, Aclerdidae (In Russian). Akad. Nauk SSR Zool. Inst. (n.s. 77) 8, 282 p.

Britton, W.E. 1916. Miscellaneous insect notes. Rep. Conn. Agric. Exp. Stn. Pt. 2:138-146.

__________. 1920. Check-list of the insects of Connecticut. Conn. State Geol. Nat. Hist. Surv. Bull. 31. 397 p.

__________. 1923. Guide to the insects of Connecticut. The Hemiptera or sucking insects of Connecticut. Conn. State Geol. Nat. Hist. Surv. Bull. 34:346-382.

__________. 1926. Entomological features of 1926. 26th Rep. Conn. State Entomol. Bull. 285:166-181.

__________. 1930. 29th report Connecticut State Entomologist. Conn. Agric. Exp. Stn., New Haven Bull. 315:483-619.

Britton, W.E. and M.P. Zappe. 1926. Inspection of nurseries in 1926. 26th Rep. Conn. State Entomol. Bull. 285:181-188.

Bullington, S.W. and M. Kosztarab. 1977a. Morphology and taxonomy of gall-like scale insects, *Kermes* spp. (Homoptera, Kermesidae) in Virginia. Va. J. Sci. 28(2):61 (Abstract).

__________. 1977b. Morphology and taxonomy of gall-like scale insects *Kermes* spp. (Homoptera: Kermesidae) in Eastern North America. N.Y. Entomol. Soc. J. 85(4):168-169 (Abstract).

__________. 1985. A revision of the family Kermesidae (Homoptera) in the Nearctic Region based on adult and third instar females. Va. Agric. Exp. Stn. Bull. 85-11:1-118.

Carnes, E.K. 1906. The Coccidae of California. State Horticultural Comm. Sacramento, Calif. 70 p.

Cockerell, T.D.A. 1894. A check list of the Nearctic Coccidae. Can. Entomol. 26(2):31-36.

________. 1895a. New facts about scale insects - I. Garden and Forest. No. 382:244.

________. 1895b. Three new species of Coccidae. Entomologist 28:100-101.

________. 1896a. Check list of the Coccidae. Bull. Ill. State Lab. Nat. Hist. 4:318-339.

________. 1896b. New Coccidae from Massachusetts and New Mexico. Can. Entomol. 28(5):222-226.

________. 1896c. A gall-making coccid in America. Science 4:299-300.

________. 1897a. Descriptive notes on two Coccidae. Entomologist 30:12-14.

________. 1897b. The third American *Kermes*. Entomol. News 8:94-95.

________. 1898a. Miscellaneous notes. Proc. Entomol. Soc. Wash. 4:64-65.

________. 1898b. Some new Coccidae of the subfamily Lecaniinae. Entomologist 31:130-132.

________. 1898c. New North American insects. Ann. Mag. Nat. Hist. (ser. 7) 2:321-331.

________. 1898d. New Coccidae from Mexico. Ann. Mag. Nat. Hist. (ser. 7) 1:426-440.

________. 1899a. Aleurodidae and Coccidae. Biol. Cent. Am. 2(2):1-37.

________. 1899b. First supplement to the check-list of the Coccidae. Article VII - Bull. Ill. Nat. Hist. Surv. 5:389- 398.

________. 1899c. Tables for the determination of the genera of Coccidae. Can. Entomol. 31:273-279.

________. 1900. Table of North American *Kermes*, based on external characters. Psyche 9:44-45.

________. 1905. Tables for the identification of Rocky Mountain Coccidae. Univ. Colo. Studies 2(3): 189-203.

________. 1906. Notes on Coccidae. Proc. Entomol. Soc. Wash. 8:33-35.

Cockerell, T.D.A. 1929. The type of genus *Coccus* (Homoptera, Coccidae). Science 70(1806):150.

________. 1940. The insects of the California islands. Proc. Pac. Sci. Cong. 6(4):282-295.

________. and G.B. King. 1898. The coccid genus *Sphaerococcus* in Massachusetts. Can. Entomol. 30:326.

Compere, H. 1926. New coccid-inhabiting parasites (Encyrtidae, Hymenoptera) from Japan and California. Univ. Calif. Publ. Entomol. Berkeley 4:33-50.

________. 1928. New coccid-inhabiting Chalcidoid parasites from Africa and California. Univ. Calif. Publ. Entomol. Berkeley 4:209-230.

Comstock, J.H. 1881. Report of the entomologist. U.S. Dep. Agric. Annu. Rep. 1880:235-373.

________. 1883. Second report on scale insects. Cornell Univ. Agric. Exp. Stn. Dep. Entomol. Rep. 2: 46-162.

Dean, G.A. 1909. Coccidae of Kansas. Kans. Acad. Sci. Trans. 22:265-275.

Dietz, H.P. and H. Morrison. 1916. The Coccidae or scale insects of Indiana. Ind. State Entomol. Annu. Rep. 8:232-236.

Doane, R.W., E.C. VanDyke, W.J. Chamberlin and H.E. Burke. 1936. Forest Insects. McGraw-Hill Book Co., Inc., N.Y. and London. 463 p.

Dodge, B.O. and H.W. Rickett. 1943. Diseases and Pests of Ornamental Plants. The Ronald Press Co., N.Y. 638 p.

Ebbers, B.C. and E.M. Barrows. 1980. Individual ants specialize on particular aphid herds (Hymenoptera: Formicidae; Homoptera: Aphididae). Proc. Entomol. Soc. Wash. 82(3):405-407.

Ehrhorn, E.M. 1898. New Coccidae from California. Entomol. News 9:185-186.

________. 1899a. Three new Coccidae. Can. Entomol. 31(1):103-104.

________. 1899b. Five new Coccidae. Can. Entomol. 31:5-7.

________. 1906. A few new Coccidae with notes. Can. Entomol. 38:329-335.

________. 1911. New Coccidae with notes on other species. Can. Entomol. 43(8):275-280.

Essig, E.O. 1914a. The Monthly Bulletin. Calif. State Comm. Hort. 3(1):97-143.

Essig, E.O. 1914b. The Monthly Bulletin. Calif. State Comm. Hort. 3(4):147.

________. 1915. Injurious and beneficial insects of California, ed. 2. Calif. State Comm. Hort. Mon. Bull. 4(4):114-118.

________. 1926. Insects of Western North America. The Macmillan Co., N.Y. 1035 p.

________. 1931. A History of Entomology. The Macmillan Co., N.Y. 1029 p.

Felt, E.P. 1901. Scale insects of importance and list of species in New York State. N.Y. State Mus. Bull. 46(9):289-377.

Felt, E.P. and H. Morrison. 1928. Coccidae. *In* M.D. Leonard, A list of the insects of New York with a list of the spiders and certain other allied groups. Cornell Univ. Agric. Exp. Stn. Mem. 101:193-202.

Felt, E.P. and W.H. Rankin. 1932. Insects and Diseases of Ornamental Trees and Shrubs. The Macmillan Co., N.Y. 507 p.

Fernald, M.E. 1903. A catalogue of the Coccidae of the world. Mass. Agric. Exp. Stn. Spec. Bull. 88. 360 p.

Ferris, G.F. 1919. A contribution to the knowledge of the Coccidae of southwestern United States. Stanford Univ. Publ., Univ. Ser. 68 p.

________. 1920. Scale insects of the Santa Cruz Peninsula. Stanford Univ. Publ., Univ. Ser., Biol. Sci. 1(1):1-57.

________. 1921. Notes on Coccidae. VII (Hemiptera). Can. Entomol. 53(3):57-61.

________. 1937. Atlas of the scale insects of North America. Vol. 1. Family Diaspididae (Part 1). Stanford Univ. Press, Calif. 275 p.

________. 1950. Report upon scale insects collected in China (Homoptera: Coccoidea). Part I. (Contribution No. 66). Microentomology 15:1-34.

________. 1955a. Some miscellaneous Coccoidea (Insecta: Homoptera). (Contribution No. 91). Microentomology 20:22-29.

________. 1955b. Atlas of scale insects of North America. Vol. 7, the families Aclerdidae, Asterolecaniidae, Conchaspididae, Dactylopiidae and Lacciferidae. Stanford Univ. Press, Calif. 233 p.

________. 1957. A review of the family Eriococcidae (Insecta: Coccoidea). Microentomology 22(4):81-89.

Fletcher, J. and A. Gibson. 1908. Entomological Record 1907. Entomol. Soc. Ontario 38th Annu. Rep. 19:113-133.

Flint, W.P. and M.D. Farrar. 1940. Protecting shade trees from insect damage. Ill. Agric. Exp. Stn. Circ. 509:1-60.

Fourcroy, A.F. 1785. Entomologia Parisiensis. Paris. 544 p. (Spec. p. 227-231).

Fulmek. L. 1943. Wirtsindex der Aleyrodiden und Cocciden- Parasiten. Entomol. Beihefte aus Berlin-Dahlem. Bd. 10. 100 p.

Garcia Mercet, R. 1912. Los enemigos de los parasites de las plantas. Mus. Nac. Cient. Nat. 10:244-245.

Garman, H. 1905. Some tree- and wood-infesting insects. Ky. Agric. Exp. Stn. Bull. 120:45-77.

Gibson, A. 1913. Reports on insects for the year. Entomol. Soc. Ont. 43rd Annu. Rep. 11-20.

Gillette, C.P. and C.F. Baker. 1895. A preliminary list of the Hemiptera of Colorado. Colo. Agric. Exp. Stn. Bull. 31 (Tech. Ser. 1):125-129.

Girault, A.A. 1911. The chalcidoid parasites of the coccid *Kermes pubescens* Bogue, with descriptions of two new genera and three new species of Encyrtidae from Illinois. Can. Entomol. 43:168-178.

Hamon, A.B. 1980. *Kermes kosztarabi* Baer (Homoptera: Kermesidae). *In* Div. Plant Industry 33rd Biennial Report, Florida Dep. Agriculture and Consumer Services. July 1, 1978-June 30, 1980. 39-40.

Hamon, A.B., P.L. Lambdin, and M. Kosztarab. 1975. Eggs and wax secretion of *Kermes kingi*. Ann. Entomol. Soc. Am. 68(6):1077-1078.

________. 1976. Life history and morphology of *Kermes kingi* in Virginia (Homoptera: Coccoidea: Kermesidae). Va. Polytech. Inst. State Univ. Res. Div. Bull. 111:1-32.

Hartman, F.T. 1916. List of the Coccidae in the collection of the New York State Museum. N.Y. State Mus. Bull. 180 (N.Y. State Univ. Bull. 606):92-109.

Headlee, T.J. 1928. Report of the department of entomology. N.J. State Agric. Exp. Stn. Rep., Year End. June 30, 1928, 125-133.

Heller, P.R. 1977. Oak *Kermes* scale, *Kermes pubescens* Bogue. Pennsylvania State Univ., University Park, Pa. Cooperative Extension Service, Ornamentals and Turf, 2 p.

Hennig, W. 1965. Phylogenetic systematics. Annu. Rev. Entomol. 10:97-116.

Herrick, G.W. 1935. Insect Enemies of Shade-trees. Comstock Publ. Co., Inc., Ithaca, N.Y. 417 p.

Himebraugh, L.C. 1904. The eggs of *Kermes gillettei* Cockerell (family Coccidae). Entomol. News 15:188.

Hollinger, A.H. 1923. Scale insects of Missouri. Mo. Agric. Exp. Stn. Res. Bull. 58:43-44.

Hollinger, A.H. and H.B. Parks. 1919. *Euclemensia bassettella* (Clemens), the *Kermes* parasite (Microlepidoptera, Tineoidea, Oecophoridae). Entomol. News 30(4):91-100.

Houard, C. 1940. Les Zoocecidies des Plantes de l'Amerique du Nord. Galles de Chenes. Paris, p. 96, 294, 300.

Houser, J.S. 1918. Destructive insects affecting Ohio shade and forest trees. Ohio Agric. Exp. Stn. Bull. 332:165-487.

Howard, L.O. 1897. A gall-making coccid in America. U.S. Dep. Agric. Div. Entomol. Bull. 7:76-77.

________. 1911. A new species of *Coccophagus* with a table of the host relations of those species of the genus known to the writer. J. Econ. Entomol. 4:276-277.

________. 1919. On the Hymenopterous parasites of *Kermes*. (Homop. Coccidae). Entomol. News 30(9):255-259.

Hoy, J.M. 1963. A catalogue of the Eriococcidae (Homoptera: Coccoidea) of the world. N. Z. Dep. Sci. Indus. Res. Bull. 150, 260 p.

Hunter, S.J. 1902. Coccidae of Kansas, IV. Additional species, food plants and bibliography of Kansas Coccidae, with appendix on other species reported from Kansas. Kans. Univ. Quart. Ser. A 10:107-145.

Jarvis, T.D. 1908. A preliminary list of the scale insects of Ontario. Entomol. Soc. Ont. Annu. Rep. 38(1907):50-72.

________. 1911. The Coccidae of Canada. Entomol. Soc. Ont. Annu. Rep. 41(1910):64-77.

Johnson, W.T. and H.H. Lyon. 1976. *Lecanium* and *Kermes* scales. *In* Insects that Feed on Trees and Shrubs. Comstock Publ. Assoc., Cornell Univ. Press, Ithaca and London. 464 p.

Kawai, S. 1980. Scale insects of Japan in colors. Natl. Agric. Educ. Assoc. 455 p.

King, G.B. 1899. Contributions to the knowledge of Massachusetts Coccidae - II. Can. Entomol. 31:139-143.

________. 1900a. The fifth species of *Kermes* from Massachusetts. Psyche 9:22.

________. 1900b. The genus *Kermes* in North America. Psyche 9:78-84.

________. 1900c. Miscellaneous notes on Coccidae from western Massachusetts. Psyche 9:116-118.

________. 1901. The Coccidae of British North America. Can. Entomol. 33:193-200.

________. 1902a. Further notes on Massachusetts Coccidae. Can. Entomol. 39:59-63.

________. 1902b. Coccidae of British North America. Can. Entomol. 34:158-161.

________. 1903a. The seventeenth American *Kermes* (Coccidae). Entomol. News 14:21-22.

________. 1903b. Some new records of Coccidae. Can. Entomol. 35:191-197.

________. 1913a. Seventh *Kermes* (Coccidae) from California. J. Entomol. Zool. 5(4):205-206.

________. 1913b. The eighth California *Kermes*. J. Entomol. Zool. 5(4):206-207.

________. 1914a. A historical *Kermes* (Coccidae). The ninth from California. J. Entomol. Zool. 6(1):48-49.

________. 1914b. The tenth California *Kermes*. J. Entomol. Zool. 6(2):100-101.

________. 1914c. The eleventh *Kermes* (Coccidae) from California. J. Entomol. Zool. 6:133.

________. 1914d. A new species of *Kermes* from Connecticut. J. Econ. Entomol. 7:150-151.

Knipscher, R.C., D.R. Miller, and J.A. Davidson. 1976. Biosystematics of *Chionaspis nyssae* Comstock (Homoptera: Diaspididae) with evidence supporting leaf and bark dimorphism of the scale. Melanderia 25, 30 p.

Kosztarab, M. 1977a. An oak *Kermes* scale. Coop. Plant Pest Rep. 2(41):813.

Kosztarab, M. 1977b. Status of scale insects of forest trees - an overview (Homoptera: Coccoidea). New York Entomol. Soc. J. 85(4):184-185. (Abstract)

__________. 1982. Observations on *Torvothrips kosztarabi* (Thysanoptera: Phlaeothripidae) inhabiting coccoid galls. Fla. Entomol. 65(1):159-164.

Kosztarab, M. and F. Kozar. 1985. The scale insects of Central Europe. Akademy Publ. (Budapest). Book in press.

Koteja, J. 1974a. Comparative studies on the labium in the Coccinea (Homoptera). Sci. Pap. Agric. Univ. Krakow. Warsaw, Poland. 89:1-162.

__________. 1974b. The occurrence of a campaniform sensillum on the tarsus in the Coccinea (Homoptera). Pol. Pismo Entomol. 44:243-252.

__________. 1974c. On the phylogeny and classification of the scale insects (Homoptera, Coccinea). Acta Zool. Cracoviensia 19(14): 267-325.

__________. 1976. The salivary pump in the taxonomy of the Coccinea (Homoptera). Acta. Zool. Cracoviensia 21(7):263-290.

__________. 1980. The genus *Nidularia* Targioni-Tozzetti, 1869 (Homoptera, Coccinea). Ann. Naturhist. Mus. Wien. 83:589-596.

Koteja, J. and E. Liniowska. 1976. The clypeolabral shield in the taxonomy of the Coccinea (Homoptera). Pol. Pismo Entomol. 46:653-681.

Koteja, J. and B. Zak-Ogaza. 1972. Morphology and taxonomy of the male *Kermes quercus* (L.) (Homoptera, Coccoidea). Acta. Zool. Cracoviensia 17:193-215.

Kotinsky, J. 1921. Insects injurious to deciduous shade trees and their control. U.S. Dep. Agric. Farmers Bull. 1169:79-80.

Kozar, F. 1974. Mass infestation and damage of the oak scale *Kermes quercus* L. (Homoptera: Coccoidea). Novenyvedelem 10(12):534-537.

Kuwana, I. 1931. The genus *Kermes* of Japan. Jap. Min. Agric. For. Sci. Bull. 2:15-29.

Lambdin, P.L. and J.K. Watson. 1980. New collection records for scale insects of Tennessee. Tenn. Acad. Sci. J. 55(3):77-81.

Latreille, P.A. 1798. Memoire sur une nouvelle espece de Psylle. *Kermes*. Bull. des Sci., Soc. Philomath. Paris 1 (15):113.

Lawson, P.B. 1917. Scale insects injurious to fruit and shade trees: the Coccidae of Kansas. Kans. Univ. Bull. (Biol. Ser.) 18(1):161-279.

Lindinger, L. 1908. Cocciden-studien. I. Zur systematik der Diaspinen. II. Kritische notizen. Berlin Entomol. Ztschr. 52(1907):96-106.

Lindinger, L. 1910. Die Cocciden - Literatur des Jahres 1908. Ztschr. f. Wiss. Insektenbiol. 6:323-330.

________. 1914. Die Cocciden - Literatur des Jahres 1909. Ztschr. f. Wiss. Insektenbiol. 10:114-120.

________. 1923. Liste neuerdings beschriebener und gezogener Parasiten und ihre Wirte VIII. Soc. Entomol. 38(1):3-4.

________. 1933. Beitrage zur Kenntnis der Schildlause (Hemipt. - Homopt., Coccid.) Entomol. Anz. Jahrg. 13(10):143.

________. 1937. Verzeichnis der Schildlaus-Gattungen. (Homoptera - Coccoidea Handlirsch 1903). Entomol. Jahrl. 46:178-198.

________. 1943. Die Schildlausnamen in Fulmeks Wirts- index. Arb. uber Morph. und Taxon. Entomol. aus Berlin. 10:145-152.

________. 1958. Richtigstellung der Schildlausnamen. Beitrage zur Entomol. Bd. 8 (3/4):365-374.

Lintner, J.A. 1896. Notes on some of the insects of the year in the state of New York. U.S. Dep. Agric. Div. Entomol. Bull. 6:54-61.

Little, E.L., Jr. 1953. Check list of native and naturalized trees of the United States (including Alaska). Agric. Handb. No. 41. U.S. Forest Service. Washington, D.C. 472 p.

Lobdell, G.H. 1929. Two new species of *Eriococcus* from Mississippi (Homoptera: Coccoidea). Ann. Entomol. Soc. Am. 22:762-767.

________. 1937. Two-segmented tarsi in coccids; other notes (Homoptera). Ann. Entomol. Soc. Am. 30(1):75-80.

MacGillivray, A.D. 1921. The Coccidae. Scarab Company, Urbana, Ill. 502 p.

Maskell, W.M. 1884. Further notes on Coccidae in New Zealand, with descriptions of new species. New Zeal. Inst., Trans. and Proc. 16(1883):120-144.

________. 1894. Remarks on certain genera of the Coccidae. Entomologist 27:93-95.

McConnell, H.S. and J.A. Davidson. 1959. Observations on the life history and morphology of *Kermes pubescens* Bogue (Homoptera: Coccoidea: Dactylopiidae). Ann. Entomol. Soc. Am. 52(4):463-468.

McDaniel, E.I. 1930. Soft scales injurious to deciduous ornamentals. Mich. State Coll. Agric. Exp. Stn. Circ. Bull. 133: 17 p.

Merrill, G.B. and J. Chaffin. 1923. Scale insects of Florida. Fla. State Plant Bd. Quart. Bull. 7:177-298.

Nassonov, N.V. 1910. Sur les transformations de *Kermes quercus* (Linn.). Bull. Acad. Imp. des Sci. St. Petersbourg (ser. 6) 4:47-60.

Newell, W. and A.H. Rosenfeld. 1908. A brief summary of the more important injurious insects of Louisiana. J. Econ. Entomol. 1:150-155.

Newstead, R. 1902. Monograph of the British Coccidae. Adlard and Son, London. Vol. 2. 207 p.

Olsen, C.E. 1919. *Kermes kingii* Cockerell, parasitized by a microlepidopteran. Bull. Brooklyn Entomol. Soc. 14(4,5):141-142.

Osborn, H. 1898. Notes on Coccidae occurring in Iowa. Proc. Iowa Acad. Sci. 5:224-231.

Osmun, J.V. 1962. Insects and other arthropods of economic importance in Indiana in 1961. Proc. Ind. Acad. Sci. 71:130-137.

Peck, O. 1963. A catalogue of the Nearctic Chalcidoidea (Insecta: Hymenoptera). Can. Entomol. Suppl. 30:934-935.

Pirone, P.P. 1972. Tree Maintenance. Oxford University Press, N.Y. 574 p.

Reyne, A. 1954. *Reynvaania gallicola*, a new eriococcid causing galls on *Quercus lineata* Bl. Tijdschr. v. Entomol. 97(4):233-241.

Riley, C.V. 1881. A new species of oak coccid mistaken for a gall. Am. Nat. 15:482.

_________. 1894. Notes on Coccidae. Proc. Entomol. Soc. Wash. 3:65-71.

Robison, W.G. Jr. 1977. Ultrastructure of Coccoidea sperm. Va. Polytech. Inst. & State Univ. Res. Div. Bull. 127:35-50.

Ruhl, M. 1913. Liste neuerdings beschriebener oder gezogener Parasiten und ihre Wirte. Soc. Entomol. Jahrg. 28(19):79-80.

_________. 1914. Liste neuerdings beschriebener oder gezogener Parasiten und ihre Wirte. Soc. Entomol. Jahrg. 29(6):25-26.

_________. 1917. Liste neuerdings beschriebener oder gezogener Parasiten und ihre Wirte. IV. Soc. Entomol. Jahrg. 32(12):49-50.

__________. 1919. Liste neuerdings beschriebener und gezogener Parasiten und ihre Wirte. VII. Soc. Entomol. Jahrg. 34(1):44.

Ruhl, M. 1923. Liste neuerdings beschriebener und gezogener Parasiten und ihre Wirte. VIII. Soc. Entomol. Jahrg. 38(1):3-4.

Saakyan-Baranova, A.A. and S.S. Muzafarov. 1972. The structure, biology and relationship of *Kermococcus quercus* L. (Homoptera, Kermococcidae) and its parasites (Hymenoptera, Chalcidoidea) (In Russian): I. Entomol. Obozr. 51(3):498-519.

Sanders, J.G. 1904. The Coccidae of Ohio, I. Proc. Ohio State Acad. Sci. 4(2):25-92.

Schmidt, G. 1939. Gebrauchliche Namen von Schadinsekten in verschiedenen Landern. Entomol. Beih. aus Berlin-Dahlem. 6:1-160.

__________. 1940. Gebrauchliche Namen von Schadinsekten in verschiedenen Landern. Entomol. Beih. aus Berlin-Dahlem. 7:161-364.

Scott, W.M. 1900. Notes on the Coccidae of Georgia. U.S. Dep. Agric. Div. Entomol. Bull. 26:49-54.

Severin, H.C. and H.H.P. Severin. 1909. A preliminary list of the Coccidae of Wisconsin. J. Econ. Entomol. 2:296-298.

Signoret, V. 1875. Notes on coccids. Soc. Entomol. de France Ann. (ser. 5) 4:vii (publ. 1874), 220, 229-230 (publ. 1875).

Silvestri, F. 1911. Dispense di entomologica agraria secundo le lezioni del Prof. F. Silvestri raccotte dal dott. Guido Grandi. Parte speciale. Portici, Vesuviano. 573 p.

Sleesman, G.B. 1945. The Coccidae or scale insects of Pennsylvania. Proc. Pa. Acad. Sci. 19:44-45.

Smith, J.B. 1910. Report of the insects of New Jersey, 1909. Trenton, N.J. State Mus., 888 p.

Smith, R.C. 1943. Common insects of Kansas. Kans. State Board Agric. Rep. 255. 440 p.

Steinweden, J.B. 1929. Bases for the generic classification of the Coccoid family Coccidae. Ann. Entomol. Soc. Am. 22(2):197-245.

Sternlicht, M. 1969. *Kermes bytinskii* n. spec. (Coccoidea, Kermesidae) in Israel and observations on its life history. Isr. J. Entomol. 4:251-270.

__________. 1972. A new species of *Kermes* Boitard (Coccoidea, Kermesidae) from England on oak. Entomol. Gaz. 23(4): 259-266.

________. 1974. A redescription of the larva of *Olliffiella cristocola* Cockerell (Coccoidea: Kermesidae). J. Entomol. (B) 42(2):195-197.

Targioni-Tozzetti, A. 1869. Introduzione alla seconda memoria per gli studj sulle cocciniglie, e catalogo dei generi e delle specie della famiglia dei coccidi. Soc. Ital. di Sci. Nat. Atti. 11:694-738.

Timberlake, P.H. 1916. Revision of the parasitic Hymenopterous insects of the genus *Aphycus* Mayr, with notice of some related genera. Proc. U.S. Nat. Mus. Wash. 50(2136):561-640.

Treherne, R.C. 1916. A preliminary list of parasitic insects known to occur in Canada. Entomol. Soc. Ont. Proc. 46th Annu. Rep., 178-193.

Trimble, F.M. 1928. Scale insects of Pennsylvania (Homoptera: Coccidae). Entomol. News 39(2):42-47.

Wang, Tze-Ching. 1982. Economic insect fauna of China. Fasc. 24. Homoptera: Pseudococcidae. Science Press, Beijing, China. 119 p.

Webster, F.M. and A.F. Burgess. 1902. A partial list of the Coccidae of Ohio. U.S. Dep. Agric. Div. Entomol. Bull. 37:109-113.

Westcott, C. 1973. The Gardener's Bug Book. Doubleday & Co., Inc. Garden City, N.Y. 4th edition. 689 p.

Williams, D.J. 1969. The family-group names of the scale insects (Hemiptera: Coccoidea). Bull. Brit. Mus. (Nat. Hist.) 23(8):317-341.

Wilkey, R.F. 1962. A simplified technique for clearing, staining, and permanently mounting small arthropods. Ann. Entomol. Soc. Am. 55(5):606.

Wilson, C.E. 1917. Some Florida scale-insects. Fla. State Plant Board Quart. Bull. 2:2-65.

INDEX TO HOST PLANTS

The scientific and common names as well as authors of many hosts were verified by John M. Tucker of the University of California, Davis, and Duncan M. Porter and Leonard J. Uttal at Virginia Polytechnic Institute and State University, Blacksburg, Virginia. The listing by Little (1959) was used as a secondary source. Synonym names are in quotation marks. The genus *Quercus* is abbreviated to *Q*.

INDEX TO SCALE INSECT TAXA

Valid names in roman type; synonyms, homonyms, manuscript names and misidentifications in *italics*. Page number for description of taxon in **boldface**.

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, sylvicultural, ornamental, and greenhouse plantings. More than 6,000 species are known; and adequate descriptions, illustrations, and keys that could enable specialists 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.

BULLETINS ON SCALE INSECTS FROM

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

<u>Research Division Bulletin No.</u>

3. Yang, S. P., and M. Kosztarab. 1967. A morphological and taxonomical study on the immature stages of *Antonina* and of the related genera (Homoptera: Coccoidea). p. 1-73.

15. Afifi, S. A., and M. Kosztarab. 1967. Studies on the morphology and taxonomy of the males of *Antonina* and of one related genus (Homoptera: Coccoidea). p. 1-43.

36. Studies on the Morphology and Systematics of Scale Insects (Considered No. 1 in this series). 1969.

I. Afifi, S., and M. Kosztarab. Morphological and systematic studies on adult males of some species of *Lecanodiaspis* (Homoptera: Coccoidea: Lecanodiaspididae). p. 1-23.

II. Afifi, S. Systematic status of the family Conchaspididae, based on the males of *Conchaspis lata* Hempel (Homoptera: Coccoidea). p. 25-37.

III. D'Ascoli, A., and M. Kosztarab. Morphological studies on the three nymphal instars of *Conchaspis lata* Hempel. (Homoptera: Coccoidea: Conchaspididae). p. 39-51.

52. Studies on the Morphology and Systematics of Scale Insects No. 2--Williams, M. L., and M. Kosztarab. 1970. A morphological and systematics study on the first instar nymphs of the genus *Lecanodiaspis* (Homoptera: Coccoidea: Lecanodiaspididae). p. 1-96.

64. Studies on the Morphology and Systematics of Scale Insects No. 3--Howell, J. O., M. L. Williams, and M. Kosztarab. 1971. Morphology and systematics of *Cerococcus parrotti* (Hunter) with notes on its biology (Homoptera: Coccoidea: Asterolecaniidae). p. 1-23.

70. Studies on the Morphology and Systematics of Scale Insects No.4--Howell, J. O., and M. Kosztarab. 1972. Morphology and systematics of the adult females of the genus *Lecanodiaspis* (Homoptera: Coccoidea: Lecanodiaspididae). p. 1-248.

74. Williams, M. L., and M. Kosztarab. 1972. Morphology and systematics of the Coccidae of Virginia, with notes on their biology (Homoptera: Coccoidea). p. 1-215.

83. Studies on the Morphology and Systematics of Scale Insects No. 5--Lambdin, P. L., and M. Kosztarab. 1973. A revision of the seven genera related to *Lecanodiaspis* (Homoptera: Coccoidea: Lecanodiaspididae). p. 1-110.

85. Studies on the Morphology and Systematics of Scale Insects No. 6. 1973.

I. Lambdin, P. L., J. O. Howell and M. Kosztarab. Morphology and systematics of five species in the Quercus group of the genus *Lecanodiaspis* (Homoptera: Coccoidea: Lecanodiaspididae). p. 1-29.

II. Howell, J. O., P. L. Lambdin and M. Kosztarab. Morphology and systematics of three species in the Eucalypti group of the genus *Lecanodiaspis* (Homoptera: Coccoidea: Lecanodiaspididae). p. 31-51.

III. Lambdin, P. L., and M. Kosztarab. A morphological study on the adult female and two nymphal stages of *Mallococcus sinensis* (Maskell) with notes on its systematic position (Homoptera: Coccoidea: Coccidae). p. 53-67.

92. Studies on the Morphology and Systematics of Scale Insects No. 7--Willoughby, P. A., and M. Kosztarab. 1974. Morphological and biological studies on two species of *Chionaspis* (Homoptera: Coccoidea: Diaspididae). p. 1-84.

111. Studies on the Morphology and Systematics of Scale Insects No. 8. 1976.

I. Hamon, A. B., P. L. Lambdin and M. Kosztarab. Life history and morphology of *Kermes kingi* in Virginia (Homoptera: Coccoidea: Kermesidae). p. 1-31.

II. Lambdin, P. L., and M. Kosztarab. The genus *Solenophora* and its type species (Homoptera: Coccoidea: Cerococcidae). p. 33-41.

III. Lambdin, P. L., J. O. Howell and M. Kosztarab. Morphology and systematics of two secies in the Quercus group of the genus *Lecanodiaspis* (Homoptera: Coccoidea: Lecanodiapididae). p. 43-54.

IV. Lambdin, P. L., and M. Kosztarab. Morphology and systematics of *Celaticoccus cantentulatus* (Froggatt): A gall-forming scale insect from Australia (Homoptera: Coccoidea: Lecanodiaspididae). p. 55-61.

127. Studies on the Morphology and Systematics of Scale Insects No. 9. 1977. Includes the Proceedings of the Symposium: Recent Advances in the Study of Scale Insects, the XV International Congress of Entomology, Washington, D.C. USA, August 19-27, 1976.

I. Miller, D. R. Introduction. p. iii.

II. Kosztarab, M. The Current State of Coccoid Systematics. p. 1-4.

III. Rosen, D. and P. DeBach. Use of Scale-Insect Parasites in Coccoidea Systematics. p. 5-21.

IV. Tremblay, E. Advances in Endosymbiont Studies in Coccoidea. p. 23-33.

V. Robison, W. G., Jr. Ultrastructure of Coccoidea Sperm. p. 35-50.

VI. Banks, H. J. Pigments of the Coccoidea--Current Knowledge and Chemotaxonomic Implications. p. 51-67.

VII. Nur, U. Electrophoretic Comparison of Enzymes of Sexual and Parthenogenetic Mealybugs (Homoptera: Coccoidea; Pseudococcidae). p. 69-84.

VIII. Williams, M. Scale Insects of the Galapagos Islands. p. 85-98.

IX. Miller, D. R. Summary. p. 99-102.

128. Studies of the Morphology and Systematics of Scale Insects No. 10--Lambdin, P. L., and M. Kosztarab. 1977. Morphology and systematics of the adult females of the genus *Cerococcus* (Homoptera: Coccoidea: Cerococcidae). p. 1-252.

146. Studies on the Morphology and Systematics of Scale Insects No. 11--Hamon, A. B., and M. Kosztarab. 1979. Morphology and systematics of the first instars of the genus *Cerococcus* (Homoptera: Coccoidea: Cerococcidae). p. 1-122.

Virginia Agricultural Experiment Station (VAES) Bulletin No.

85-11. Studies on the Morphology and Systematics of Scale Insects No. 12 (Contribution No. 1 to a National Biological Survey). 1985.

I. Bullington, S. W., and M. Kosztarab. Revision of the family Kermesidae (Homoptera) in the Nearctic Region based on adult and third instar females. p. 1-118.

II. Baer, R., and M. Kosztarab. A morphological and systematic study of the first and second instars of the family Kermesidae in the Nearctic Region (Homoptera: Coccoidea). p. 119-257.

The Research Division bulletins, numbers 3-146, are available on an exchange basis for your publications or those from your office from Michael Kosztarab, Department of Entomology, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061, USA. The VAES Bulletin 85-11 is also available free from the Extension Division Distribution Center, 1120 Landsdowne Street, Blacksburg, Virginia 24060 (703-961-6192).

Virginia's Agricultural Experiment Stations

1 —— Blacksburg
Virginia Tech
Main Station

2 —— Steeles Tavern
Shenandoah Valley Research Station
Beef, Sheep, Fruit, Forages, Insects

3 —— Orange
Piedmont Research Station
Small Grains, Corn, Alfalfa, Crops

4 —— Winchester
Winchester Fruit Research Laboratory
Fruit, Insect Control

5 —— Middleburg
Virginia Forage Research Station
Forages, Beef

6 —— Warsaw
Eastern Virginia Research Station
Field Crops

7 —— Suffolk
Tidewater Research and Continuing Education Center
Peanuts, Swine, Soybeans, Corn, Small Grains

8 —— Blackstone
Southern Piedmont Research and Continuing Education Center
Tobacco, Horticulture Crops, Turfgrass, Small Grains, Forages

9 —— Critz
Reynolds Homestead Research Center
Forestry, Wildlife

10 —— Glade Spring
Southwest Virginia Research Station
Burley Tobacco, Beef, Sheep

11 —— Hampton
Seafood Processing Research
and Extension Unit
Seafood