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The Ohio State University, Ph.D., 1962
Zoology

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THE ARMORED SCALE INSECTS OF OHIO
(Homoptera: Coccoidea: Diaspididae)

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By

MICHAEL KOSZTARAB, Ing. Hort.

The Ohio State University
1962

Approved by

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Entomology
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by the aid rendered by several individuals and institutions.

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Individuals too numerous to mention here gave permission or aid in collecting scale insects on their property or in the parks under their supervision. The names of scale insect collectors or abbreviations are given after each data in the manuscript.
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INTRODUCTION

The primary object of this study has been to compile general and specific information concerning the armored scale insects in Ohio.

The armored scale insects are the largest known family of scale insects and are economically important in Ohio. The last work on the scale insects of Ohio was compiled by J. G. Sanders in 1904. Numerous changes have been made during the past 58 years in generic groupings and in specific names. New biological and distributional data have been published in the literature. A relatively large collection of Ohio scale insects (Houser's Collection at The Ohio State University), with mostly unpublished records, needed to be revised and to be identified in order to bring up to date our knowledge of Ohio scale insects.

Sanders (1904b), in his work on the Ohio scale insects, included the scale insects collected in the greenhouses and those collected on the marketed southern fruits. Most of the greenhouse scale insect species listed from Ohio greenhouses by Sanders and later by Miller (1922) were recently eradicated as the result of modern chemicals (organic phosphates) used for the control of these pests. The author was unable to collect any of the six species of armored scale insects, which were listed by Miller (1922) from The Ohio State University Horticulture Greenhouses. Scale insects which were found in Ohio greenhouses and on marketed southern fruits are tropical or sub-
tropical in origin, and therefore they are unable to overwinter and to breed outdoors in Ohio. These species are not included in the present work.

The author included six species known in the adjacent or nearby states—New York, Pennsylvania, and Indiana—because the species recorded in these states are known to occur under climatic conditions similar to those in Ohio, and are known from hosts which occur in Ohio.

The description of each species was based on females since males were available in only a few species. While this study is essentially a taxonomic one, numerous ecological and biological data have been included. Since relatively few distributional records have been published on the Ohio armored scales, an effort has been made to ascertain this information for species within Ohio. The author made collections in 52 counties in Ohio, also in Illinois, Indiana, Kentucky, Maryland, Michigan, and Missouri. Data are given on host plants with reference to the relative abundance of the species where possible. A further effort has been made to gather information on the life cycle of each species. During these studies it was necessary to develop a relatively simple method of rearing, to secure males, parasites and predators of scale insects. Where sufficient fresh material was available, the eggs were counted and also the color of different stages was described.

This work is an attempt to provide means by which students other than specialists of scale insects may identify armored scale insects from Ohio and from the adjacent states. The author hopes
that this study will stimulate interest in the scale insects, which will result in the accumulation of additional distributional records and biological data, and also may lead to the discovery of new species in Ohio. Fifty-two species are discussed in this work, of which four are new species and described herein, sixteen additional species are here recorded from Ohio for the first time, and one of these was previously reported from Europe and Asia.
METHODS OF STUDY

This study involved the collecting of scale insects and their predators, the color description of different stages, the rearing in laboratory in order to secure males, parasites and predators of armored scales, the mounting of specimens on slides, and making determinations, and the drawing of plates. The methods applied, materials and equipment used in different stages of this work, are described below.

Collecting. -- In addition to the collections borrowed from different sources, there was a need for more and especially for live scale insect material. The collecting trips were planned in order to cover the major climatic, altitudinal, and faunistic areas in Ohio. Besides collecting fresh material, the field trips were useful in obtaining additional data on the biology and ecology of armored scale insects. The scales were collected on pieces of living bark, twigs, or other plant parts, with the aid of a sharp horticultural budding knife or shears. The material was saved in tightly closed cellophane bags to minimize desiccation. The fresh collected material was used in laboratory for color description, egg counting, rearing, and mounting.

Color Description. -- "Munsell Book of Color" (Anonymous, 1929-42) was used as an aid in the determination of the color of different stages and of the scale covers. The charts of this book are easily removable. After obtaining the needed specimens for color determini-
nation (at least 10 specimens were used in each case), the specimens were kept on a microscope slide and placed on the chart of the "Munsell Book of Color." The chart was selected in order to include the color patterns which nearly matched the color of the specimens under investigation. Under a binocular microscope the slide with the specimens was moved above the chart until the closest similar color pattern was obtained. After finding the square of color pattern which resembled most the color of the specimens, the technical description of the color was determined (e.g., reddish yellow on chart 22.5, color value No. 8, chroma No. 10, which was abbreviated as: rY 22.5-8/10). The advantage of this method is that there is less chance for bias in the color determination. There is a wide range of prefixed color patterns and by referring to the number of color chart, value and chroma, the color can be recalled at any time and any place by the use of this color chart.

Rearing.—The author placed for rearing all the fresh collected material in order to clear some of the questions pertaining to the biology of the armored scale insects in Ohio.

The males of many armored scale insect species are not known as yet. The question arises: Are these species unisexual or are they bisexual? The present taxonomy of armored scale insects is based on female characters, and as such, is not quite satisfactory. If we knew the males, probably many of our present taxonomic difficulties would be solved. Males of scale insects cannot be collected with nets or with other common field collecting methods. These tiny two-winged creatures, which cannot feed and usually live only for hours,
must be reared from the infested host plant. We also lack information on the parasites of scale insects. Parasites can be reared from scales, if the material will stay alive so the parasites can complete their development.

To get the male scale insects and the parasites of scale insects, different rearing methods may be used. In the case of greenhouse scales, the infested potted plants may be covered with gauze, or the whole plant may be placed in a covered glass cylinder, so that the males and parasites cannot escape after emergence. The pieces of twigs infested with the living scales may be kept in water, or without water under glass cylinder (Fig. 1), until the emergence of males and parasites. On the twigs which are kept in water the scales have a better chance to complete their development, than on the twigs which were kept dry.

In many cases it is impossible to collect scales on twigs that can be kept in water, but are collected on bark from the trunk or branches of infested trees. If such pieces of bark are kept in glass cylinder, they will dry and the scales will not be able to complete their life cycle, and usually no males or parasites will emerge. Moisture proof cellophane bags were used for rearing, to keep the material from drying too fast. After the material was checked under a binocular microscope, to avoid rearing mixed infestations, it was placed in the bags, and the bags were sealed tightly by folding the end of the bag 3-4 times, and then securing it with two paper clips (Fig. 2). The contents of the bags were checked under a binocular microscope at regular intervals. The emerged males or
Fig. 1.—Rearing of male scale insects and parasites in a glass cylinder.
Fig. 2.—Rearing of male scale insects and parasites in a cellophane bag.
scale parasites were anesthetized with cigarette smoke and were removed with a fine brush, killed in cyanide, and were stored dry or in alcohol.

The material did not dry too fast in the cellophane bags, so most of the scales and their parasites were able to complete their development. For example, by rearing with this method, after 10 days an average of 68 per cent of armored scales were still alive, while the scales which were kept outside the bags, but in the same area, dried and died on the host in a few hours. The humidity remained high in these bags, even in an extremely dry environment; the average relative humidity for 14 days inside these bags was 85.5 per cent, while the average for the environment in which the bags were kept was 29.9 per cent (Fig. 3). The temperature in these bags showed only a slight difference (an average of 2°F) from the environment (Fig. 4).

The disadvantages of using cellophane bags are as follows:

1. Wet material, such as material collected in or after a rain, will get moldy.

2. The bags should not be placed where they will be exposed to direct sunlight. Under such conditions water will condense inside the bags and the material may be completely destroyed by the growth of fungi.

The advantages of using cellophane bags are as follows:

1. The cellophane bag rearing was found the least expensive. The price of these bags is from $3.50 to $4.50 per thousand.

2. Rearings in cellophane bags are easy to handle and to check under a binocular microscope.
Fig. 3.—The fluctuation of relative humidity in different types of rearings, compared with the environment (room). Rearing material on infested twigs and leaves in cellophane bags, on twigs in tightly covered glass jar, and on twigs in glass cylinder covered with gauze. Observations made for a period of 14 days.
Fig. 3.

- cello. w. twigs
- cello. w. leaves
- glass jar
- glass cyl.
- room

DAYS
Fig. 4.—The fluctuation of temperature in different types of rearings, compared with the environment (room). Rearing material on infested twigs and leaves in cellophane bags, on twigs in tightly covered glass jar, and on twigs in glass cylinder covered with gauze. Observations made for a period of 14 days.
Fig. 4.
3. Only a relatively small space is required, and about 25-30 bags can be stored in a cigar box.

4. After the rearing was completed the material was stored in the same bags, without transferring it.

The cellophane bags used for rearing were made from moisture proof film, weight 195, thickness .001 mm, nomenclature MSD-54; they were 2 1/2 x 5 1/2 inches in size, and of the fold-bottom type. These bags can be secured from Cello-Poly Bag Co., 1279 E. Hudson Street, Columbus 1, Ohio.

Mounting Armored Scales.—The author changed slightly the procedure adapted by Miss Louise M. Russell at the U.S. Department of Agriculture, Agricultural Research Service, Entomology Research Division. The steps of mounting procedure are described below.

1. The freshly collected live material was kept for at least two hours in 70 per cent alcohol, before mounting.

2. Old dry scales, or the pre-treated live material were transferred to 10 per cent KOH for 10 minutes or more, and usually were heated in the KOH for a few minutes until the body contents were soft.

3. All the body contents were removed (eggs, internal organs, etc.) while in KOH, by pressing the insect, or making a small hole on the exoskeleton. The hole was made on the anterior end, or on the lateral side of the body, so as not to destroy taxonomically important morphological features.

4. After the specimens were made transparent, they were transferred to acetic acid alcohol for 20 minutes or more. (The
procedure for making acetic acid alcohol and acid fuchsin stain are described below.)

5. Specimens were stained in acid fuchsin for 5, 10, or more minutes. After staining they were transferred to 70 per cent alcohol for 5-15 minutes to wash out the excess stain.

6. Transferred to 95 per cent alcohol for 5-10 minutes.

7. Transferred to 100 per cent alcohol for 5-10 minutes.

8. Transferred to clove oil for 10 minutes or more.

9. Mounted in Canada balsam. Usually two specimens were mounted (dorsal and ventral views) on each slide. No. 1, round, 18 mm, cover glasses were used.

10. The slides were immediately numbered with a diamond point pencil, to avoid any mixing of material.

After some practice, this whole process takes an average of 40 minutes per slide, if mounting continuously for a longer period of time. The author was able to reduce this procedure to 20 minutes when the material permitted the omission of the 70 per cent and 100 per cent alcohol.

Acetic acid alcohol: mixed 20 cc glacial acetic acid and 45 cc distilled water with 50 cc of 95 per cent alcohol.

Acid fuchsin (after Borchsenius, 1950): dissolved 1 gr fuchsin in 10 ml of 96 per cent alcohol, and added 5 ml glacial acetic acid; the above was dissolved gradually in 100 ml distilled water and after 24 hours the solution was filtered.
Determination.—The specific determination of the mounted material was accomplished by the aid of a Spencer No. 18 M. Phase Microscope, equipped with phase turret condenser, a 10x eye piece, and objectives of 10x, 43x, and an oil immersion objective of 97x. The determinations were made by using 430x and 970x magnifications.

Drawing of Plates.—The selected specimens on the slides were projected to drawing paper in a dark room. The outlines and all visible characters were drawn on the drawing board with a sharp pencil. After this outline was made the specimen was checked under a binocular microscope and fine details, and characters which were not distinct or clear by projection, were completed. The pencil drawing was finished with India ink.

The microscope slide projector used (Model Tech.) was manufactured by Ken-A-Vision Mfg. Co., Inc. The projector was adjusted in order to get the desired magnification. For all drawings an objective of 6 1/2 mm and a long tube type eye piece of 10x magnification were employed. The drawings of the pygidia were made large enough to permit half size reduction for the manuscript.
ARMORED SCALE INSECT MATERIAL EXAMINED

University of California, Department of Entomology and Parasitology, Davis, California. Mounted material sent for study through the courtesy of Professor Howard L. McKenzie.

Florida Department of Agriculture, Division of Plant Industry, Gainesville, Florida. Loaned slides.

Kosztarab Collection, Columbus, Ohio.

Ohio Agricultural Experiment Station, Department of Entomology, Wooster, Ohio. Unmounted material sent for study by Dr. Roy W. Rings and Dr. R. B. Neiswander.

Ohio Department of Agriculture Laboratories, Insect and Plant Disease Control, Reynoldsburg, Ohio. Loaned unmounted material and slides through the courtesy of Mr. James T. Walker.

The Ohio State University, Department of Zoology and Entomology, Columbus, Ohio. The entire Houser Collection and a part of Sanders Collection were loaned through the courtesy of Professor Josef N. Knill.

Pennsylvania Department of Agriculture, Bureau of Plant Industry, Harrisburg, Pennsylvania. Loaned a large quantity of unmounted material through the courtesy of Mr. G. B. Sleesman.

Purdue University, Agricultural Experiment Station, Department of Entomology, Lafayette, Indiana. Loaned unmounted and mounted material through the courtesy of Dr. Donald L. Schuder.
Professor Charles A. Reese, Department of Zoology and Entomology, The Ohio State University, Columbus, Ohio. Professor Reese loaned slides of armored scale insects.

United States Department of Agriculture, Agricultural Research Service, Entomology Research Division. The important, essential, and pertaining material of the National Cococoid Collection has been made available through the courtesy of Dr. Harold Morrison.

The author contacted forty-two research and educational institutions, and many individuals for borrowing their armored scale insect material from Ohio and adjacent states. Unfortunately only few institutions and individuals proved to have such collections available.
LIST OF ABBREVIATIONS

Collectors

AEM - A. E. Miller (Houser Collection)
AFB - A. F. Burgess (Houser Collection)
ALQ - A. L. Quaintance (Houser Collection)
CAR - C. A. Reese (Reese Collection and Houser Collection)
GBS - G. B. Sleesman (Pennsylvania Department of Agriculture Collection)
JGS - J. G. Sanders (Sanders Collection)
JLK - J. L. King (Houser Collection)
JSH - J. S. Houser (Houser Collection)
MK - M. Kosztarah (Kosztarah Collection)
PHF - P. H. Freytag (Kosztarah Collection)
WNG - W. H. Goodwin (Houser Collection)

Collections

HC - Houser Collection, The Ohio State University
FlaDA- Florida Department of Agriculture Collection
KC - Kosztarah Collection
NCC - National Coccoid Collection (U.S.D.A.)
ODA - Ohio Department of Agriculture Collection
PaDA - Pennsylvania Department of Agriculture Collection
PC - Purdue University Collection
SC - Sanders Collection, The Ohio State University
Collecting Places

OAES  -  Ohio Agricultural Experiment Station (Grounds)
OSU  -  The Ohio State University (Campus)

* Example: (CAR), (HC). Collected by C. A. Reese, material in the Houser Collection.
KEY TO THE FAMILIES OF SCALE INSECTS IN OHIO

The key refers only to the characters of the adult female, unless otherwise stated.

1. Abdominal spiracles present; males usually with compound eyes and ocelli ........................................... 2

1'. Abdominal spiracles absent; males with ocelli only ............................................................... 3

2(1). Anal ring distinct and flat, bearing many pores and with six long setae ..................................................... ORTHEZIIDAE

2'. Without an anal ring bearing pores and setae ................................................................................. MARGARODIDAE

3(1'). Last abdominal segments of female fused into a pygidium; female with removable scale; antennae rudimentary; legs absent; labium 1-segmented ....................................................... DIASPIDIDAE

3'. Pygidium absent; labium with more than one segment ................................................................. 4

4(3'). Dorsum with 8-shaped (shaped like the figure 8) pores .......................................................... ASTEROLECANIIDAE

4'. Dorsum usually without 8-shaped pores ...................................................................................... 5

5(4'). Abdomen with a distinct anal cleft ......................................................................................... 6

5'. Abdomen without an anal cleft ......................................................................................................... 7

6(5). Anal opening covered by a single triangular or oval anal plate (none reported from Ohio, but occur in nearby states) ................................................................. ACLERIDIDAE
6'. Anal opening covered by an operculum formed of 2 triangular plates (anal plates lacking in genus Physokermes which is represented only on conifers) .................................................... COCCIDAE (Lecaniidae)

7(5'). Anal ring without pores and setae, or if setae are present they are short and not paired; cuticle at maturity hard, sclerotized, and not segmented; usually globular or bud-shaped; occurring only on oaks ............................................................ KERMITAE

7'. Anal ring with 2 or more pairs of long setae, and usually with pores ......................................................... 8

8(7'). Dorsal ostioles and usually 1 to 4 ventral circuli present; the insect in life covered with a white powdery secretion; during oviposition the females are usually found at the anterior end or inside a white woolly ovisac .............................................. PSEUDOCOCCIDAE

8'. Dorsal ostioles and ventral circuli absent; the insect usually naked, but at the time of oviposition is often found in an oval, felt-like ovisac ......................................................... ERIOCOCCIDAE
The body is covered with a removable scale (Fig. 5) which is composed of two exuviae and waxy secretions. This scale may extend underneath the insect and completely envelope it. In the genera Fiorinia and Leucaspis the adult females remain within the cast skin of the second molt, and therefore are called pupillar. 

The head of the Diaspididae is fused with the succeeding two segments, forming the prosoma (Fig. 5). Eight abdominal segments are more or less distinct, while the ninth to eleventh segments have been greatly reduced. The segmental lines are usually better visible on the dorsum as furrows, or intersegmental sclerotizations. The terminal segments of the abdomen are fused into a pygidium.

The antennae (Fig. 5) are reduced to unsegmented tubercles, bearing one or more setae, while the eyes are usually reduced to weakly sclerotized spots. The labium is one-segmented and the piercing-sucking stylets (Fig. 5) are modified from the mandibles and maxillae.

Legs are lacking and only in a few species are indicated by small sclerotized tubercles. Spiracles (Fig. 5) usually have no taxonomic value. Associated with the spiracles in the Diaspidini, one or more quinquelocular disc pores are present, while in the Aspidiotini these pores are usually absent. The pores around the vulva are called perivulvar pores (Fig. 5). These pores usually are
Fig. 5.- General Morphology of a Diaspididae Female
arranged in five groups: a *median group* just anterior to the vulva, and two groups at each side, the *anterior lateral groups* and the *posterior lateral groups*. The median group may be partly or entirely absent. In some species of *Diaspididae* all five perivulvar pore groups are absent, while in others, such as in *Carulaspis juniperi* (Bouché) and species of *Lopholeucaaspis*, there is a tendency for more than five groups to be present. The vulva (Fig. 5) is on the ventral surface of the pygidium.

Members of the family *Diaspididae* form the scale covering from secreted wax. This wax is produced by glands that discharge through tubular *ducts*. Many ducts are so small that their use in taxonomy is not possible at the present, while the larger so called *macroducts*, are important in the species description. There are *two-barred macroducts*, which are relatively short and broad, and their inner closure seems to be formed from two parallel, transverse, sclerotized bars. The presence of these ducts is an important characteristic of the tribe *Diaspiderini*. In the tribe *Aspidiotini* the *one-barred ducts* are present, which are slender and bear one sclerotized bar as inner closure. Their length is at least ten times the breadth. Dorsal ducts may be arranged in well defined groups, and the groups depending on their location on the pygidium are named *marginal, submarginal, and submedian dorsal ducts* (Fig. 5).

The *anus* (Fig. 5) is a small, circular or oval opening in the dorsum of the pygidial area. The size and relative position of the anus is a key character in separating the Genera *Aegirallaspis* and *Hemiberlesia*. 
Sclerotic structures are frequently present along the margin of the pygidium. The marginal scleroses, which arise in the spaces between the lobes or from the bases of the lobes, are called paraphyses. They are slender and well developed in Melanaspis (Fig. 20) and related genera, while in Diaspidiotus (Fig. 11) these paraphyses are shorter and thicker. When the basal sclerosis of the median lobes is lacking, the median lobes are united basally and their internal sclerotization is called zygosia.

The pygidal segments are in part produced at their lateral margins into flattened, sclerotized processes or lobes. Their size, shape, and number are useful generic and specific characters. The median lobes are yoked together at the base, and form a definite notch in the pygidium of the species of Phenacaspis (Fig. 51). In the genus Chionaspis (Fig. 31) the median lobes are usually close together, and definitely zygotic. The area between the lobes is marked as the interlobular space.

Plates (Fig. 6) are present on the margin of the pygidium. They may be confined to the interlobular spaces, or they may occur along the entire margin of the pygidium. Since there are difficulties in staining these hyaline processes, their structure sometimes is not well visible. Some plates are more or less branched or fimbriated and may bear a single microduct which discharges at the apex of the points or branches. The presence of these plates is usually characteristic in the tribe Aspidiotini. The entire plate may be an elongate conical process, rarely bifid or slightly fimbriate at the tip.
Through this process extends one, or rarely more than one, microduct. These plates are called *gland spines* (Fig. 5) and occur primarily in the tribe Diaspidini. When the gland spines are basally swollen, short and sclerotized, they are called *gland tubercles* (Fig. 5). In some species of Aspidiotini, along the lateral margin of pygidium, short tube-like structures with microduct orifice at their apex are present, for which the term "gland tubes" is introduced here. *Gland tubes* are well developed in *Diaspidiotus osborni* (Fig. 15).
SUBFAMILY AND TRIBES

All species of Diaspididae from Ohio belong to the subfamily Diaspidinae. The members of this subfamily form a homogeneous group in Ohio. Their characteristics are those of the family which was described in the previous section (p. 23). The Diaspidinae are represented in Ohio by two tribes.

KEY TO THE TRIBES OF DIASPIDINAE IN OHIO

1. Macroduts of the one-barred type; second pygidial lobes not bilobed; fimbriated plates usually present; gland tubercles rarely or never present; usually no disc pores associated with anterior spiracles; antennae rarely with more than one seta; body in most species rounded or pear-shaped, rarely elongated .................. Aspidiotini

1'. Macroduts of the two-barred type; second pygidial lobes usually bilobed; gland spines normally present, but in some species replaced by fimbriated plates, in latter case usually with gland tubercles; one or more pores are associated with anterior spiracles; antennae usually with two or more setae; female in most of the genera forms an elongated scale, if the scale is circular, then its color usually is white (Fig. 5) .. .. Diaispidini

28
TRIBE ASPIDIOPTINI

KEY TO THE GENERA OF THE TRIBE ASPIDIOPTINI IN OHIO

1. Pygidium without paraphyses, and retracted into abdomen; body heavily sclerotized at full maturity (Fig. 21). ................. Nucluspis

1'. Pygidium with paraphyses, and not retracted into abdomen; body usually only slightly sclerotized ............ 2

2(1). Three paraphyses in the space between the second and third lobes .............. 3

2'. No more than two paraphyses arising between the second and third lobes ............. 4

3(2). Pygidium tapering to an acute apex; only three pairs of lobes present; perivulvar pores in four groups; on leaves (Fig. 9) .............. Acutaspis

3'. Pygidium short, not tapering to an acute apex; fourth lobe developed or indicated by a sclerotized point; perivulvar pores lacking or present in five small groups; on bark (Fig. 19) ........ Melanaspis

4(2'). Four or five plates between the setae of second and third lobe area; plates large, elongate and acute; mesal paraphysis of first interlobular space much larger than lateral paraphysis, swollen apically and directed toward meson; perivulvar pores absent (Fig. 10) ............... Clavaspis

29
Three or fewer plates between the setae of second and third lobe area; plates of various shape; mesal paraphysis of first interlobular space seldom larger than lateral paraphysis, usually not swollen apically, and not directed toward meson; perivulvar pores present or absent .......................................................... 5

Anal opening conspicuously large, its diameter somewhat greater than length of median lobes, placed about twice this diameter from bases of median lobes; second and third lobes represented by large, broad, sclerotized points (Fig. 17) ......................... Hemiberlesia

Anal opening smaller than length of median lobes ............. 6

Only the median pair of lobes developed; second and third pair at most indicated as small points; plates usually small, sometimes poorly developed; anal opening well removed from apex of pygidium (Fig. 15) ........................................ Diaspidiotus

At least two pair of lobes developed; the second pair rarely reduced to small hyaline points, if reduced then the plates laterad of the second pair of lobes are well developed and fimbriated ............ 7

Hates laterad of the second lobes wide, fimbriated, and usually longer than second lobes; interlobular paraphyses reduced; diameter of anal opening almost the same as the length of median lobes; all Ohio species with perivulvar pores (Fig. 6) ........ Abgrallaspis
Plates laterad of second lobes poorly developed and usually shorter than second lobes; if longer than second lobes then the perivulvar pores are absent (as in *Quadraspidotus perniciosus*); interlobular paraphyses well developed; diameter of anal opening much shorter than length of median lobes (Fig. 25) .................. *Quadraspidotus*

Genus *Abgrallaspis* Balachowsky

*Abgrallaspis* Balachowsky, 1948, p. 66; 1956, p. 14;
Schmutterer, 1959, p. 73; Davidson, 1960, p. 46.

*Ephedraspis* Borchsenius, 1950, p. 216.

*Scale of Female.*—Circular or oval, convex, color light; exuviae central or subcentral.

*Female.*—Circular or pyriform.

*Pygidium.*—Two or three pairs of lobes present. Plates large, wide, well fimbriated on outer margin. Paraphyses small, hardly recognizable. Dorsal ducts short, relatively wide, quite numerous. Perivulvar pores usually present. Anal opening large, usually almost same length as the length of median lobes.

*Type of the Genus.*—*A. cyanophylli* (Signoret).

**KEY TO SPECIES OF ABGRALLASPIS**

1. Second pair of lobes elongated, as long as or longer than median lobes; preferred host maple ....................... *comstocki* (Johnson)
1' Second pair of lobes shorter than median lobes ........ 2
2(1') Second lobes large, at least half the size in
area of median lobes, their width is more than half
of the width of median lobes; occurs on
conifers ............ ithaceae (Ferris)
2' Second lobes variable in shape and size, but less
than half the size of median lobes, their width
always less than half of the width of median lobes;
occurs on hosts other than conifers . townsendi (Cockerell)

Abgrallaspis comstocki (Johnson)

Fig. 6

Aspidiotis comstocki Johnson, 1896b, p. 383; Fernald, 1903, p. 254;
Sanders, 1904b, p. 58; Dietz and Morrison, 1916b, p. 298;
Hollinger, 1923, p. 10; Britton, 1923, p. 373; Felt and
Morrison, 1928, p. 200; Sleesman, 1945, p. 48. Aspidiella
comstocki (Johnson), MacGillivray, 1921, p. 405. Hemiberlesia
comstocki (Johnson), Ferris, 1938, Ser. II:235. Abgrallaspis
comstocki (Johnson), Davidson, 1960, p. 53.

Scale of Female.—Not seen. According to Davidson (1960),
this scale is circular, unless appressed against a leaf vein, whitish;
exuviae submarginal.

Female.—Circular, length on slide about 0.8 mm.

Pygidium.—Median lobes longer than wide, straight and paral-
lel, close together, with two slender plates between them, close to
the apex notched on both sides; second lobes usually longer than
median lobes, rounded apically; third lobes sometimes represented by a hyaline point. Plates well developed, fimbriate, present as far as the seta which marks the fifth segment. Paraphyses only slightly developed between median and second lobes. Dorsal macroducts large and broad, few in number; one duct located between median lobes, extending to about the top of anal opening; one or two ducts between median and second lobes. Few ventral ducts located submarginally. Vulva in about the middle of pygidium. Perivulvar pores in four small groups of 2 to 6 pores per group. Anal opening slightly smaller than length of median lobes and removed by about twice its diameter from base of median lobes.

Scale of Male.—According to Johnson (1896b) the male scale is elongated oval, grayish white, about 1.0 mm long, 0.5 mm wide.

Host and Distribution.—Occurs on leaves of Acer saccharum L., and A. saccharum Marsh. Reported by Sanders (1904b) from leaves of sugar maple, at Columbus, Ohio. This species is known to occur in several states east of the Rocky Mountains.

Material Examined.—The accompanying figures were based on the original Johnson material from maple, Mt. Carmel, Illinois, July 1, 1895 (W. G. Johnson), (NCC), received through the courtesy of Dr. Harold Morrison.
Fig. 6. — Abgrallaspis comstocki (Johnson)

Fig. 7. — Abgrallaspis ithacae (Ferris)
Abgrallaspis ithaceae (Ferris)

Fig. 7

*Abgrallaspis ithaceae* Ferris, 1938, Ser. II:185. *Aspidiotus abietis* Comstock, 1883, p. 57, according to Ferris (1938), homonym of the earlier *Aspidiotus abietis* (Schrank). *Aspidiotus abietis* (Schrank), Amos, 1933a, p. 206, as a misidentifi-
cation. *Abgrallaspis ithaceae* (Ferris), Davidson, 1960, p. 60.

Common Name.—Hemlock scale.

Scale of Female.—Circular, slightly convex, gray, lighter on margin; about 1.5 mm in diameter; exuviae central.

Female.—Circular, tapering toward the apex; length on slide about 0.75 mm. Derm usually membranous at maturity.

Pygidium.—Median lobes prominent, about as long as wide, rounded apically, notched on both sides, well separated from each other; second lobes smaller, rounded apically and notched on lateral sides; third lobes replaced by small hyaline points. Plates shorter than the lobes, present in the normal two-two-three formula. Two slender plates between median lobes; broad and apically fimbriate plates in the first and second interlobular space; usually 3-5 slender plates anterior to the seta marking segment six. Dorsal macroducts quite large and short, numerous, in irregular rows extending to segment three; one duct between median lobes, extending to the middle of anal opening; 3-5 ducts between segments seven and eight; usually 2 ducts between segment six and seven. Ventral ducts in small groups along the margin of pygidium. Anal opening oval, its diameter about
equal to the width of median lobe, removed from base of median lobes about twice the latter's diameter.

Scale of Male.—Not seen. According to Ferris (1938), the scale of male is elongate oval, blackish, exuviae near one end.

Host and Distribution in Ohio.—Occurs on needles of conifers.


The accompanying illustrations are based on the above Ohio material.

Abgrallaspis townsendi (Cockerell)

Fig. 8


Scale of Female.—Circular, flat, whitish or light gray, about 1.5 mm in diameter; exuviae subcentral.

Female.—Circular, length on slide 0.8-0.9 mm.
**Pygidium.**—Median lobes large, prominent, well separated, about as long as wide, notched on both sides, rounded apically; second lobes variable, well developed in the material examined; third lobes reduced to plate-like structures or hyaline points. Plates in the normal pattern, strongly fimbriated. Paraphyses very slightly developed. Dorsal macroducts usually confined to segments four to six; one between median lobes, extending into anal opening area; 2 or 3 ducts between median and second lobes; lateral from second lobes two more or less distinct rows of 5-8 ducts each; a few scattered ducts around the two rows of ducts. Ventral ducts in small groups, along the margin of pygidium. Perivulvar pores in four small clusters of 3 to 10 pores per cluster; one or two median perivulvar pores may be present. Anal opening slightly oval, its diameter moderately wider or about equal with the length of median lobes.

**Scale of Male.**—Elongate oval, almost white; length about 0.9-1.0 mm; exuviae at one end.


**Other Material Examined.**—PENNSYLVANIA: West Chester, on leaves of *Magnolia acuminata* L., Aug. 15, 1919 ("J.K.P."), (PaDA); Andorra: Andorra Nurseries, on twigs of *Ilex glabra* (L.) Gray, Feb. 22, 1944 (GBS), (PaDA).
Additional Biological Data.—Overwintered as adults, some with live internal parasitic larvae, in Painesville, Ohio.
The accompanying illustrations are based on the above material from *Ilex opaca* Ait.

**Genus Acutaspis** Ferris


**Scale of Female.**—Usually circular, flat, exuviae central or subcentral.

**Female.**—Circular or pyriform; prosomatic region often with a sclerotized point or protuberance on each side, about opposite the posterior spiracles.

**Pygidium.**—Strongly acute, angle subtended by apex being less than 90 degrees; margin sclerotized. Three pairs of lobes present.

Plates minute. Paraphyses long and slender. Dorsal ducts exceedingly long and slender. Perivulvar pores in four small groups.

**Type of the Genus.**—*A. perseae* (Comstock).

**Notes.**—Genus Neotropical. One species occurs in Ohio. The members of the genus seem to occur on leaves, rather than on bark.

*Acutaspis morrisonorum* sp.n.

Fig. 9a–f

**Scale of Female** (Fig. 9a).—Slightly oval, flat, yellowish-brown, lighter on the margin, with the exuviae central. First larval exuviae with white margin. Length of the scale 1.5 mm, width 1.125 mm.
Fig. 8. — Abgrallaspis townsendi (Cockerell)

Fig. 9. — Acutaspis morrisonorum sp. n.
Sample of 22 scales gave mean of length 1.351 mm, width 1.036 mm, range of length 1.250-1.625 mm, width 1.0-1.125 mm.

**Female**—Pear-shaped, orange yellow, sclerotized on margin of pygidium. Length of the type on slide 0.625 mm, width 0.825 mm. Sample of 20 females gave mean of length 0.850 mm, width 0.640 mm, range of length 0.675-0.875 mm, width 0.575-0.70 mm.

Antenna with one longer setae (Fig. 9b). Anterior spiracles as in Fig. 9c. Lateral margins of the thoracic region slightly produced (Fig. 9d) laterally.

**Pygidium**.—Rounded apically, with three pairs of small and short lobes (Fig. 9e); median lobes semi-circular, shorter in length than width; second lobes broader than the first; third lobes largest; all lobes with two paraphyses, arising laterally. The paraphyses of the inner angles always shorter than those of the outer angles. Three paraphyses in the interlobular space between lobes 2 and 3. A series of short paraphyses beyond the third lobe. Plates minute, confined to interlobular spaces (Fig. 9f). Dorsal ducts exceedingly long and slender, their pores being arranged in series in the interlobular spaces, and along the margin anterior to the third lobes. Few setae along the entire margin of the body. Margin of prepygidial segments and the thoracic region with a few small ducts. Perivulvar pores in four small groups, anterior laterals 7 and 9, posterior laterals 6 and 8; mean from a sample of 20 specimens of anterior lateral groups 8, range 5 to 10, the mean of the posterior lateral groups 5, range 3 to 9.

No males are known.
Holotype female deposited in the U.S. National Museum.

Paratypes, 1 female in the Houser Collection (OSU), and 19 females in the author's collection.

Both holotype and paratype specimens were collected from the upper surface of leaves of *Tsuga caroliniana* Engelm., in Secrest Arboretum, Wooster, Ohio, on July 7, 1960, by the author. Material was re-collected from the same tree on January 29, 1961, by Ralph Sechriest.


**Additional Biological Data.**—This species overwintered as a second stage nymph in Wooster, Ohio, during the winter of 1960-61. At the same locality high parasitization was observed, but no parasites were reared from the collected material.

**Notes.**—*Acutaspis morrisonorum* is similar to *Acutaspis perseae* (Comstock), and especially to *A. agavis* (Townsend and Cockerell). It can be separated from *A. perseae* by the following characteristics:

The lateral margins of the thoracic region of *A. morrisonorum* do not bear heavily sclerotized tubercles, as in *A. perseae*. The length of *A. morrisonorum* on the slide is always less than one millimeter, while the length of *A. perseae* exceeds one millimeter. The apical half of the pygidium of *A. perseae* is more acute, thus the angle subtended is always less than 80 degrees, while in *A. morrisonorum* the angle is greater than 80 degrees. Based on the material at hand *A. morrisonorum* occurs on conifers, while *A. perseae* seems to occur on other hosts than conifers.
Acutaspis morrisonorum can be separated from A. agavis by the following:

There are about 25-30 small slender ducts which form a distinct row on each side of the prosomal margin in the type of A. agavis, while in A. morrisonorum these ducts are hardly visible, do not form a distinct row, and are less in number, about 12-18 ducts on each side of prosoma. Acutaspis agavis is known only from Agave spp. (family Amaryllidaceae), in Texas and Mexico, while A. morrisonorum occurs on needles of conifers, east of the Mississippi, in Eastern United States, Quebec in Canada, and Bermuda Island. There is no geographical overlapping in the distribution of the two species.

Dr. Harold Morrison and his wife Emily Morrison were among the first who collected material of this species in the United States. Dr. H. Morrison made available for study the pertaining material of the National Coccoid Collection, and with Mrs. Morrison aided in many ways the preparation of this work. The author wishes to express his gratitude toward Dr. and Mrs. Morrison by naming this species after them.

The author suggests the common name "round conifer scale" for this species.

_Genus Clavaspis MacGillivray_

_Clavaspis MacGillivray, 1921, p. 391; Ferris, 1938, Ser. II:202;_

Scale of Female.—Circular, exuviae subcentral.

Female.—Circular or pyriform.

Pygidium.—Median lobes prominent. Plates usually simple.

Paraphysis arising from outer basal angle of median lobe much larger than lateral paraphysis and swollen apically, also directed toward meson.

Type of the Genus.—Aspidiotus subsimilis var. anomae Houser, which is considered by Ferris to be a synonym of Clavaspis herculanea (Cockerell and Hadden).

Clavaspis ulmi (Johnson)

Aspidiotus ulmi Johnson, 1896b, p. 388; Fernald, 1903, p. 280; Sanders, 1904b, p. 67; Dietz and Morrison, 1916b, p. 293; Miller, 1922, p. 60; Hollinger, 1923, p. 17; Britton, 1923, p. 375; Felt and Morrison, 1928, p. 201; Amos, 1933a, p. 206; Sleesman, 1945, p. 48. Hendaspidiotus ulmi (Johnson), MacGillivray, 1921, p. 440. Clavaspis ulmi (Johnson), Ferris, 1938, Ser. II:211.

Scale of Female.—Circular, convex, gray or yellowish white, about 1.5 mm in diameter; exuviae submarginal. Ventral scale thin, white.

Female.—Circular, light yellow (Y 25.0-8/6); length on slide about 1.1-1.25 mm.

Pygidium.—Acute, slightly sclerotized. Median lobes large, protruding, more or less rounded, both margins notched; second and
third lobes reduced to small sclerotized points. Plates prominent, slender, about as long as the lobes, occasionally slightly toothed; no plates between median lobes; two plates in first interlobular space; usually 6-7 plates beyond second lobes. Median lobes with sclerotized basal process. First pair of intersegmental scleroses with mesal member enlarged, apically swollen, and pointed toward meson; second pair of scleroses small and of about equal size. Dorsal ducts small, slender, arranged in three definite furrows; usually five in the first, about ten in the second, and around eight in the third furrow. A few ventral ducts along the margin of pygidium. Porivulvar pores absent. Anal opening small, removed from base of median lobes by about three times the latter's length.

Host and Distribution in Ohio.—Most of the distribution records are from southwestern Ohio, but some are from central, northern, and eastern counties of the state. Occurs on bark. *Acer saccharinum* L., Cincinnati: Washington Park, Nov. 4, 1914 (JSH, JLK). On trunk of *Aesculus glabra* Willd., Highland Co.: north of Hillsboro, July 15, 1961, live females with eggs in their body, (MK, PHF). On trunk of *A. hippocastanum* L., Columbus: OSU, Feb. 17, 1961, second stage larvae, (MK). On trunk of *Catalpa bignonioides* Walt., Dayton, Sept. 7, 1914 (JSH). On trunk of *C. speciosa* Warder, Columbus: OSU, Oct. 11, 1919 (F. R. Lowry), (HC); Warren Co.: Lebanon, July 1, 1961 (MK). *Catalpa* sp., Cleveland, Apr. 10, 1913 (JLK, JSH); Columbus (Sanders, 1904b); OSU, (Miller, 1922), (CAR). *Tilia* sp., Ottoville, March 22, 1915 (F. T. Ulrich), (HC). On trunk of *Ulmus americana* L. Columbus (Sanders, 1904b); Ottawa Co.: East Harbor State Park, Sept. 7,

Other Material Examined.—Kansas: Lawrence, Catalpa sp., Oct. 11, 1898 (P. J. Parrott), (HC).

Additional Biological Data.—Overwintered as second stage nymphs in Franklin Co.; males emerged and the first stage nymphs appeared between May 8-15 in Columbus (1961).

Parasites Reared.—Thysanidae: Thysanus sp.


The accompanying illustrations are based on material from Catalpa speciosa Warder, Warren Co.: Lebanon, July 1, 1961.

Genus Diaspidiotus Leonardii


Scale of Female.—Circular to oval, exuviae central or sub-central.

Female.—Circular to pyriform.

Pygidium.—Only median lobes developed. Plates usually small and fimbriated. Intersegmental scleroses present. Perivulvar pores present or absent. Anal opening well removed from apex of pygidium.

Type of the Genus.—D. ancylus (Putnam).
KEY TO SPECIES OF DIASPIDIOTUS

1  Perivulvar pores present ............................................... 2

1' Perivulvar pores absent; associates especially
   with sweetgum, Liquidambar
   styraciflua .................. liquidambaris (Kotinsky)

2(1) Dorsal macroducts present on segments anterior
   to fifth segment ............................................................... 3

2' Dorsal macroducts absent on segments anterior
   to fifth segment .............................................................. 4

3(2) With more than 8 dorsal macroducts on third and
   fourth segments; 5-10 duct orifices at base of
   first interlobular space; usually 3-4 long,
   simple or bifurcate plates lateral from third
   lobe area .............................................. caryae sp.n.

3' With less than 8 dorsal macroducts on third and
   fourth segments; 3-6 duct orifices at the base of
   first interlobular space; usually 2-3 short, stout,
   simple plates lateral from third lobe
   area .............................................. hunteri (Newell)

4(2') Plates large and well fimbriated .................................. 5

4' Plates small, not fimbriated, dagger-like; as-
   sociated especially with oak, also other hosts
   belonging to the plant families Fagaceae and
   Corylaceae .................. osborni (Newell and Cockerell)
5(4) Two small acute plates between median lobes; median lobes notched on lateral side only; 21-53 dorsal macroducts on each side of pygidium ....... ancyclus (Putnam)

5' No plates between median lobes; median lobes notched on both sides; usually 20-27 dorsal macroducts on each side of pygidium ....... uvae (Comstock)

**Diaspidiotus ancyclus** (Putnam)

*Fig. 11*

*Diaspis ancyclus* Putnam, 1878, p. 321. *Aspidiotus uncyclus* (Putnam), Comstock, 1883, p. 292; Osborn, 1900, p. 72; Fernald, 1903, p. 252; Sanders, 1904b, p. 57; O'Kane, 1909, Part III, p. 4; Dietz and Morrison, 1916b, p. 303; Houser, 1918, p. 283; Miller, 1922, p. 61; Hollinger, 1923, p. 9; Britton, 1923, p. 372; Felt and Morrison, 1928, p. 200; Amos, 1933a, p. 206; Sleeman, 1945, p. 48; Porter et al., 1959, p. 76.


**Common Name.**—Putnam scale.

**Scale of Female.**—Circular, convex, dark to light gray; about 1.5 mm in diameter; exuviae yellow, submarginal or subcentral.

**Female.**—Circular, young females more or less oval. Cephalothoracic region of mature females sclerotized, especially on the
Fig. 10.— *Clavaspis ulmi* (Johnson)

Fig. 11.— *Diaspidiotus ancylius* (Putnam)
margin. Young females ocher yellow (Y.25.0-8/8). Length on slide of young females about 0.75-0.85 mm, width 0.5-0.6 mm; length of old females 1.25-1.4 mm, width 1.2 mm.

**Pygidium.**—Median lobes close together, wider than long, notched about halfway on outer margins, rounded at apex. Second lobes usually represented as a rounded prominence, terminating in a sharp hyaline point. Third lobes lacking. Space between median lobes closed about halfway, and with a pair of slender acute plates. Two elongated plates in the first interlobular space, slightly shorter than median lobes, mesal plate usually bifurcate at apex, lateral plate larger, fimbriated on lateral margin; 3 plates in the second interlobular space, but usually only 2 are visible because mesal plate small and covered by seta of second lobe; 2 lateral plates, about as long or longer than median lobes, fimbriated on outer margins; lateral from third lobe area usually 2-3 simple slender plates, and 2-3 small, pointed, tooth-like structures on margin of pygidium. Intersegmental scleroses well developed. Dorsal macroducts usually in definite rows or furrows, varying in number; young females usually with fewer ducts. Between median lobes two ducts, or sometimes only one visible, extending to anal opening area; 3-7 ducts in the first interlobular space; usually 7-16 ducts in a row starting in the second interlobular space; usually 1 duct on the margin, lateral from third lobe area; anterior from the latter duct in about middle of pygidium, usually 3-4 ducts in a row; mesal from seta marking the fifth segment begins a row of 5-18 ducts, extending to lateral scar; usually 1-5 ducts laterad of seta marking fifth segment. Ventral ducts few,
located along margin of pygidium. Setae long and slender, those laterad of second lobes longer than median lobes. Perivulvar pores in four or five groups, strongly varying in number; medians 0-7; anterior laterals 7-15; posterior laterals 6-9. Anal opening slightly oval, less in diameter than length of median lobes, removed from base of median lobes by about 3 times its diameter.

Scale of Male.—Not seen. According to Ferris (1938), the scale of male is elongate, gray, exuviae near one end.

This species, based on the material studied, shows a wide degree of variation. Through the courtesy of Dr. Harold Morrison it has been possible to see mounted specimens marked as "from Putnam," and specimens marked as "topotype," also a mounted specimen of Aspidiotus ohicensis York, marked as "type." This latter species is synonymous with D. ancylu (Putnam). Specimens even from the topotype material, on which the above description and figures are based, show a wide degree of variation. This species may represent more than one species. The material which shows close resemblance to the "typical specimens" is listed first, and that which is questionable is listed separately.

This material is probably identical with the material on which the original description was based, collected at Columbus: OSU, March 24, 1905. *Euonymus latifolia* Scop., Licking Co.: Dawes Arboretum, June 17, 1961 (MK). *Euonymus* sp., Cincinnati: Spring Grove Cemetery, Nov. 6, 1914 (JSH, JLK). On twigs of *Hypericum spathulatum* (Spach) Steud., Adams Co.: Lynx Cemetery, July 15, 1961 (MK).

1915 (JSH), data from R. W. Rings. *Salix* sp., Preble Co., Aug. 26,
(JGS). On twigs of *Tsuga* sp., Columbus, Oct. 2, 1960 (J. N. Knull),
(KC). *Ulmus americana* L., and *U. procera* Salisbury, Canton, Oct. 1915

Other Material Examined.—IOWA: Davenport. No collecting
date, but the following notes on labels: "No. 759, *Diaspis ancyulus*
on *Acer dasycarpum*, from Putnam" (NCC). This host is a synonym of
*Acer saccharinum* L. Dr. H. Morrison stated (personal communications)
about this material: "Although there is no positive evidence, I
suspect that these slides come closer to representing type material
than anything else that is now in existence." On "maple" *Acer* sp.,
(same location as previous) Apr. 30, 1908, (Elizabeth Putnam), slide
marked "Topotype" (No. 759), (NCC). VIRGINIA: Shenandoah National
Park, on *Betula lutea alleghaniensis* (Brit.) Ashe., Aug. 1, 1958,
close to the "typical specimens" (MK).

*Acarina* Associated.—Oribatei: Cymbaeremaeidae: *Scaphereman-
eus marginalis* (Banks); Oribatulidae: *Dometorina* sp.n.; Mesostigmata:
Phytoseiidae: *Amblyseius* sp.

The accompanying illustrations are based on the above listed
topotype material, from Iowa.
**Diaspidictus caryae** sp.n.

Fig. 12

**Scale of Female.**—Circular, almost flat, yellowish white or grayish from dirt and dust, 2.0–2.5 mm in diameter; exuviae yellowish, subcentral. Ventral scale thin, white, adheres to the bark.

**Female.**—Circular, at maturity the entire body heavily sclerotized; length on slide 1.5–1.7 mm, width 1.3–1.5 mm.

**Pygidium.**—Relatively large, semi-circular. Median lobes large, about as long as wide, notched about half way on lateral margins, rounded apically. Space between median lobes closed about half way, or more often at two-thirds of the length of median lobes. Second lobes slightly indicated as a low prominence. Plates of various shape; 2 simple, acute plates between median lobes; 2 large and fimbriate plates in the first interlobular space; 3 fimbriate plates in the second interlobular space, mesal plate smallest, acute, only slightly fimbriated, lateral plate largest, and well fimbriated; usually 3–4 simple or bifurcate plates lateral from third lobe area. Intersegmental scleroses well developed. Dorsal ducts in large number, about 80 to 100 on each side of pygidium, including segments three and four. No submedian dorsal duct groups present. Usually 2 ducts between median lobes, which extend to the anal opening area; 5–10 ducts (average 7) in a short row between median and second lobes; usually 14–16 ducts in a row beginning at the margin of second interlobular space; large number of ducts lateral from this row, not arranged in definite rows, and extending to the third abdominal segment; about 8–10 ducts on each side of third segment. Ventral ducts
in large number along the margin of pygidium. Marginal setae about as long or longer than plates. Perivulvar pores in five groups: median group 3-10 (average 6); anterior laterals 11-21 (average 14); posterior laterals 8-14 (average 11). Anal opening round or slightly oval, removed from base of median lobes by about twice its diameter.

No males were observed.

Host and Distribution in Ohio.—On bark of twigs of "hickory," Carya sp., Ottawa Co.: Gypsum, Sept. 5, 1914 (J. L. King). Material includes 14 females, of which 5 are parasitized, 2 second instar and 6 first instar nymphs.

Holotype female deposited in the U.S. National Museum.

Paratypes, 1 female in the Houser Collection (OSU), and 7 females in the author's collection.

Both holotype and paratype specimens are from the above listed material.

This species in general has some resemblance to Diaspidiotus bumeliae Ferris (1938, Ser. II:217), from which it differs as follows:

1. There are about 80-100 dorsal ducts on each side of the pygidium in Diaspidiotus caryae, while in D. bumeliae there are about 45-65 such ducts.

2. The plates, laterad from third lobe area, are simple or at most bifurcate just at their apex in D. caryae, while in D. bumeliae these plates are with long branches at their apex.

3. Lateral plate of second interlobular space is fimbriated only on lateral margin in D. caryae, while in D. bumeliae this plate is well fimbriated on both margins.
4. In the first interlobular space there are 5-10 ducts (average 7) in *D. caryae*, while in *D. bumeliae* there are 2-6 such ducts.

5. Ventral ducts are numerous (more than 20) on each side of the pygidial margin in *D. caryae*, while in *D. bumeliae* there are only about 6-12 such ducts.

6. Median group of perivulvar pores is composed of 3-10 pores (average 6) in *D. caryae*, while in *D. bumeliae* there are 0-2 such pores.

7. Known host of *D. caryae* is *Carya* sp., while *D. bumeliae* is known only from other hosts, which are not related to *Carya*.

8. *Diaspidiotus caryae* is known only from Northern United States, while all distributional records of *D. bumeliae* are from the Southern United States (Oklahoma, and Texas) and Mexico.

*Diaspidiotus hunteri* (Newell)

Fig. 13

*Aspidiotus hunteri* Newell, 1899, p. 10; Fernald, 1903, p. 265.

*Aspidiotus piceus* Sanders, 1904a, p. 96. *Diaspidiotus hunteri* (Newell), MacGillivray, 1921, p. 412; Ferris, 1938, Ser. II:222.

Scale of Female.—Circular, flat, gray, darker in the center; about 2.0 mm in diameter; exuviae subcentral.

Female.—Circular, with protruding pygidial area. Cephalothoracic area sclerotized at full maturity. Length on slide of co-
Fig. 12.— *Diaspidiotus caryae* sp. n

Fig. 13.— *Diaspidiotus hunteri* (Newell)
types about 1.5–1.6 mm, width 1.3–1.4 mm. Length of Sanders specimens on slide about 1.0–1.2 mm, width 0.9–1.0 mm.

Pygidium.—Semi-circular. Median lobes well developed, prominent, about as long as wide, usually notched on lateral side, sometimes notched on the inner margin, rounded apically. Width of area between median lobes about one-third of the width of a median lobe. Second and third lobes reduced, inner angle of second lobes sometimes more or less developed. Two elongated, acute plates between median lobes. Other plates well developed, wide and fimbriated, especially those on the outer margin, in the Sanders material; smaller and without definite fimbriation in the cotype material. Only two plates visible in the second interlobular space. Usually 2–3 short, stout, simple plates laterad of third lobe area, on margin of pygidium. Intersegmental scleroses weakly developed. Dorsal macroducts small and slender, usually in well defined rows; 1 between median lobes; 3–6 ducts in a short row starting at the base of first interlobular space; 6–9 ducts in a row starting at the base of second interlobular space; 1 duct on the margin, laterad of third lobe area; anterior to the latter duct, usually 2 or 3 more ducts; a longer row of 7–10 ducts starting mesally, and 3–4 ducts laterally from the seta marking fifth segment; 6–10 ducts in a row, starting near the seta marking fourth segment; 2–3, or more ducts, on third segment, to a distance from margin; usually 4 or more short ducts on margin of first to third abdominal segments, with their duct orifice toward lateral margin of each segment. (The latter marginal ducts are not present in the cotypes.) Ventral ducts few, mostly located submarginally.
Perivulvar pores in five groups; medians 2–8 (cotypes 4–6); anterior laterals 15–20 (cotypes 8–10); posterior laterals 8–13. Anal opening slightly oval, about as long as the length of median lobes; removed from base of median lobes by about two and a half times its diameter.

No male scales were seen.


Other Material Examined.—Through the kindness of Dr. Harold Morrison it has been possible to examine and to use for comparison two cotype specimens from Ribes sp., bearing the following on the label: "Aspidiotus hunteri Newell–6387-Co-type. On Currant, Alton, Iowa 1897."

The Ohio material differs in certain morphological characteristics from the cotypes. These differences are mentioned in the description of the species.

The accompanying illustrations are based on the above listed Ohio material.

**Diaspidiotus liquidambaris** (Kotinsky)

Fig. 14

Scale of Female.—Circular, convex, white or light gray; about 1.2 mm in diameter; exuviae yellow, subcentral.

Female.—Circular, yellow (Y 22.5-8/12); length on slide 0.6-1.0 mm, depending on age. Cephalothoracic region becomes sclerotized at maturity.

Pygidium.—Median lobes large, prominent, about as long as wide, notched on both sides, rounded apically; second lobes reduced to elongated, hyaline, plate-like processes which are enlarged at base. Plates well developed, slender, simple or variously toothed or fimbriate. Two slender, apically fimbriate plates between median lobes; lateral plates present as far as the seta which marks the fifth segment. Intersegmental scleroses moderately developed. Dorsal macroducts vary in number, slender; one between median lobes, extending to the top of anal opening; usually 3 duct orifices between median and second lobes. Ventral ducts few, in groups along the margin of pygidium. Setae longer than lobes. Perivulvar pores lacking. Anal opening oval, removed from base of median lobes about twice the latter's diameter.

Scale of Male.—Elongate oval, white; exuviae at one end.

Host and Distribution in Ohio.—Occurs on leaves, especially on the under surface, also on twigs. Causes small galls and discoloration on the upper surface of leaves of sweetgum, Liquidambar styraciflua L. Columbus: OSU, June 19, 1961 (MK); Central Ohio, Jan. 1962 (J. T. Walker), (ODA); Cuyahoga Co.: North Royalton, June 14, 1961 ("R.F.W."); (ODA).
Additional Biological Data.—Overwintered as mature, unmated females, and males in pupal stage, at the base of buds on twigs in Central Ohio (1961–62). Almost all eggs hatched by June 19, 1961 in Columbus.

The accompanying illustration is based on the above material from Columbus.

_Diaspidiotus osborni_ (Newell and Cockerell)

Fig. 15

Aspidiotus osborni Newell and Cockerell, Osborn, 1898, p. 229;

Scale of Female.—Circular, or slightly elongated, flat, light gray, usually as the color of the bark; about 1.5 mm in diameter; exuviae subcentral, orange yellow.

Female.—Circular, at full maturity cephalothoracic region heavily sclerotized and with moderate constrictions between prothorax and mesothorax, also between mesothorax and metathorax; color of live young female yellow (rY 22.5–8/10). Length on slide about 1.0 mm.

Pygidium.—Median lobes large, protruding, slightly separated, closed about half way, outer margins sloping toward the meson and notched about midway; second and third lobes lacking. Plates small,
Fig. 14.—Diaspidiotus liquidambaris (Kotinsky)

Fig. 15.—Diaspidiotus osborni (Newell & Cockerell)
elongated, dagger-like; no plates between median lobes. Scleroses present at base of median lobes, between segments six and seven, also between seven and eight. Dorsal macroducts relatively few, slender; one between median lobes; 2–4 in the first interlobular space; laterad of this two row of ducts, which do not extend to the fourth segment. Few ventral ducts, some ending in small, stout, tube-like structures, gland tubes, on the margin of pygidium. Setae usually longer than median lobes. Perivulvar pores in four small groups of 3 to 10 in a group, occasionally with 1 or 2 pores in the median group. Anal opening relatively small, removed 2 or 3 times its diameter from the base of median lobes.

Egg.—Color yellow (Y 25.0–8/6).

Scale of Male.—Elongate oval, gray, exuviae at one end.

Host and Distribution in Ohio.—Occurs on bark. Usually on hosts belonging to the plant families Fagaceae and Corylaceae.


Other Material Examined.—PENNSYLVANIA: Fatland, on *Quercus borealis* Michx., March 24, 1944 (GBS), (PaDA).

Additional Biological Data.—Usually very scarce on the host. Most eggs already hatched by July 1 (1961), in the Cincinnati area, and by July 10 (1961) in Central Ohio. Although several collections were made, no parasites were reared.

The accompanying illustrations are based on material from *Quercus alba* L., Lucas Co.: Oak Openings, July 8, 1961.
**Diaspidothus uvae** (Comstock)

*Fig. 16*

**Aspidiotus uvae** Comstock, 1881, p. 309; Fernald, 1903, p. 280; Sanders, 1904b, p. 68; Zimmer, 1912, p. 115; Dietz and Morrison, 1916b, p. 305; Hollinger, 1923, p. 17; Britton, 1923, p. 375; Felt and Morrison, 1928, p. 201; Sleesman, 1945, p. 48.

**Diaspidothus uvae** (Comstock), MacGillivray, 1921, p. 412; Ferris, 1938, Ser. II:225; Balachowsky, 1950, p. 497; McKenzie, 1956, p. 63.

**Common Name.**—Grape scale.

**Scale of Female.**—Circular or slightly elongated, flat, white or yellowish white, on sycamore its color resembles the color of bark; about 1.5-1.7 mm in diameter; exuviae central or subcentral, orange yellow (YR 15.0-6/10). Ventral scale present, white, thin, adheres to the bark.

**Female.**—Circular, mature females often with retracted pygidium, horseshoe-shaped, their cephalothoracic region sclerotized, especially along the margins. Young females greenish yellow (gY 27.5-8/8). Length on slide 1.2-1.5 mm.

**Pygidium.**—Median lobes prominent, slender, parallel, without plates between them, notched on both sides, inner notch closer to the tip, lobes rounded at apex; second lobes reduced to small hyaline points; third pair entirely lacking. Plates as long as the setae; those in the first and second interlobular space more or less fimbriated; usually 3-5 simple or weakly fimbriated plates laterad of third lobe area. Intersegmental scleroses well developed. Dorsal
ducts slender; sometimes one duct between median lobes; usually 4 ducts between median and second lobes; 15-20 ducts on fifth and sixth segment in two more or less definite rows which extend as far as the lateral scar. Ventral ducts small, along the margin of pygidium. Perivulvar pores in four small groups, mesal group sometimes represented by one or two pores. Anal opening oval, removed from base of median lobes by about 2 or 3 times its diameter.

Scale of Male.—Not seen. According to Sasscer (Zimmer, 1912), the scale of male is elongate, length 0.9-1.0 mm, width 0.5 mm; slightly darker and more convex than female scale; exuviae at one end.

L., Lawrence Co.: Ironton, Feb. 24, 1912 (J. T. Wolfe), Nov. 2, 1915 (H. C. Rudman), (HC); no location, Sanders (1904b).


Additional Biological Data.—This insect overwintered as mature females in Columbus (1961–62). According to Zimmer (1912), the males appear in June; females are ovoviviparous and give birth to 35 to 50 young during May and June; there is one yearly generation.

Parasites Reared.—Sulophidae: Prospaltella sp.

Acarina Associated.—Mesostigmata: Uropodidae: "Urodictybus—type" deutonymphs; Immature Oribatei.

The accompanying illustrations are based on the above listed material from Vitis vinifera L., Maryland.

Genus Hemiberlesia Cockerell

Hemiberlesia Cockerell, 1897c, p. 9, 12; Ferris, 1938, Ser. II:232; Balachowsky, 1948, p. 57; Borchsenius, 1950, p. 223; Balachowsky, 1956, p. 104; Schmutterer, 1959, p. 65; Davidson, 1960, p. 27. Marlattaspis MacGillivray, 1921, p. 387.

Scale of Female.—Circular to oval, usually strongly convex; exuviae central or subcentral.
Female.—Circular to pyriform.

Pygidium.—Median lobes prominent, close together; second
and third lobes usually reduced. Plates elongated, fimbriated, in
the normal 2-2-3 formula. Paraphyses present. Dorsal ducts few,
long and slender. Anal opening circular, conspicuously large, its
diameter somewhat greater than length of median lobes.

Type of the Genus.—H. rapax (Comstock).

KEY TO SPECIES OF HEMIBERLESIA

1  Perivulvar pores present; anal opening removed
   about once its diameter from base of median
   lobes ........................................... lataniae (Signoret)

1' Perivulvar pores absent; anal opening removed
   about twice its diameter from base of median
   lobes ........................................... diffinis (Newstead)

Hemiberlesia diffinis (Newstead)

Fig. 17

Aspidiotus affinis Newstead, 1893a, p. 186, a preoccupied name,

Aspidiotus diffinis Newstead, 1893b, p. 281; Fernald, 1903,
p. 257. Hemiberlesia diffinis (Newstead), MacGillivray,
1921, p. 437; Ferris, 1938, Ser. II:238; Davidson, 1960,
p. 37.

Scale of Female.—Elongate, oval, high convex; length about
1.3 mm; exuviae large, at anterior end.
Fig. 16.— Diaspidiotus uvae (Comstock)

Fig. 17.— Hemiberlesia diffinis (Newstead)
Female.—Circular, cephalothoracic derm remains membranous at maturity; length on slide about 1.0 mm.

Pygidium.—Tapering toward the apex. Three pairs of sclerotized lobes, median lobes close together and about as long as wide, notched on both sides, but inner notch much smaller and closer to apex, lateral margins sloping toward meson; second lobes almost triangular, distinctly notched on lateral margins; third lobes smaller than second, acute. Plates elongated, fimbriated, present in the normal 2-2-3 formula. A few small slender, pointed plates around the seta marking segment five. Paraphyses present in the first and second interlobular spaces. Dorsal macroducts few, long and slender, about 15 present on segment five and six; one between median lobes. Ventral ducts small, located submarginally in small groups. Vulva in about the middle of pygidium. Perivulvar pores lacking. Anal opening round, conspicuously large, its diameter greater than the length of median lobes, removed about twice this diameter from the base of median lobes.

Scale of Male.—Similar to that of the female, but smaller.


The accompanying illustrations are based on the above listed material from Liriodendron tulipifera L.
Hemiberlesia lataniae (Signoret)

Fig. 18


Scale of Female.—Circular, high convex, grayish; about 1.5 mm in diameter; exuviae submarginal.

Female.—Circular, mature females with membranous cephalothorax; length on slide about 1.1 mm.

Pygidium.—Median lobes large, prominent, close together, slightly convergent, wider than long, notched on both sides. Second and third lobes represented by small, acute, hyaline points. Plates present in the normal 2-2-3 formula, elongate, fimbriate; those between median lobes small, slender, hardly visible. Paraphyses present in the first and second interlobular space. Dorsal macroducts few, slender, most arranged in two furrows; one between median lobes; 2 between paraphyses of first interlobular space; an average of 15 dorsal ducts on each side of the pygidium. Ventral ducts very small, numerous, located submarginally. Perivulvar pores in four
small groups. Anal opening circular, quite large, greater in diameter than median lobes; removed from their bases by about this diameter.

Scale of Male.—Unknown.

Host and Distribution in Ohio.—Occurs on all parts of the host, except roots. Probably generally distributed all over the temperate areas of the world, also in greenhouses. On *Morus rubra* L., Cincinnati: Ault Park, Nov. 5, 1914 (JSH, JLK). On *Morus* sp., Cincinnati: Glenwood Flats, Nov. 7, 1914 (JSH, JLK), on "Russian mulberry," Cincinnati: Zoo, Nov. 8, 1914 (JSH, JLK). On *Prunus* sp., "plum" (?) Columbus, Feb. 23, 1914. In Sanders' Collection. Questionable material, probably mislabeled and identical with the material listed by Sanders (1904b, p. 64) as: "On palm *Areca lutescens*, in Ohio State University Conservatory." The present label bears the host as "plum" which may be a misspelling of "palm." On *Wisteria* sp., Cincinnati: Glenwood Flats, Nov. 7, 1914 (JSH, JLK).

The accompanying illustrations are based on the above material from *Morus rubra* L.

Genus *Melanaspis* Cockerell

Scale of Female.—Circular, sometimes oval, high convex, hard, thick and brittle, dark brown or black; exuviae central or subcentral. Ventral scale present.

Female.—Circular, derm at maturity membranous.

Pygidium.—Short, the angle of its apex usually much more than 90 degrees. Four pairs of lobes, fourth pair sometimes reduced to sclerotized points. Plates minute, slightly fringed at apex. Paraphyses well developed; three in the space between second and third lobe. Dorsal ducts long and slender.

Type of the Genus.—M. obscurus (Comstock).

KEY TO SPECIES OF MELANASPIS

1 Perivulvar pores present; in first interlobular space a long paraphysis is followed laterally by a short one; associated especially with oak and hickory . . . . . . . . . . . . . . obscura (Comstock)

1' Perivulvar pores absent; in first interlobular space a short paraphysis is followed laterally by a long one; associated especially with maple and hackberry . . . . . . . . . . . . . . tenebricosa (Comstock)

Melanaspis obscura (Comstock)

Fig. 19

Fig. 18.—*Hemiberlesia lataniae* (Signoret)

Fig. 19.—*Melanaspis obscura* (Comstock)
**obscura** (Comstock), Ferris, 1941, Ser. III:36; McKenzie, 1956, p. 77.

**Common Name.**—Obscure scale.

**Scale of Female.**—Circular, convex, hard, thick, brittle, gray; about 2 mm in diameter; exuviae subcentral. Ventral scale present.

**Female.**—Circular, light yellow (Y 25.0-8/6), pygidium darker, sclerotized at the margin; length, on slide, about 1.5 mm. Antennae with one long seta. Prepygidial segments not lobed laterally.

**Pygidium.**—Large, with broad, rounded apex. Three pairs of well developed lobes; median pair short, broad, their outer margins notched; second and third pair very short, broad, their outer margins sloping and toothed; fourth lobes each reduced to a sclerotized tooth. Plates extremely minute, hardly visible; two plates beyond the third lobe; one plate in each of the remaining interlobular spaces. Margin of pygidium sclerotized beyond the area of fourth lobes. Median lobes with sclerotized basal process. In first interlobular space a relatively long paraphysis, followed by a shorter process; in second interlobular space three paraphyses, the median one much longer than the two others; three smaller paraphyses in the third interlobular space; several small, fused paraphyses beyond fourth lobe. Dorsal ducts of two sizes; both kinds long, slender. A few ventral ducts scattered along margin of pygidium. Perivulvar pores in five small groups; usually no sharp division between anterior and posterior lateral groups.

**Other Material Examined.**—FLORIDA: Lake City, **Quercus nigra** L., May 18, 1898 (ALQ), det. T.D.A. Cockerell. MARYLAND: Baltimore, **Quercus sp.**, July 7, 16, Aug. 28, 1958 (JL); PENNSYLVANIA: Andorra, on trunk of **Q. macrocarpa** Michx., July 11, 1947 (GBS). WEST VIRGINIA: Morgantown, no host given, Feb. 21, 1917 (CAR).
Additional Biological Data.—Larvae hatched between July 14–28 (1961) in Columbus. Though high parasitization was observed in several locations, no parasites were reared.

Acarina Associated.—Oribatei: Oribatulidae: Lucoppia sp.

Economic Importance.—Houser (1918) gives examples of severe damages caused by this species. The author observed heavy, layered infestations on oaks in Columbus, which probably caused the death of many branches.

The accompanying illustrations are based on material from Quercus macrocarpa Michx., Harding Co.: north of Ridgeway, July 9, 1961.

Melanaspis tenebricosa (Comstock)

Fig. 20

Aspidiotus tenebricosus Comstock, 1881, p. 308. Chrysomphalus tenebricosus (Comstock), Fernald, 1903, p. 294; Hollinger, 1923, p. 31; Felt and Morrison, 1928, p. 201. Aonidiella tenebricosa (Comstock), MacGillivray, 1921, p. 443.

Melanaspis tenebricosa (Comstock), Ferris, 1941, Ser. III:367.

Common Name.—Gloomy scale.

Scale of Female.—Circular, dark gray or black, convex, hard, thick, brittle; about 1.2–1.5 mm in diameter; exuviae subcentral; ventral scale snowy white.

Female.—Circular, length on slide 1.2 mm.
Pygidium.—Short and broad. Three pairs of lobes present, median lobes short, apically rounded, outer margin notched; second pair almost triangular, smaller than first; third pair about the size of median lobes, but more sloping and toothed on outer margin; fourth pair more or less reduced. Margin of pygidium toothed and sclerotized beyond fourth lobe. Plates small and stout; one minute plate in the first interlobular space; two plates in each of the remaining interlobular spaces. Anterior margin of pygidium with a characteristic semicircular sclerotization. Median lobes with sclerotized basal process. Paraphyses well developed; in the first interlobular space one short paraphysis is followed laterally by another which is twice as long; in the second interlobular space three paraphyses of which the median is the largest, lateral smaller, and mesal the smallest; in the third interlobular space two paraphyses of which the mesal is larger than the lateral. Only a few dorsal ducts present; these are long and slender. Ventral ducts few, most along margin of pygidium. Perivulvar pores lacking. Anal opening small, close to apex of pygidium.

Scale of Male.—Not seen. According to Comstock (1881) the scale of male is oval, same color as that of the female; exuviae near anterior end. Ventral scale as that of the female, but the margin is less thickened.

Host and Distribution in Ohio.—Occurs on bark. Distributed along the East Coast States up to New York. No Ohio material was found in the National Coccoid Collection. Ferris (1941), studied Ohio material, but no host or location was given. The author was not able to collect this species.

The accompanying illustrations are based on the above material from Virginia.

Genus Nuculaspis Ferris


Scale of Female.—Elongate oval, black with gray margin; exuviae central.

Female.—Circular, at full maturity heavily sclerotized and with pygidium retracted into the apex of body.


Type of the Genus.—N. californica (Coleman).

Nuculaspis californica (Coleman)

Fig. 21

Aspidiotus californicus Coleman, 1903, p. 64. Aspidiotus pini Comstock, 1881, p. 306 (a preoccupied name). Aspidiotus abietis (Schrank), as a misidentification in the Houser Collection.

Nuculaspis californica (Coleman), Ferris, 1938, Ser. II:251.
Fig. 20.—Melanaspis tenebricosa (Comstock)

Fig. 21.—Nuculaspis californica (Coleman)
Common Name.—Black pine leaf scale.

Scale of Female.—Elongated oval, black with gray margin; length about 2.0 mm; exuviae central.

Female.—At full maturity heavily sclerotized, circular, pygidium retracted into the apex of body; length on slide about 1.0 mm. Young females egg-shaped, length on slide about 0.7-0.8 mm.

Pygidium.—Rounded at apex. Four pairs of lobes present; first pair larger than others, rounded; fourth pair more or less reduced in size. Plates inconspicuous, short and broad, fringed; two plates between median lobes and in first interlobular space; three plates in second interlobular space; plates of varying number and shape between third and fourth lobe. Intersegmental scleroses absent. Dorsal ducts concentrated along the margin of pygidium, these relatively large, stout, several on margin of prepygidial segments as far as third abdominal segment. Perivulvar pores in two or four groups. Anal opening relatively large, removed from apex of pygidium by about three times its diameter.

Scale of Male.—Elongate oval, black, length about 1.2 mm, width about 0.5 mm; exuviae yellow, located centrally.

Host and Distribution in Ohio.—Occurs on needles. Pinus echinata Mill., Marietta, July 2, 1915 (V. H. Lynch), (HC).

Additional Biological Data.—Houser in his collecting notes stated that the young of this species appeared during the first part of July in 1915.
The accompanying illustrations are based on the above material from *Pinus virginiana* L.

**Genus Quadraspispidotus MacGillivray**


**Scale of Female.**—Circular, slightly oval, convex, usually dark gray; exuviae central or subcentral.

**Female.**—Circular or pyriform.

**Pygidium.**—Two pairs of lobes, which usually are close together; third lobe sometimes represented by a slight prominence. Plates in most species small and simple. Intersegmental scleroses present. Perivulvar pores present or lacking. Anal opening much shorter than length of median lobes.

**Type of the Genus.**—*Q. ostreaeformis* (Curtis).

**KEY TO SPECIES OF QUADRASPISPIDOTUS**

1. Perivulvar pores present . . . . . . . . . . . . . . 2

1'. Perivulvar pores absent; three fork-like plates lateral from third lobe; polyphagous, but with preference for hosts belonging to family Rosaceae . . . . . . . . . . . . . . . . . . . . perniciosus (Comstock)
2(1) Second lobe reduced to a sclerotized point;
occurs on Taxodium distichum .................................. taxodii Ferris

2' Second lobe well developed ......................................................... 3

3(2') Third lobe indicated at least by a point;
mesal paraphysis of first interlobular space
not strongly swollen apically ....................................................... 4

3' Third lobe entirely absent; mesal paraphysis of
first interlobular space strongly swollen
apically, club-like ......................................................... forbesi (Johnson)

4(3) With distinct constriction between prothorax
and mesothorax, and between mesothorax and meta-
thorax; only one minute plate between median
lobes and in each interlobular
space ................................................................. juglans-regiae (Comstock)

4' With a constriction between mesothorax and
metathorax only; two plates between median
lobes and in each interlobular space ........................................ 5

5(4') Fourth abdominal segment with 4-7 dorsal macron-
ducts; 3-4 duct orifices at the base of first
interlobular space; median lobe about as long
as wide; occurs chiefly on hosts belonging to
the family Rosaceae ......................................................... ostreaformis (Curtis)

5' Fourth abdominal segment with 8-20 dorsal macro-
ducts; 5 or more duct orifices at the base of
first interlobular space; median lobes wider
than long; occurs chiefly on poplar and willow. . . . . . . . . . . . giga (Thiem and Gerneck)

**Quadraspidiotus forbesi** (Johnson)

**Fig. 22**

*Aspidiotus forbesi* Johnson, 1896a, p. 151; 1896b, p. 380; Osborn, 1900, p. 72; Fernald, 1903, p. 259; Sanders, 1904b, p. 60; Dietz and Morrison, 1916b, p. 302; Hollinger, 1923, p. 11; Britton, 1923, p. 373; Felt and Morrison, 1925, p. 200; Amos, 1933a, p. 206; Sleesman, 1945, p. 48. **Forbasasis** *forbesi* (Johnson), MacGillivray, 1921, p. 422. **Quadraspidiotus forbesi** (Johnson), Ferris, 1938, Ser. II:256; McKenzie, 1956, p. 79.

**Common Name.**—Forbes scale.

**Scale of Female.**—Circular or oval, convex to almost flat, gray, from 1.0-2.0 mm in diameter; exuviae subcentral or marginal.

**Female.**—Circular, young females reddish yellow (rY 22.5-8/10), egg laying females yellowish red (yR 17.5-7/10), slightly sclerotized and darker on pygidium; length on slide 0.8-1.0 mm.

**Pygidium.**—Slightly pointed. Median lobes prominent, close together, notched on lateral margin; second lobes smaller, notched on lateral margin; third lobes reduced to a small hyaline point. Plates inconspicuous, simple, usually two in the space between the second and third lobes. Intersegmental scleroses well developed; first pair with mesal member enlarged and apically swollen; other scleroses much smaller. Dorsal ducts small, slender, arranged in
row s, few in number. Few ventral ducts along the margin of pygidium. Perivulvar pores in four or five small groups. Anal opening removed about three times its diameter from the base of median lobes.

First Stage Nymphs.—Yellow (Y 25.0-8/8).

Scale of Male.—Elongate oval, dark gray with lighter margin, length about 1.0 mm, width about 0.5 mm; exuviae toward one end.

Data from R. W. Rings, who also stated: "this species is a persistent pest in this area."  

_**P. pennisylvanica**_ L., Cleveland: Gordon Park, April 9, 1913 (JLK, JSH); Columbus: OSU, May 22, 1961, live young females on trunk (MK).  


_**Viburnum opulus**_ L., Columbus, June 23, 1961 (MK). No host mentioned: Chillicoth, Sept. 9, 1911 (JSH); Cleveland, April 27, 1912 (JSH); Columbus, Osborn (1900); Portage, April 18, 1913 (H. A. Dauterman), (HC).

**Other Material Examined.**—**PENNSYLVANIA**: Philadelphia, Fairmont Park, on _**Pyrus communis**_ L., July 20, 1949 (PDADA).

**Additional Biological Data.**—Eggs hatched in Columbus during the first part of July, and wingless males emerged between April 14-21, 1961.

**Parasites Reared.**—**Eulophidae**: _**Alerus**_ sp., _**Aphytis diaspidis**_ (How.), _**Prosaptella murtfeldti**_ How., _**Prosaptella**_ sp. **Thysanidae**: _**Thysanus**_ sp.

**Acarina Associated.**—**Acaridae**: _**Thyreophagus entomophagus**_ (Laboulbene); **Oribatidae**: _**Cymbaeremaeidae**: _**Scapheremaeus marginalis**_ (Banks); **Oribatulidae**: _**Lucoppia**_ sp., _**Zygoribatula pyrostigma**_ (Ewing); **Prostigmata**: _**Cheyletidae** undet., **Erythraeidae**: _**Balaustium**_ sp.
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**Economic Importance.**—There are evidences that this species occasionally becomes a pest in Ohio orchards.

The accompanying illustrations are based on material collected from *Prunus pennsylvanica* L., Columbus: OSU, May 22, 1961 (MK).

**Quadraspidiotus gigas** (Thiem and Gerneck)

**Fig. 23**

*Aspidiotus (Euraspidiotus) gigas* Thiem and Gerneck, 1934, p. 131.

*Diaspis gigas* (Thiem and Gerneck), Borchsenius, 1950, p. 226. *Quadraspidiotus gigas* (Thiem and Gerneck), Bala-


**Scale of Female.**—Circular, moderately convex, gray; length 1.8–2.0 mm. Exuviae central or subcentral, orange yellow.

**Female.**—Pear-shaped, with evident constriction between mesothorax and metathorax, prepygidial segments distinctly marked; length on slide 1.4–1.6 mm.

**Pygidium.**—Broad, acute at apex. Median lobes large, short and wide, notched on lateral side; second pair smaller, about as wide as median lobes, notched on outer margin; third pair small. Two small plates between median lobes; two plates between median and second lobes, mesal plate simple, lateral plate fimbriate at apex; two larger and more fimbriate plates between second and third lobes. Intersegmental scleroses present, enclosing about 5 duct orifices between median and second lobes; enclosing about 2–3 duct orifices between second and third lobes. Dorsal macroducts as follows: one
Fig. 22. - *Quadraspidiotus forbesi* (Johnson)

Fig. 23. - *Quadraspidiotus gigas* (Thiem & Gerneck)
between median lobes; usually 5-10 between median and second lobes; about 10-15 in a row beginning between second and third lobes; about 10-20 in a row beginning near the seta which marks the fifth segment and extending to the lateral scar of the pygidium; 8-16 on fourth segment. Ventral ducts in large number, located submarginally. Vulva in about the middle of pygidium. Perivulvar pores in five groups as follows: median 5-7; anterior laterals 13-18; posterior laterals 9-13. Anal opening round, removed from base of median lobes by about twice its diameter.

**Scale of Male.**—Elongate oval, dark gray; length about 1.2 mm.

**Host and Distribution in Ohio.**—Occurs on bark, especially on willow and poplar. Probably introduced from Europe. These are the first authenticated records of this species from the United States. On *Populus alba* L., Cincinnati: May 19, 1913 (JSH), Cincinnati: Windermere Ave., and Adam Park, Nov. 7 and 9, 1914 (JSH, JLK); Cleveland, March 1912 (JLK). *P. canadensis* Moench, Bloomingdale, Jan. 7, 1915 "very plentiful, trees suffering," (JSH); Cincinnati: Zoo, Nov. 8, 1914 (JSH, JLK). *Salix* sp., Cleveland, 1908, associated with *Chionaspis salicis-nigrac* (Walsh), (WHG); "On Boulevard, south of St. Clair," March 7, 1912 (JSH), Oct. 22, 1912, "very severe" (JSH).

**Other Material Examined.**—**WYOMING:** Laramie, very heavy infestation on trunk and branches of roadside trees, *Salix* sp., Aug. 22, 1961 (MK).

**Economic Importance.**—There are enough evidences that this species definitely damages trees.
The accompanying illustrations are based on the above material from Wyoming.

**Quadraspidiotus juglans-regiae** (Comstock)

**Fig. 24**


**Common Name.**—Walnut scale.

**Scale of Female.**—Circular, slightly convex, soft, light to dark gray; about 1.5-2.0 mm in diameter; exuviae subcentral. Ventral scale thin, white, adheres to the bark.

**Female.**—At full maturity the entire body heavily sclerotized, characteristic constrictions between prothorax and mesothorax, also between succeeding segments. Color of young females light yellow (rY 22.5-8/6), egg laying females darker (YR-Y 20.0-7/8). Length on slide 1.2-1.6 mm, width 0.9-1.25 mm.

**Pygidium.**—Large, broad, and acute. Two pairs of well developed lobes, third pair usually reduced to a sclerotized point.
Median lobes wide, notched on lateral margins; second pair with sloping and undulated outer margins. Plates small, simple, resembling spines. Intersegmental scleroses developed. Dorsal ducts small, slender, numerous, arranged in rows; one duct between median lobes; usually four ducts in the first interlobular space; first row of about 12 ducts, beginning between second and third lobes; second row beginning near seta which marks the margin of fifth segment, and extends to lateral scar; beyond this row on the margin usually 3-4 ducts. Ventral ducts few, along the margin of pygidium. Perivulvar pores in four groups; median group absent, or represented by 1 to 4 pores. Anal opening small, removed about three or four times its diameter from the base of median lobes.

Scale of Male.—Elongate oval, gray, length about 1.25 mm; exuviae toward one end. Male scales have a tendency to cluster in a circle, almost in a perfect asterisk, around females.

"very severe" (JSH, JLK). *Sorbus americana* Marsh., Cincinnati:


**Other Material Examined.**—CALIFORNIA: *Populus deltoides* Marsh., 1913. FLORIDA: Lake City, on *Liquidambar styraciflua* L., April 7, 1898 (ALQ). ILLINOIS: Bond Co., on *Acer* sp., March 25, 1961 (MK).


**Additional Biological Data.**—This species has two or more yearly generations in Ohio. Overwinters as adults and mates in early spring. Males appeared as early as March 14-28 in the Columbus area, latter also between May 7-21, in 1961. Egg laying was observed from
June and continued through first half of July in Fayette and Hamilton Counties. First stage nymphs were observed at Put In Bay on Sept. 4, 1960.

Parasites Reared.—Encyrtidae: Chiloneurimus microphagus (Mayr), Coccidencyrtus sp., probably ensifer (How.), C. infuscatus Compere & Annecke, Plagiomerus sp., probably diaspidis Crawford.
Buphagidae: Azotus or Alerus sp., Physcus sp.


Predators.—Coccinellidae: Adalia bipunctata L., Chilocorus bivulnerus Muls. These coccinellids were found in Ohio and in Kentucky around gnawed scales, apparently feeding on them.

Economic Importance.—Houser (1918) noted that this species especially in the cities kills trees, but more frequently merely giving them unhealthy appearance.

The accompanying illustrations are based on material from Acer saccharinum L., Cuyahoga Co., March 5, 1961.

Quadraspidiotus ostreaformis (Curtis)

Fig. 25

Aspidiotus ostreaformis Curtis, 1843, p. 605; Marlatt, 1899, p. 76; Fernald, 1903, p. 268 (most of the European synonyms of this species are listed here); Sanders, 1904b, p. 64; Britton, 1923, p. 374; Felt and Morrison, 1928, p. 200. Diaspidiotus ostreaformis (Curtis), Borchsenius, 1950, p. 226. Quad—
Fig. 24.—*Quadraspidoïthus juglans-regiae* (Comstock)

Fig. 25.—*Quadraspidoïthus ostreaeformis* (Curtis)
**raspidictua ostreiformis** (Curtis), MacGillivray, 1921, p. 410; Ferris, 1938, Ser. II:258; Lupo, 1948, p. 175; Balachowsky, 1950, p. 405; Zahradnik, 1951, p. 115; Schmutzer, 1959, p. 77; Kosztarab, 1959, p. 414.

**Common Name.**—European fruit scale.

**Scale of Female.**—Circular, convex, dark gray; length 1.4-1.7 mm. Exuviae subcentral or sometimes central, orange yellow.

**Female.**—Pear-shaped, length on slide 1.2-1.5 mm.

**Pygidium.**—Large and broad. Median lobes large, usually not notched or only slightly notched on lateral margin, rounded apically; second pair much smaller, rounded apically, usually notched on outer margin; third pair reduced to a sclerotized point. Two slender simple plates between median lobes, these shorter than median lobes; two plates between median and second lobes, mesal plate pointed, lateral plate more or less fimbriate at apex; two large and wide plates between second and third lobes, with lateral plate larger. Inter-segmental scleroses present, enclosing 2 duct orifices between segments six and seven, and 3-4 duct orifices between segments seven and eight. Dorsal macroducts as follows: one at the base of median lobes; 3-4 between median and second lobes; 6-8 in a row beginning between second and third lobes; 8-10 in a row beginning near the seta which marks the fifth segment extending to the lateral scar of the pygidium; 4-7 on fourth segment. Ventral ducts in three small groups, located submarginally. Vulva in about the middle of pygidium. Perivulvar pores in five groups as follows: median 4-6; anterior laterals 7-10;
posterior laterals 7-9. Anal opening round, removed from base of median lobes by about three times its diameter.

**Scale of Male.**—Not seen. According to Schmitterer (1959) the scale of male is elongated oval, light to dark gray, length about 1.2-1.3 mm.

**Host and Distribution.**—Occurs on bark of deciduous trees, especially fruit trees. Introduced from Europe. There are many records about its occurrence in different states of the United States, but probably these records should be critically re-examined. In the Houser Collection many slides were marked as *Quadraspidiotus ostreaeformis*, but only one was this species: from *Malus pumila* Mill., Gypsum, Ohio, June 13, 1900 (W. J. Miller). In the Sanders Collection the following Ohio material was found: from plum, *Prunus domestica* L., Salem, Sept. 6, 1903 (JGS). Mr. G. B. Sleesman sent material from *Syringa vulgaris* L., Girard, Pennsylvania, Dec. 13, 1920 (F. M. Trimble), (PaDA).

The accompanying illustrations are based on the above Ohio material from plum.

**Notes.**—It is the author's opinion that the illustration of *Quadraspidiotus ostreaeformis* (Curtis) in the Ferris Atlas (1938, Ser. II:258) was based on *Q. gigas* (Thiem and Gerneck) material. The description given by Ferris, which accompanies the figures, also justifies this assumption. The earlier United States records on *Q. ostreaeformis* should be reevaluated with the suspicion that those records may cover both species.
Quadraspidiotus perniciosus (Comstock)

Fig. 26


Common Name.—San Jose scale.

Scale of Female.—Almost circular, slightly convex, light to dark gray; about 1.5-2.0 mm in diameter; exuviae central or sub-central.

Female.—Young females pear-shaped, older females almost circular, reddish yellow (rY 22.5-6/12). Length on slide 0.8-1.2 mm.

Pygidium.—Slightly sclerotized, pointed at apex. Two pairs of lobes well developed, third pair scarcely indicated; median pair prominent, notched on outer margin; outer margin of second pair undu-lated. Two small plates between median lobes; two slender, slightly fringed plates between median and second pair; three similar plates between second and third pair of lobes; three short and broad, variously fringed plates beyond third lobes, each bearing a microduct.
Intergenital scleroses present. Few, slender, dorsal ducts. Few ventral ducts along the margin of pygidium. Perivulvar pores absent. Anal opening oval, removed from the base of median lobes about three times their diameter.

**First Stage Nymph.**—Reddish yellow (rY 22.5-8/10).

**Second Stage Nymph.**—Yellow (Y 25.0-8/12).

**Scale of Male.**—Oval, gray, length 0.8-1.0 mm; exuviae toward one end.


Additional Biological Data.—This ovoviviparous species in Central Ohio apparently has two or more generations yearly. Overwintered as second stage larvae in Central Ohio, 1960-61. Females with a few crawlers were collected at Oldham Co., Kentucky on Dec. 3, 1961. Large numbers of crawlers were noted on June 17, in Licking Co., also on Sept. 6, 1961, in Licking and Tuscarawas Counties. Males appeared in Central Ohio during June 7-18 and Oct. 10-Nov. 16 in 1960 (MK).
Parasites.—Rice (1937) observed the following Hymenoptera parasites on San Jose scale in Ohio. Eulophidae: Ablerus clisiocampae Ashm., Aphytis diaspidis (How.), A. mytilaspis (LeBaron), Aspidiotiphagus citrus (Craw), Prospaltella murtfeldtii (How.), P. perniciosi Tower, this species ranked first in economic importance as the natural enemy of the scale. Thysanidae: Thysanus pulchra (Gir.).

The author reared the following parasites from Ohio material. Eulophidae: Aphytis diaspidis (How.), A. mytilaspis (LeBaron), A. near mytilaspis (LeBaron), Marietta sp., Prospaltella murtfeldtii (How.), P. perniciosi Tower.

Predators.—Rice (1937) found the coccinellid Scymnillus atterrimus Horn., feeding on San Jose scale in Ohio. Houser (1918) states that Microweisia melissa (Live.) and Chilocorus bivulnerus Luls., both Coccinellidae, were found most useful in the control of this species in Ohio. Coccinellid larvae were noted feeding on the species at Columbus: OSU, Oct. 10, 1960 (IK).

Acarina Associated.—Oribatei: Cymbaeremaeidae: Scapheremaeus marginalis (Banks).

Fungi.—Houser (1918) observed at Ironton, Ohio, the red fungus Sphaerostilbe sp., which killed the scales on currant.

Economic Importance.—According to Houser (1918) the San Jose scale was found to be the most destructive scale insect of fruit trees in Ohio, and also caused severe injury to some ornamentals. It is the author's opinion that this species lost some of its economic
importance in Ohio probably due to the heavy parasitization and to the wide application of modern insecticides in the fruit growing areas of Ohio.

The author would like to emphasize the importance of wild and cultivated hosts (such as ornamental trees and shrubs) hedge shrubs, especially osage orange, in the spread of the San Jose scale. These hosts are present around the orchards and usually are not treated with insecticides, therefore may serve as reservoir hosts for the scale insect, and later may become the sources of reinfestation of the orchards.

The accompanying illustrations are based on material collected from Prunus pennsylvanica L., at Mentor, Ohio, Aug. 8, 1917 (JSH).

**QuadraspSSERTUS taxodii Ferris**

Fig. 27


**Scale of Female.** —Circular, flat, light or dark gray, usually covered with particles of bark; about 1.2 mm in diameter; exuviae marginal.

**Female.** —Circular, slightly pointed at apex, margin of cephalothoracic region slightly sclerotized; length on slide 0.9-1.1 mm.

**Pygidium.** —Median lobes about as long as wide, rounded at apex, well separated, with a notch on outer margin; second pair
Fig. 26. *Quadraspidiatus perniciosus* (Comstock)

Fig. 27. *Quadraspidiatus taxodii* Ferris
reduced to small, acute, strongly sclerotized point; third lobes lacking. Only one slightly developed plate is present, located in the interlobular space between the median and second lobes. Inter-segmental scleroses present, the second pair poorly developed. Dorsal ducts small and few in number. Few ventral ducts confined to margin of pygidium. Marginal setae well developed, quite long. Vulva hardly visible. Perivulvar pores in four small groups. Anal opening about as large as diameter of median lobes, removed about four times its diameter from the base of median lobes.

Scale of Male.—Not seen.

Host and Distribution.—Occurs in cracks of bark, also under bark. No records from Ohio, but reported from the bordering state of Pennsylvania by Sleesman (1945), who loaned the following material used for the above description and figures: Taxodium distichum (L.) Rich., Pennsylvania: Lansdale, Carroll Nurseries. According to Ferris (1938) this species is also reported from the same host from Texas and Louisiana.
TRIBE DIASPIDINI

KEY TO THE GENERA OF THE TRIBE DIASPIDINI IN OHIO

| 1 | Female enclosed within cast skin of second molt (pupillar form) | 2 |
| 1' | Female not enclosed within cast skin of second molt (nonpupillar form) | 3 |
| 2(1) | Dorsal ducts as large as those on margin of pygidium; median lobes not zygotic; two well developed and wide plates in each interlobular space; on deciduous trees (Fig. 48) | Lopholeucaspis |
| 2' | Dorsal ducts lacking; marginal ducts moderately large; median lobes zygotic; on needles of Tsuga sp. (Fig. 44) | Fiorinia |
| 3(1') | Median lobes fused into a single broad lobe with no trace of division; each marginal duct of pygidium with a swollen, sclerotic rim about its mouth; on oaks (Fig. 56) | Quernaspis |
| 3' | Median lobes sometimes fused at base but always with some indication of their paired character | 4 |
| 4(3') | Median lobes zygotic | 5 |
| 4' | Median lobes nonzygotic | 8 |
| 5(4) | Prosoma swollen, more or less quadrate, wider than the rest of the body; median lobes forming a | 107 |
distinct notch in apex of pygidium; on rose, raspberry, blackberry (Fig. 29) ....... Aulacaspis

5' Prosoma not swollen, and not quadrate; body turbinate or elongate ......................... 6

6(5') Body turbinate or pear-shaped, widest beyond middle of prosoma; median lobes large and prominent (Fig. 55) ....... Pseudaulacaspis

6' Body elongate, often spindle-shaped, widest on abdomen; median lobes various, less prominent ........ 7

7(6') Free outer margin of median lobes usually as long as or longer than the free inner margin; lobes without median apical notch in the pygidium (Fig. 39) ........ Chionaspis

7' Free outer margin of median lobes always shorter than the free inner margin; lobes more or less divergent and forming a definite notch in the pygidium (Fig. 51) ........ Phenacaspis

8(4') Body pear-shaped or almost circular; without gland tubercles on margin of anterior abdominal segments .... 9

8' Body elongated, often spindle-shaped; with gland tubercles on margin of anterior abdominal segments ... 10

9(8) Second lobes reduced to small points; with or without a few submedian dorsal ducts, which are never arranged in definite rows; apex of pygidial gland spines usually bent; on deciduous trees, especially rosaceous trees (Fig. 43) ....... Epidiaspis
9' Second lobes well developed, submedian dorsal ducts arranged in definite rows; apex of pygidial gland spines not bent; on conifers (Fig. 30) . . Carulaspis

10(8') Dorsal median pygidial furrow present, extending from anal opening posteriorly to median lobes; median lobes close together, and without gland spines between them (Fig. 57) . . . . . . . . . . Unaspis

10' Dorsal median pygidial furrow absent; median lobes not close together, and with two gland spines between them . . . . . . . . . . . . . . . . . . . . . 11

11(10') Median pygidial lobes small, not notched, widely separated; the gland spines between them about twice as long as the lobes (Fig. 28) . . . . . Acidonidomylus

11' Median pygidial lobes large, notched on both sides, not widely separated; the gland spines between them about the same size or slightly longer than the lobes (Figs. 5, 46) . . . . . Lepidosaphes

Genus Acidonidomylus Leonardi

Acidonidomylus Leonardi, 1903, p. 102; MacGillivray, 1921, p. 275;

Scale of Female.—Oystershell-shaped, white or light brown, exuviae terminal.

Female.—Elongate spindle-shaped. No spurs on any abdominal segments.
Pygidium.—Median lobes widely separated, non-zygotic, usually with a pair of gland spines between them; second lobes well developed; third lobes reduced. Gland spines slender, along margin of pygidium. Dorsal ducts smaller than marginal ducts. Perivulvar pores in five small groups.

Type of the Genus.—*A. concolor* (Cockerell).

*Aonidomytilus multiglandulatus* sp.n.

Fig. 28

*Aonidomytilus solidaginis* (Hoke), Schuder, 1954, p. 172 (misidentification).

Scale of Female.—Oystershell-shaped, light brown, yellowish white toward apex. Length 2.3 mm; eviscer apical, orange yellow.

Female.—Quite slender, spindle-shaped, margins lobed; length on slide 1.4-1.85 mm, average length 1.65 mm. Antennae with two setae. Anterior spiracles with 4-12 pores (average 6, 12 counted). Posterior spiracles with only 1-3 pores (average 2, 12 counted). A group of dorsal ducts on margin of metathorax, also on margin of each prepygidial segment. A group of gland tubercles laterad of posterior spiracles, also on lateral margin of first abdominal segment. Marginal gland spines present from second to fourth abdominal segment.

Pygidium.—Broad, rounded apically, slightly sclerotized around the apex. Median lobes small, pointed apically about as long as wide, widely separated; second pair well developed, outer lobule much smaller than inner; third pair reduced to sclerotized point.
Gland spines slender; median spines at most twice as long as median lobes, not branched, needle-shaped; one laterally unpectinate spine located laterally from mesal and second pair of lobes. Numerous dorsal macroducts, which are smaller than marginal ducts, some arranged in definite rows; submedian ducts from third to seventh segment in short rows, often with two rows on one segment; submarginal ducts scattered along the margin, sometimes in rows. Few ventral ducts present, located in groups of 3-4 ducts, as follows: one group anterior to second pair of lobes; two more groups laterad of the previous group, close to the margin of pygidium. Vulva hardly visible, located about the middle of pygidium. Perivulvar pores in five groups; median 0-6, anterior laterals 8-12, posterior laterals 9-12. Anal opening round, surrounded by a sclerotized area.

Egg.—Color light purple (P 85.0-7/4).

Scale of Male.—Not seen.

Material Examined.—On peeling bark of twigs of Hypericum spathulatum (Spach) Steud., Indiana: Tippecanoe Co., Agronomy Farm, June 19, 1961. Received unmounted material through the courtesy of Professor D. L. Schuder, who also collected the material.

Additional Biological Data.—In the above material the females had died and eggs were found (18-28 per female) under each scale. It is assumed that probably the second stage nymphs overwinter.

The accompanying illustrations are based on the above material.
Holotype female deposited in the U.S. National Museum.
Paratypes 3 females in the author's collection. Both holotype and paratype specimens are from the above listed material. The closest related species is Aonidomytilus solidaginis (Hoke), from which A. multiglandulatus differs as follows:

1. There are more than 30 submedian dorsal macroducts on each side of the pygidium and on the prepygidial segments, and often there are two rows of ducts on some of the segments in A. multiglandulatus, while in A. solidaginis the number of submedian dorsal macroducts is less than 30, and only one row of ducts is present on each segment. Hence the specific name.

2. Ventral ducts in A. solidaginis present in large groups as follows: one group of about 4 ducts anterior from the second pair of lobes; two groups of ducts of about 10 or 11 each, lateral on pygidium; one group of about 7-11 ducts on each of the two prepygidial segments. In A. multiglandulatus these ducts are fewer in number, never more than 3-4 in a group.

3. Median lobes pointed and not notched in A. multiglandulatus, while in A. solidaginis the median lobes are broadly rounded at apex and usually slightly notched on both sides.

4. Median gland spines at most twice as long as median lobes in A. multiglandulatus, while in A. solidaginis these spines are three times as long as the median lobes.

5. Anterior spiracles with 4-12 pores, (average 6, 12 counted), posterior spiracles with 1-3 pores (average 2, 12 counted)
in *A. multiglandulatus*, while in *A. solidaginis* these pores are in groups of 10-18 (average 14, 28 counted), and 3-8 (average 6, 28 counted), consecutively.

6. The known hosts of *A. solidaginis* are Solidago sp., Aster sp., and Baccharis halimifolia, all belong to family Carduaceae, while *A. multiglandulatus* is known only from *Hypericum spathulatum* and *Hypericum* sp., which belong to the family Hyperaceae.

Dr. Harold Morrison called the author's attention to this taxonomical problem and through his courtesy the author was able to study the material which represents these two species in the National Coccoid Collection. In this collection *A. solidaginis* is represented from Alabama, Florida, Maryland, South Carolina, Virginia and Cuba, while *A. multiglandulatus* is known from Illinois, Indiana, Maryland, Missouri, and Virginia.

Material from type of *Aonidomytilus hyperici* Ferris was obtained through the courtesy of Professor Howard L. McKenzie. Although the host preference may suggest some similarity, *A. multiglandulatus* definitely is not identical with *A. hyperici*.

Genus *Aulacaspis* Cockerell

Scale of Female.—Circular to slightly oval, flat to convex, white; exuviae central or subcentral.

Female.—Elongate, with swollen prosoma which is broader than the rest of the body.

Pygidium.—Three or four pairs of lobes present. Median lobes joined by a sclerotized yoke; other lobes (if present) bilobed. Gland spines well developed. Dorsal ducts short, arranged in submarginal and submedian rows. Perivulvar pores in five groups.

Type of the Gems.—A. rosae (Bouché).

Aulacaspis rosae (Bouché)

Fig. 29


Common Name.—Rose scale.
Fig. 28. - Aonidomytilus multiglandulatus sp. n.

Fig. 29. - Aulacaspis rosae (Bouché)
Scale of Female.—Circular, flat, white to grayish white, about 1.5-2.0 mm in diameter. Exuviae subcentral.

Female.—Elongated, somewhat mushroom-shaped, with prosoma swollen, brownish dark red (YR 12.5-4/6), length on slide 1.0-1.1 mm, width 0.6-0.7 mm. Margin of the three anterior abdominal segments strongly lobed.

Pygidium.—Median lobes well developed, zygotic, divergent, forming a median notch, their inner margins finely serrate. Second and third pairs bilobed, rounded at their apex. Gland spines long and strongly developed, also present in groups on margin of second and third abdominal segments. Dorsal ducts short, arranged in rows composed of submarginal and submedian series; on fourth to seventh abdominal segments include one or a pair of large marginal ducts; submarginal series extend to fifth and submedian series to sixth segments; no ducts between median lobes. A few ventral ducts in a submarginal row, others on the margin of fourth segment. Vulva hardly visible. Perivulvar pores in five large groups. Anal opening round, relatively small, located about the middle of pygidium.

Eggs.—Oval, light brown (YR 15.0-5/6).

Scale of Male.—Elongated, white, tricarinate, exuviae at one end.

Male.—Reddish, with wings.

Host and Distribution in Ohio.—Generally distributed in Ohio. Occurs on stem of host, especially close to the ground. Hydrangea sp., Ashtabula, Dec. 1, 1914 (JSH). Rosa carolina L., Adams Co: Green Township, July 15, 1961 (MK). R. rugosa Thunb., Cleveland,
Mar. 7, 1912 (JSH). *Rosa* sp., Canal Winchester, - , Bogue (1896a); Columbus: OSU, Mar. 13, 1920 (AEM); "wildrose," Wooster: in woods, April 27, 1912 (JSH); Fairfield Co.: Buckeye Lake, Sept. 11, 1921.


Other Material Examined.—IOWA: Ames, on "blackberry," May 9, 1916, (CAR); MARYLAND: Ellicott City on *Rubus* sp., May 10, 1959 (MK).


Parasites Reared.—Encyrtidae: *Arrhenophagus chionaspidis* Aur., *Chiloneurimus microphagus* (Mayr).

Economic Importance.—This species is known to cause serious damage to raspberry, blackberry and roses.
The accompanying illustrations are based on the above listed material from *Rosa carolina* L.

**Genus Carulaspis** MacGillivray


**Scale of Female.**—Circular, slightly convex, white; exuviae central or subcentral.

**Female.**—Circular, or slightly oval. Derm membranous except on pygidium.

**Pygidium.**—Median lobes well developed, non-zygotic; second pair bilobed; third pair reduced. Gland spines present. Dorsal ducts slightly smaller than marginal ducts, arranged in distinct rows. Perivulvar pores usually in five compact groups. Anal opening round, slightly posterior from middle of pygidium.

**Type of the Genus.**—*C. visci* (Schrank).

**Carulaspis juniperi** (Bouché)

Fig. 30

It is the author's opinion that the earlier published United States records of *Carulaspis carueli* (Targioni-Tozzetti) and *C. visci* (Schrank) should be re-evaluated in the light of most recent studies on these species.

Common Name.—Juniper scale.

Scale of Female.—Circular, slightly convex, white, about 1.0-1.5 mm in diameter; exuviae subcentral or central.

Female.—Circular, young females yellow (Y 25.0-8/8), females with eggs darker (YR 17.5-5/8). Length on slide 0.7-0.8 mm. Antenna with one strong and recurved seta. Anterior spiracles with one or two pores.

Pygidium.—Triangular, rounded at apex. Median lobes well separated, rounded at apex, small, about as long as wide, with small paraphyses; second lobes deeply bilobed, the inner lobule more or less triangular, sloping toward meson, with small paraphyses, its outer lobule much smaller; third pair vestigial. Gland spines well developed. In the material examined the number of dorsal macroducts was between 110-148 per female. Marginal ducts arranged in the usual Diaspidinae pattern, one between median lobes. Dorsal ducts slightly smaller than marginal ducts, arranged in rows on second to fifth segments. In the material at hand no submarginal macroduct was found anterior to second lobes, which was noted by Ferris (1937). Only few ventral ducts present. Vulva located anterior to anus. Peri-
vulvar pores usually in five compact groups; rarely two additional small groups present, anterior to the anterior lateral groups. Anal opening round, large, posterior from the middle of pygidium.

**Scale of Male.**—Elongated, slightly tricarinate, white, about 0.7-1.0 mm in length; exuviae at one end.

**Male.**—Winged, orange yellow.


**Additional Biological Data.**—Overwintered as mature females filled with eggs in 1960-61 (Adams Co., Cleveland, Franklin Co.). First stage larvae appeared between June 10-18 (1960) in Franklin
Males emerged during July 2-12 (1960), and July 26-Aug. 14 (1961) in Franklin Co.

Parasites Reared.—Eulophidae: Aphytis near mytilaspis (LeBaron), probably a new species according to DeBach. Aspidiotiphagus citrinus (Craw), Prospaltella sp.

Acarina Associated.—Oribatei: Cymbaeremaeidae:

Scapheremaeus marginalis (Banks).

Economic Importance.—Discoloration of leaves was noted in case of heavy infestations.

The accompanying illustrations are based on the above listed material from Juniperus virginiana L.

Genus Chionsispis Signoret


Scale of Female.—Oystershell-shaped, usually convex, white; exuviae at anterior end.

Female.—Elongate, spindle-shaped, lobed laterally, color in most species reddish.

Pygidium.—Median lobes close together, zygotic, their yoke usually well sclerotized; second lobes always present, bilobed, in most species rounded apically; third lobes similar to second lobes, but smaller, sometimes entirely lacking. Gland spines well developed.
Dorsal ducts arranged in rows, forming submedian and submarginal series. No ducts or gland spines between median lobes. Perivulvar pores in five groups.

*Type of the Genus.*—*C. salicis* (Linnaeus).

<table>
<thead>
<tr>
<th>KEY TO SPECIES OF CHIONASPIS</th>
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<tbody>
<tr>
<td>1 Median lobes fused except for a small apical notch .................................................. 2</td>
</tr>
<tr>
<td>1′ Median lobes separate for at least half of their length ........................................... 4</td>
</tr>
<tr>
<td>2(1) Median lobes almost triangular, tapering toward apex, finely serrate on lateral margins; only 1–3 submedian dorsal ducts on fourth and fifth segment; known only from <em>Nyssa</em> and <em>Celtis</em> .................................................. sylvatica Sanders</td>
</tr>
<tr>
<td>2′ Median lobes rounded at apex, not serrate on lateral margins; more than 3 submedian dorsal ducts on fourth and fifth segment ........................................... 3</td>
</tr>
<tr>
<td>3(2′) One or two submedian dorsal ducts on segment six; known only from hickory and walnut . . . caryae Cooley</td>
</tr>
<tr>
<td>3′ No submedian dorsal ducts on segment six; occurring on hosts of the family Ulmaceae (elm, hackberry) ........................................... americana Johnson</td>
</tr>
<tr>
<td>4(1′) Median lobes noticeably elongate, divergent mesally, finely serrate on margin, never deeply notched, separate completely to the base .................................................. 5</td>
</tr>
</tbody>
</table>
4'. Median lobes not so, short and rounded, or laterally notched or partially fused .......... 6

5(4) Median lobes separated and parallel at base, strongly divergent toward apex; all dorsal ducts large and same size, usually 4-6 submedian ducts on third to fifth segment; known only from Wisteria ............................................ wistariae Cooley

5'. Median lobes not parallel at base, but yoked by a short sclerosis, moderately diverging toward apex; dorsal ducts of two sizes; usually 6-8 large and 2-4 small submedian ducts on third to fifth segment; known only from poplar and willow ........................................................ longiloba Cooley

6(4') Dorsal macroducts few, usually not more than 2-3 in any submedian group; submedian group anterior to segment five lacking or composed of small ducts only; submarginal group of fifth segment composed of 3 or 4 ducts ......................... 7

6'. Dorsal macroducts more numerous, usually 5 or more ducts in any submedian group; submedian groups anterior to segment five present and composed of large and small ducts; submarginal group of fifth segment composed at least of 4 or 5 ducts, usually more ......................... 9

7(6) Median lobes short, never longer than wide, almost semicircular, not notched on either
side; usually on hosts belonging to family
Rosaceae ........................................ furgura (Fitch)

7' Median lobes elongated, longer than wide,
notched at least on lateral side ............... 8

8(7') Median lobes with distinct elongated zygosis
at base; occurs on maple ................. acercola Hollinger

8' Median lobes with short, indistinct zygosis
at base; occurs on Gleditsia and
Fraxinus ....................................... gleditsiae Sanders

9(6') Inner margin of median lobes straight, parallel
at base, broadly diverging toward apex, its
diverging margin definitely longer than lateral
margin; on Cornus ................................ corni Cooley

9' Inner margin of median lobes not parallel at base,
moderately diverging from base to apex, both
margins approximately equal ...................... 10

10(9') Median lobes broad, rounded, more or less semi-
circular, often with a pair of small tooth-like
projections between them; usually on Populus, Salix,
and Fraxinus ................................ salicia-nigrae (Walsh)

10' Median lobes elongated, tapering toward apex,
ever with a pair of tooth-like projection
between them ................................. 11

11(10') Median lobes with their mesal margins parallel
and closely appressed at their base; inner lobule
of second lobes without a notch on lateral margin;
known in Ohio only from Juglana cinerea . lintneri Comstock
Median lobes diverging from their base; inner lobule of second lobes with a notch on lateral margin; known from *Platamus* only . . . . *parkii* Hollinger

**Chionaspis acericola** Hollinger

**Fig. 31**


**Scale of Female.**—Oystershell-shaped, flat, white to light gray, about 2.0 mm long; exuviae apical, brownish.

**Female.**—Elongate spindle-shaped, segments rounded laterally; length on slide about 0.8-1.0 mm.

**Pygidium.**—Triangular, acute and sclerotized at apex. Median lobes rounded, slightly notched on inner and outer margins, close together, their basal yoke with an elongated sclerosis; second pair bilobed, inner lobe slightly crenate on outer margin, outer lobule smaller; third pair reduced. Gland spines well developed, each with one duct. Marginal ducts in the usual arrangement. Dorsal ducts reduced in number; submedian groups with only 2-3 small ducts on the third segment; 2-3 small or sometimes one large duct on the fourth segment; usually only one large, but sometimes also with one or two small ducts on the fifth segment. Submarginal groups usually with three ducts on third segment; 2-4 ducts on fourth segment; always with one duct on fifth segment. Ventral ducts few, located submarginally. Vulva hardly visible, about the middle of pygidium.
Fig. 30.—Carulaspis juniperi (Bouché)

Fig. 31.—Chionaspis acericola Hollinger
Perivulvar pores in five large groups. Anal opening round, just anterior from vulva.


**Additional Biological Data.**—Overwintered in egg stage and on April 24, 1960, there were still a few eggs unhatched under the female scales.

The accompanying illustrations are based on the above listed material from *Acer rubrum* L.

**Chionaspis americana** Johnson

![Chionaspis americana](image)

**Chionaspis americana** Johnson, 1896b, p. 390; Cooley, 1899, p. 41; Sanders, 1904b, p. 43; Dietz and Morrison, 1916b, p. 264; Houser, 1918, p. 290; Miller, 1922, p. 60; Ferris, 1937, Ser. I:15; Sleesman, 1945, p. 44; McKenzie, 1956, p. 93. *Fundaspis americana* (Johnson), MacGillivray, 1921, p. 338.

**Common Name.**—Elm scurfy scale.

**Scale of Female.**—Oystershell-shaped, white or grayish white, about 1.5-2.5 mm in length.

**Female.**—Spindle-shaped, segments deeply lobed, reddish brown, length on slide about 1.0-1.3 mm.
Pygidium.—Broadly acute. Median lobes prominent, closely appressed, rounded apically, notched on lateral margins; second lobes bilobed, inner lobule more or less acute, notched, outer lobule much smaller and rounded; third lobes reduced. Gland spines large, each with one or two ducts. An elongated sclerosis between the median lobes and another in the first interlobular space. Submedian dorsal ducts present on third to fifth segments, the groups on third and fourth segments composed of large and small ducts, on fifth segment only 4-5 large ducts present. Ventral ducts present, most located submarginally. Vulva in the middle of pygidium. Perivulvar pores in five large groups. Anal opening round, anterior from vulva.

Eggs.—Ovoid, yellowish red (yR 7.5-4/6).

Scale of Male.—Elongated oval, tricarinate, white, length about 0.7 mm; exuviae yellow, at one end.

Host and Distribution in Ohio.—Widely distributed in Ohio. Occurs on bark. Celtis sp., Columbus, Apr. 7, 1920 (AEL1). "Platanus occidentalis L.," Columbus: OSU, Miller (1922). Ulmus americana L., Ashtabula, Dec. 1, 1914 (JSH); Belmont Co., Sept. 6, 1961 (MK); Champaign Co.: Cedar Swamp, July 9, 1960 (MK); Cleveland, March 6, 1912 (JSH), Feb. 21, 1915 (JLK); Columbus, May 28, 1960 (MK), Columbus: OSU, Apr. 11, 1960 (MK); Cuyahoga Co., Mar. 5, 1961 (MK); Pickaway Co., July 16, 1961 (MK); Wooster, Mar. 10, 1914, "severe infestation" (JSH). Ulmus sp., Cincinnati, Nov. 4, 7, 1914 (JSH, JLK); Cleveland, Mar. 12, 1936, "abundant," (JSH), data from R. W. Rings; Columbus, - , (CAR), Columbus: OSU, Feb. 11, 1920 (AEM);
Delaware Co.: Deep Run, May 31, 1920 (AEM); Mahoning Co.: Hubbard, Oct. 9, 1912 (F. W. Schlupp), (HC); Marietta, Mar. 31, 1916 (JSH); Wooster, Apr. 27, 1912 (JSH).


Additional Biological Data.—This insect overwinters in the egg stage, and the eggs hatch in May. Since eggs were found under live females in Pickaway Co., on July 16, 1961, it is assumed that there are two yearly generations. Johnson (1916b) also noted two yearly generations in Illinois. An average of 57 eggs per female (maximum 75, minimum 14) were counted in the material collected from Ulmus americana L. in Cuyahoga Co., Mar. 5, 1961 (MK).

Parasites Reared.—Eulophidae: Aphytis diaspis (How.), Marietta sp., Prosaptella sp. A high degree of parasitization, 84 per cent, was noted in the material collected in Illinois: Bond Co., Mar. 25, 1961 (MK).

The accompanying illustrations are based on material from Ulmus americana L., Cuyahoga Co., March 5, 1961.

Chionaspis caryae Cooley

Fig. 33

Chionaspis caryae Cooley, 1898, p. 86, 1899, p. 40; Fernald, 1903, p. 214; Sanders, 1904b, p. 44; Dietz and Morrison, 1916b, p. 266; Hollinger, 1923, p. 22; Britton, 1923, p. 363; Ferris, 1942, Ser. IV:386; Sleesman, 1945, p. 46.
Fig. 32.—Chionaspis americana Johnson

Fig. 33.—Chionaspis caryae Cooley
Scale of Female.—Irregular, oystershell-shaped, convex, dirty white, length 1.5-2 mm; exuviae brown.

Female.—Elongate spindle-shaped, segments produced laterally, length on slide about 1.0 mm.

Pygidium.—Triangular, rounded at apex. Median lobes large, broad, fused basally, separated apically by a distinct notch, each lobe rounded apically and slightly notched on lateral margin; second pair bilobed, first lobule rounded apically, notched laterally, second lobule much smaller, rounded apically; third pair poorly developed, with serrate margin. First gland spine with two ducts, others with one duct. Marginal ducts of the normal pattern. Submedian dorsal macroducts present on third and sixth segment; usually one or two ducts, rarely none on sixth segment; about 5-6 large ducts on fourth and fifth segments; usually one or two small ducts with 5-6 large ducts on third segment. Submarginal macroducts in rows on third and fifth segments. Few ventral ducts present. Vulva located anterior to middle of pygidium. Perivulvar pores in five large groups. Anus rounded, located anterior from vulva.

Scale of Male.—Oblong, with median carina, white, about 0.5-0.7 mm long; exuviae brown.

Host and Distribution in Ohio.—Known only from a few localities in Ohio. Occurs on bark. Carva alba K. Koch, Ottawa Co.: Catawba Island, July 10, 1902, Sanders (1904). C. ovata (Mill.) K. Koch, "Columbus: OSU," May 31, 1920, Miller (1922); Wooster, July 1, 1917 (JSH), Wooster: OAES, Aug. 8, 1917 (P. R. Lowry), (HC);


The accompanying illustrations are based on material from Carya ovata (Mill.) K. Koch., Wooster, Ohio, July 1, 1917 (JSH).

Chionaspis corni Cooley

Fig. 34

Chionaspis corni Cooley, 1899, p. 15; Osborn, 1900, p. 72; Fernald, 1903, p. 215; Sanders, 1904b, p. 45; Dietz and Morrison, 1916b, p. 267; Houser, 1918, p. 290; MacGillivray, 1921, p. 331; Miller, 1922, p. 60; Britton, 1923, p. 363; Felt and Morrison, 1928, p. 198; Ferris, 1937, Ser. I:16; McKenzie, 1956, p. 93.

Common Name.—Dogwood scale.

Scale of Female.—Elongated, broadening posteriorly, white, length 1.8-2.5 mm; exuviae orange yellow.

Female.—Spindle-shaped, expanded posteriorly, margins lobed, length on slide 1.2-1.3 mm.

Pygidium.—Broad, almost semicircular. Mesal margin of median lobes parallel for almost half of their length, and then strongly divergent; the diverging margin straight; second pair bilobed, both lobules rounded at apex, outer lobule much smaller; third pair small, rounded. Gland spines large, slender, each with one duct. Submedian dorsal duct groups well developed, only small
duets on segments 1 and 2, one or two small ducts, usually with
7-8 ducts on segments 3 and 4, usually 5-6 large ducts on segments
5 and 7. Five to ten submarginal ducts in each row on segments 3
to 6. Ventral ducts accumulated submarginally. Vulva slightly
anterior from the middle of pygidium. Perivulvar pores in five
large groups. Anus round, located anterior to vulva.

Scale of Male.—Not seen. Cooley (1899) described it as
follows: "Length 0.6-0.8 mm, moderately but plainly tricarinate.
Exuviae pale yellow occupying one-third to one-half the length of
the scale."

Host and Distribution in Ohio.—One collection from Central
Ohio, all others from Northern Ohio. Occurs on bark. *Cornus amomum*
Mill., Erie Co.: Sandusky, Osborn (1900), Sanders (1904b). *C.
florida* L., Columbus: OSU, Mar. 30, 1920 (P. R. Lowray), (HC). Heavy
infestation on twigs of *C. racemosa* Lamm., Erie Co.: Castalia, Rest-
haven Wildlife Area, Sept. 2, 1960 (MK). *C. sanguinea* L., Cleveland,
1908, (WHG), (HC), Cleveland: Gordon Park, 1912 (C. R. Neillie),
(HC). *Cornus* sp., Lucas Co.: Cedar Point, June 30, 1912 (JLK);
Wooster, April 27, 1912, June 27, 1914 (JSH).

Other Material Examined: KANSAS, on *Cornus asperifolia*
Michx., (J. B. Norton), (HC).

Additional Biological Data.—According to Houser (1918) this
species overwinters in egg stage. Mature females were found on

Parasites Reared.—Eulophidae: *Aphytis diaspidis* (How.),
*Prospaltella* sp. High parasitization rate was noted by the author.
The accompanying illustrations are based on material listed above, from *Cormus racemose* Lam.

**Chionaspis furfura** (Fitch)

*Fig. 35*


*Chionaspis furfur*us (Fitch), Comstock, 1881, p. 315.

*Chionaspis furfur*us var. *fulvus* King, 1899, p. 334.

*Chionaspis furfur*us (Fitch), Bogue, 1896a, p. 7; Cooley, 1899, p. 23; Osborn, 1900, p. 72; Sanders, 1904b, p. 46; Dietz and Morrison, 1916b, p. 270; Houser, 1918, p. 288; MacGillivray, 1921, p. 331; Miller, 1922, p. 60; Hollinger, 1923, p. 23; Britton, 1923, p. 364; Ferris, 1937, Ser. I:18; Sleesman, 1945, p. 44; McKenzie, 1956, p. 97; Porter et al., 1959, p. 78.

**Common Name.**—Scurfy scale.

**Scale of Female.**—Oystershell-shaped, broadened posteriorly, thin, white, length 2.5-3.0 mm; exuviae yellowish-brown.

**Female.**—Spindle-shaped, laterally lobed, reddish, length on slide 1.0-1.2 mm.

**Pygidium.**—Median lobes well developed, apically rounded; second pair broad, bilobed; third pair rudimentary. Gland spines large, those lateral from median lobes smaller. An elongated sclerosis between median lobes. Few dorsal ducts; submedian groups present only on third to fifth segments, usually composed of 2 or 3
Fig. 34.—Chionaspis corni Cooley

Fig. 35.—Chionaspis furfura (Fitch)
ducts; submarginal groups composed of 2 to 4 ducts on third to fifth segments. Few ventral ducts, usually located submarginally. Two small setae at the base of each median lobe. Marginal setae on venter much smaller than those on dorsum. Vulva hardly visible. Perivulvar pores in five large groups. Anal opening round, anterior to vulva.

**Scale of Male.**—Elongated oval, tricarinate, white, length 0.7-0.9 mm; exuviae yellow.

**Egg.**—Ovoid, reddish (yR 7.5-3/6).


*Juglans cinerea* L., Champaign Co.: Mechanicsburg, July 13, 1914 (JSH); Washington Co.: Vincent, May 23, 1913; Wooster, Oct. 3, 1912 (JSH).

*J. nigra* L., Pike Co.: south of Piketon, July 16, 1961 (MK). *Malus pumila* Mill., Cuyahoga Co., March 5, 1961 (MK); Franklin Co.: Westerville, Dec. 1, 1900, (W.N.), Osborn (1900); Logan Co., July 9, 1961 (MK); Union Co.: New California, July 9, 1961 (MK); Wooster, Dec. 1, 1900 (W.N.), Osborn (1900). *Malus* sp., Ashtabula, Dec. 1, 1914, "severe on wild crab" (JSH); Columbus: OSU, March 6, 1920 (AEM); Cuyahoga Co., March 5, 1961 (MK); Franklin Co.: Gahanna, March 15, 1900 (Lewis Bobb), (HC); Highland Co., July 15, 1961 (MK); Hocking Co.: Neotoma, April 16, 1960 (PFH, MK); Medina Co., - , (CAR).

*Prunus avium* L., Muskingum Co.: Zanesville, April 2, 1920 (AEM).


Additional Biological Data.—This species overwinters in the egg stage, and the eggs begin hatching the end of April. Since eggs were found under live females in Highland, Logan, and Pike Counties between July 9-16, 1961, it is assumed that there are two yearly generations in Ohio. An average of 64 eggs (maximum 82, minimum 42) per female were found (20 counted) in the material studied.

Parasites Reared.—Eulophidae: Aphytis sp.

Predators.—The lady-bird beetle, Chilocorus bivulnerus Mills., was noted by Sanders (1904b) to be predaceous on this species in Ohio. The author observed the following three species to prey upon this scale in Lucas Co.: Coccinella novemnotata Hbst., C. trifasciata L., and Hippodomia convergens Guer.
Economic Importance.—This species occasionally becomes a pest in untreated orchards in Ohio; it causes reddish spots and small pits on the bark of twigs.

The accompanying illustrations are based on material from *Malus pumila* Mill., Cuyahoga Co., Ohio, March 5, 1961 (MK).

**Chionaspis gleditsiae** Sanders

**Fig. 36**


**Scale of Female.**—Oystershell-shaped, light gray or dirty white, about 1.5-2.0 mm in length; exuviae at one end.

**Female.**—Spindle-shaped, segments laterally rounded; color of overwintering females yellow (Y 22.5-8/12), after egg laying brownish (YR 20-5/8); length on slide 0.7-0.9 mm.

**Pygidium.**—Triangular, acute, with sclerotized lobes. Median lobes prominent, rounded at apex, notched on inner and outer margin, basal yoke with a small elongated sclerosis; second pair bilobed, inner lobule much larger than outer lobule, crenate on outer margin, outer lobule inconspicuous, more or less triangular; third pair reduced to small sclerotized area. Gland spines large, first gland spine with two ducts, all others with one duct. Marginal and dorsal ducts well developed; submedian groups reduced in number of ducts, usually 2-3 small ducts on the third segment; one large and 1-2 small
ducts on the fourth segment; usually 3-4 large ducts on the fifth segment; sometimes one large duct on sixth segment. A row of ventral ducts located submarginally. Vulva large, about the middle of pygidium. Perivulvar pores in five groups, median group usually confined to a row of 8-9 pores. Anal opening round, located anterior to vulva.

Color of eggs reddish brown (YR 15-5/6); first stage nymphs light yellow (Y 22.5-8/8); second stage nymphs light yellow (Y 22.5-8/6).

Scale of Male.—Elongated, white, about 0.6 mm long, exuviae yellow, located at one end.

Males.—Wingless.


Additional Biological Data.—Overwintered as mature females in Franklin Co. in 1961. An average of 21 eggs were counted under females in Hocking Co. on June 11, 1961. All instars were present on July 1, 1961, in Hamilton Co., also on Sept. 13, 1960, in Ottawa Co. Houser stated in his collecting notes that wingless males emerged in laboratory in large numbers on Nov. 8, 1912, from material collected in Ottawa Co: Gypsum, on Nov. 5.

Parasites Reared.—One female of Encyrtidae and one specimen of Eulophidae.

Predators.—Coccinellidae: Scymnus sp.

Acarina Associated.—Acaridae: Thyreophagus entomophagus (Laboulbene), Hemisarcoptidae: Hemisarcoptes malus (Shimer).

The accompanying illustrations are based on material from Gleditsia triacanthos L., Cincinnati, Nov. 9, 1914 (JSR, JLK).
Chionaspis lintneri Comstock

Fig. 37


Scale of Female.—Elongate oystershell-shaped, white to grayish white, length about 2.5 mm; exuviae yellow brown; ventral scale thin and white.

Female.—Spindle-shaped, laterally lobed, length on slide about 1.3-1.4 mm.

Pygidium.—Median lobes prominent, more or less acute, diverging, yoked by a short median sclerosis; second and third pair bilobed, each rounded apically, mesal lobules much larger. Gland spines long and slender, usually 6-9 on margin of third and fourth segments. Submedian dorsal ducts form larger groups; only small ducts on first segment; large ducts mixed with few small ducts on second and third segments; usually 5-10 large ducts on fourth to sixth segments. Numerous well developed submarginal dorsal ducts. Most ventral ducts located submarginally. Setae on venter much smaller than those on dorsum. Perivulvar pores in five large groups. Anal opening round, located immediately posterior to median perivulvar pore group.

Scale of Male.—Oblong, tricarinate, white, length about 0.8-1.0 mm; exuviae yellow.

Male.—Winged, yellow.
Fig. 36.—Chionaspis gleditsiae Sanders

Fig. 37.—Chionaspis lintneri Comstock
Host and Distribution in Ohio.—Occurs on bark. *Juglans cinerea* L., Medina Co.: Wadsworth, June 1914, first stage larvae were noted, also many males emerged from this material, (CAR), (HC).

Other Material Examined.—MICHIGAN: East Lansing, heavy infestation on twigs and branches of *Juglans cinerea* L., 1914 (CAR), (HC).

The accompanying illustrations are based on material from *Juglans cinerea* L., in Medina Co.: Wadsworth, Ohio, June 1914 (CAR), (HC).

**Chionaspis longiloba** Cooley

Fig. 38


Scale of Female.—Elongate oystershell-shaped, white, length about 1.5 mm; exuviae yellowish brown.

Female.—Spindle-shaped, segments produced laterally, length on slide 0.8–0.9 mm.

Pygidium.—Triangular, pointed at apex, lobes slightly sclerotized. Median lobes conspicuous, divergent and yoked together by a short sclerosis, acutely rounded, finely serrate on lateral sides; second and third pairs well developed, finely serrate on lateral sides and rounded at apex, outer lobule always smaller than inner lobule. Gland spines long and slender. Submedian dorsal duct group arranged as follows: small ducts on first and second segments, usually 6 large and 3–4 small ducts on third segment, about 6–8 large
and 2-4 small ducts on fourth and fifth segments, usually 4-6 large ducts on sixth segment. Submarginal duct groups present with several ducts on second to fifth segments. A few ventral ducts present. Perivulvar pores in five large groups. Anus rounded and located close to median group of perivulvar pores.

**Scale of Male.**—Not seen. Cooley (1899) described it as follows: "Length 0.6-0.8 mm. Oval without carinae. Exuvia brownish or colorless."

**Host and Distribution in Ohio.**—Occurs on bark. According to Sanders (1904b) it was found on cottonwood, *Populus deltoides* Marsh., Lake Co.: Painesville (G. A. Runnor).


The accompanying illustrations are based on the above material from Michigan.

**Chionaspis ortholobis** Comstock

This species was listed from Ohio by Sanders (1904b). The material on which Sanders' description was based was re-examined and it was found to be identical with *Chionaspis parkii* Hollinger (see data under this species). According to Ferris (1937), the records of the occurrence of *C. ortholobis* east of the Rocky Mountains are open to question and some of them are very definitely erroneous. Since the author was unable to obtain authentic material of the species from Ohio or from Eastern United States, this species is not discussed herein.
Chionaspis parkii Hollinger

Fig. 39

C. ortholobis Comstock, as a misidentification by Sanders, 1904b, p. 48.

Scale of Female.—Oystershell-shaped, white, length 2.0—2.2 mm; exuviae brownish.

Female.—Spindle-shaped, segments rounded laterally, length on slide about 1.0 mm.

Pygidium.—Large, broad, triangular, apical margin sclerotized. Each pair of lobes well separated from the others. Median lobes small, distinctly pointed, their mesal margins divergent, yoked by a short sclerosis. Second pair small, bilobed, rounded apically, mesal lobule notched on outer margin, outer lobule much smaller; third pair smaller than second pair, rounded apically. Gland spines relatively small. Submedian dorsal duct groups well developed; only small ducts on first and second segments, usually 7-10 large and 2-4 small ducts on third segment; about 6-8 large ducts on fourth segment; double row of 8-12 large ducts on fifth segment; usually 3-5 large ducts on sixth segment. Submarginal dorsal duct groups well developed. Only a few scattered ventral ducts present. Setae on venter much smaller than on dorsal side. Perivulvar pores in five large groups. Anal opening round, located on anterior half of pygidium.
Fig. 38.—Chionaspis longiloba Cooley

Fig. 39.—Chionaspis parkii Hollinger
Scale of Male.—Not seen. According to Hollinger (1923),
the male scale is elongate, parallel-sided, white, about 0.7 mm
long, and 0.2 mm wide.

Host and Distribution in Ohio.—Occurs on bark. On peeling
bark of *Platamus occidentalis* L., Licking Co.: Newark, Jan. 4, 1903
(JGS), (SC); this material was identified as *Chionaspis ortholobis*
Comstock, by J. G. Sanders.

Other Material Examined.—INDIANA: Tippecanoe Co.: Wea Creek,
on *Platamus* sp., April 20, 1932 (J. M. Amos), (PC).

The accompanying illustrations are based on the above Ohio
material.

*Chionaspis salicis-nigrae* (Walsh)

Fig. 40

*Aspidiotus salicis-nigrae* Walsh, 1868, p. 39. *Mytilaspis salicis*

LeBaron, 1872, p. 140 (preoccupied name). *Chionaspis salicis*
(Linnaeus), Comstock, 1881, p. 320 (misidentification).

*Chionaspis salicis-nigrae* (Walsh), Cooley, 1899, p. 19;
Fernald, 1903, p. 225; Sanders, 1904b, p. 49; Dietz and
Korrison, 1916b, p. 272; Houser, 1918, p. 289; MacGillivray,
1921, p. 330; Miller, 1922, p. 60; Hollinger, 1923, p. 27;
Britton, 1923, p. 365; Felt and Korrison, 1928, p. 198;
Ferris, 1937, Ser. I:24; Slesman, 1945, p. 44; McKenzie,
Common Name.—Black willow scale.

Scale of Female.—Oystershell-shaped, broad, convex, white, length 2.5-3.5 mm. Exuviae yellowish.

Female.—Broad spindle-shaped, lobed laterally, length on slide 1.3–1.7 mm.

Pygidium.—Very broad in proportion to its length. Lobes sclerotized. Median lobes broad, rounded; second pair with two distinct rounded lobules, outer lobule much smaller; third pair more or less reduced. Besides great individual variability there are two major morphological groups represented in the material studied. In one of these groups on which the accompanying illustrations are based (most of the specimens collected from Populus spp., belong to this group), the median lobes are well separated at their bases, and between them is a pair of small tooth-like projection. The submedian dorsal duct group on the sixth segment is composed of a small number of large ducts. Usually no submarginal ducts on sixth segment. In the other morphological group, which is represented from Ohio: Hocking Co., on Fraxinus americana L., and on Salix sp., the median lobes are closely united, not bearing tooth-like projections at their bases. On sixth segment the submedian dorsal duct group is composed of about 6–12 small ducts. One or sometimes two or more additional submarginal ducts are present on sixth segment. Intermediate forms between the two above morphological groups were found in the Ohio material.

Gland spines conspicuous, large, pointed. Few ventral ducts located submarginally. Vulva in the middle of pygidium. Perivulvar
pores in five large groups. Anal opening round, located close to median group of perivulvar pores.

**Scale of Male.**—Elongated oval, slightly tricarinate, white, length 0.8–1.0 mm. Exuviae brownish to almost colorless.

**Eggs and First Instar Nymphs.**—Purplish red.

Hocking Co.: Conkles Hollow, May 19, 1960 (LK), Crane Hollow, April 16, 1960 (PHF, LK); Wooster, July 1, 1920 (AEM).


Additional Biological Data.—This species overwinters in the egg stage and the eggs hatched during the first half of May in Hocking County in 1961. It is assumed to have two yearly generations in Ohio.

Parasites Reared.—Eulophidae: Aphytis diaspidis (How.).

The accompanying illustrations are based on material from Populus tremuloides Michx., Ohio: Hocking Co., May 20, 1961 (LK).

Acarina Associated.—Oribatei : Cymbaeremiaidae :

Scapheremaecus sp.

Chionaspis sylvestica Sanders

Fig. 41

Chionaspis sylvestica Sanders, 1904a, p. 95, 1904b, p. 50; Hollinger, 1923, p. 28; Felt and Morrison, 1928, p. 198; Ferris, 1937, Ser. I:25; Sloesman, 1945, p. 44. Fundaspis sylvestica (Sanders), MacGillivray, 1921, p. 338.

Scale of Female.—Elongated, oystershell-shaped, white, length 1.5-2.0 mm.

Female.—Spindle-shaped, lobed laterally, acute posteriorly; length on slide 0.8-0.9 mm.
Fig. 40. - Chionaspis salicis-nigrae (Walsh)

Fig. 41. - Chionaspis sylvatica Sanders
Pygidium.—Triangular, acute, sclerotized on apex. Median lobes prominent, characteristically fused except for a small apical notch, finely serrate on lateral margins, each with a transverse basal sclerosis; inner lobule of second pair rounded apically, sometimes serrate on outer margin, outer lobule triangular, sharp-pointed; third pair serrate, reduced to a sclerotized area. First gland spine short, all others large, sharp-pointed. Submedian dorsal duct groups reduced in number; no ducts on first to third segment; sometimes one duct on fourth segment; only 1-3 ducts on fifth segment. Submarginal dorsal ducts few in number and present only on third to fifth segments. A few ventral ducts located submarginally. Vulva hardly visible. Perivulvar pores in five groups. Anal opening small, round, located anterior to middle of pygidium.

Scale of Male.—Elongated, oval, tricarinate, white, length 0.7-0.9 mm; exuviae yellow.

Host and Distribution in Ohio.—Known from Central Ohio and from the eastern half of the state. Occurs on bark. On twigs of Celtis occidentalis L., Franklin Co.: Route 23, at Blacklick Creek, May 20, 1961 (MK); this is probably the first record of the scale on a host other than sourgum. On trunk and branches of Nyssa sylvatica Marsh., Carroll Co.: Carrollton, Mar. 14, 1916 (M. S. Fawcett), (HC); Fairfield Co.: Sugar Grove; Guernsey Co.: Quaker City, Sanders (1904a); Hocking Co., May 20, 1961 (MK); Licking Co.: Dawes Arboretum, June 17, 1961 (MK), Newark, Sanders (1904a); Perry Co.: Somerset, Sanders (1904a); Scioto Co.: Portsmouth, Aug. 14, 1917 (JSH); Wayne Co.: Wooster Cemetery, Sept. 3, 1913 (JSH).
Other Material Examined.—MARYLAND: Baltimore, on Nyssa sylvatica Marsh., Aug. 28, 1956 (MK).

Additional Biological Data.—Reddish brown eggs were present under the scales in Franklin Co., on May 20, 1961.

Parasites Reared.—Encyrtidae: Chiloneurinus microphagus (Mayr). Eulophidae: Prospaltella sp.

The accompanying illustrations are based on material from Nyssa sylvatica Marsh., Hocking Co., May 20, 1961 (MK).

Chionaspis wistariae Cooley

Fig. 42


Although MacGillivray (1921) and Ferris (1955) transferred this species to the genus Phenacaspis Cockerell and Cooley, the author did not find enough morphological evidence to justify such nomenclatural change.

Scale of Female.—Variable in shape and size. Elongate oystershell-shaped, white, length 1.5-2.5 mm.

Female.—Spindle-shaped, expanding toward posterior end, laterally lobed, length on slide 0.9-1.1 mm.

Pygidium.—Triangular, sclerotized at apex. Median lobes large, conspicuous, separated and parallel at base, diverging toward a rounded apex, finely serrate on inner margins; second pair
bilobulate, rounded at apex; third pair more or less reduced, rounded or serrate. Cland spines large and slender. All dorsal ducts large. Submedian dorsal duct groups as follows: No ducts on first and second segments; usually 4-6 ducts on third to fifth segments; 2-4 ducts on sixth segment. Submarginal dorsal ducts in groups of 5 to 10 on third to fifth segments. A few ventral ducts along margin of pygidium. Two setae at base of each median lobe. Marginal setae much smaller on ventral than on dorsal side. Perivulvar pores in five groups. Anal opening round, located just posterior to median group of perivulvar pores.

Scale of Male.—Elongated-oval, white, distinctly tricarinate, length about 1.0 mm; exuviae yellowish brown.

Host and Distribution.—Occurs on bark, leaf petioles, and leaves, especially along the main veins of the leaves. This species is known from the bordering state of Pennsylvania, from different locations in California. It was introduced to the United States from Japan.


Acarina Associated.—Oribatei : Cymbaeremaeidae : Scapheremaeus (?) marmoratus (Berlese); Haplozetidae : Peloribates sp.

The accompanying illustrations are based from the above material.

Notes.—Takahashi (1953) noted that in Japan the females of the overwintering generation of this species, on the bark, are Chionaspis-type, with the median lobes expanded, rounded and pro-
truding, while those on the leaves in the summer are of *Phenacaspis*-type, with the median lobes being narrow, pointed at the outer corner of the apex and entirely in an incision at the hind end of pygidium. No intermediate form has been detected by him. Although there were specimens studied from bark and from the leaves of the above material, the author did not find such major morphological differences.

**Genus *Epidiaspis* Cockerell**


*Cockrellaspis* MacGillivray, 1921, p. 306.

**Scale of Female.**—Circular to slightly oval, white; exuviae subcentral or central.

**Female.**—Circular to pyriform, derr membranous except on pygidium.

**Pygidium.**—Median lobes prominent, non-zygotic; second and third lobes reduced. Gland spines large. Dorsal ducts scattered, and present on pygidium to seventh segment. Perivulvar pores in five groups. Anal opening posterior to center of pygidium.

**Type of the Genus.**—*E. leperi* (Signoret).

**Epidiaspis leperi** (Signoret)

*Fig. 43*

*Diaspis leperi* Signoret, 1869, p. 437; Sleesman, 1945, p. 47.

*Diaspis pyri* Colvée, Fernald, 1903, p. 232. *Epidiaspis*
Fig. 42. - Chionaspis wistariae Cooley

Fig. 43. - Epidiaspis leperii (Signoret)
Common Name.—Italian pear scale.

Scale of Female.—Circular, convex, white, yellowish white or gray, about 1-1.2 mm in diameter; exuviae subcentral or central.

Female.—Circular to pyriform, metathorax and the three anterior abdominal segments usually lobed at the margins, red to orange yellow, cephalothoracic margins sclerotized; length on slide about 0.7-1.0 mm.

Pygidium.—Median lobes large, prominent, close together, rounded, slightly notched on outer margins; second and third pair reduced to small sclerotized points. Large gland spines on margin of pygidium and on margin of propygidial segment, apex of pygidial gland spines usually bent toward median lobes. Three pairs of intersegmental scleroses. Marginal ducts large, other dorsal ducts irregularly arranged; one duct between median lobes. Only a few ventral ducts present. Perivulvar pores usually in five compact groups, but occasionally in seven groups as on the illustration. Anal opening located about the middle of pygidium.

Scale of Male.—Elongated, white, about 0.6-0.8 mm long; exuviae at one end.
Male.—Wingless, orange yellow.

Host and Distribution.—This species was not collected in Ohio, but is known from New York and Pennsylvania. Occurs on bark, mainly on rosaceous trees. Material examined was from *Pyrus communis* L., Somerton: Sickle Nursery, Pennsylvania, June 29, 1944 (GBS).

The accompanying illustrations are based on the above listed material.

Genus *Fiorinia* Targioni-Tozzetti


Scale of Female.—Usually elongate. Composed of second exuviae which may be covered with a thin film of wax. First exuviae at apex of scale.

Female.—Elongate, membranous. Pupillarial; the adult female being retained in the exuviae of second stage. Antennae relatively large, close together, at anterior margin of the head.

Pygidium.—Median lobes sygotic, usually forming a median notch in the pygidium; second pair bilobed. Marginal ducts large, few small dorsal ducts located on the submedian or submarginal area. Perivulvar pores in five groups or absent.

Type of the Genus.—*F. fioriniae* (Targioni-Tozzetti).
Fiorinia externa Ferris

Fig. 44


Scale of Female.—Not seen. Ferris (1942) described it as follows:

Scale of the female of the type common to the genus, being composed almost entirely of the sclerotized and elongate second exuvia. Color a pale yellow or slightly reddish brown, the exuvia more or less translucent. The scale shows a specific peculiarity in that the first exuvia is exceedingly thin and transparent and seems ordinarily to be detached from the second, to which it is connected only by a thin film of wax. Scale of the male not seen.

Female.—Elongated, margins almost parallel, tapering at apex, length on slide 0.9-1.1 mm. Derm membranous except for the pygidium. Pupillarial; the adult female is retained within the exuviae of the second stage.

Pygidium.—Sclerotized, with small areas of weaker sclerotization. Median lobes relatively small, zygotic, forming a median notch, and sunk into apex of pygidium, conspicuously serrate; second pair well developed, bilobed, each lobule rounded apically; third pair lacking. Two long gland spines at the apex of pygidium, located laterad of median and second pair of lobes. One to three stout and pointed gland spines on each of the three prepygidial segments; anterior to these is a marginal cluster of small gland spines. Marginal ducts large, 5 or 6 on each side of the pygidium. Few ventral ducts located submarginally. Perivulvar pores in five groups;
median group composed of only 3-4 pores. Anal opening round located just behind the median group of perivulvar pores.

Host and Distribution.—Occurs on needles of hemlock. It was described from Tsuga sp., from Baltimore, Maryland. On Tsuga sp., Kent, Ohio, Feb. 21, 1929 (W. O. Hollister), (NCC). Dow (1962) mentioned it from Ohio based on a report from John A. Weidhaas of Cornell University.

The accompanying illustrations are based on material received through the courtesy of R. Morrison, from Tsuga sp., Baltimore, Md., Feb. 12, 1954 (E. Acton), (NCC).

Genus Lepidosaphes Shimor


Scale of Female.—Oystershell-shaped, usually strongly convex, brownish or gray; exuviae at anterior end.

Female.—Elongate spindle-shaped, strongly lobed and often with spurs on abdominal margin.
Pygidium.—Median lobes well developed and separated, never yoked together; second lobes bilobed; third lobes more or less reduced. Gland spines large, present along margin of pygidium and of prepygidial segments. Dorsal ducts present on segments one to six, arranged in rows; marginal ducts larger, 6-7 on each side of pygidium. Perivulvar pores in five groups. Anal opening close to the anterior margin of pygidium.

**Type of the Genus.**—*L. ulmi* (Linnaeus).

**KEY TO SPECIES OF LEPIDOSAPHESES**

<table>
<thead>
<tr>
<th>1</th>
<th>Dorsal ducts on sixth segment numerous and forming a continuous group extending from margin of pygidium almost to the anus</th>
<th><em>ulmi</em> (Linnaeus)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1'</td>
<td>Dorsal ducts on sixth segment in small number, usually 1-3 ducts</td>
<td>2</td>
</tr>
<tr>
<td>2(1')</td>
<td>Usually 4-9 submedian dorsal ducts in each row on second to fourth segments; occurs on <em>Bionymis</em> and <em>Pachysandra</em> in Ohio</td>
<td><em>yanagicola</em> Kuwana</td>
</tr>
<tr>
<td>2'</td>
<td>Usually 3-5 submedian dorsal ducts in each row on second to fourth segment; occurs on umbrella pine and <em>Sophora japonica</em></td>
<td><em>sciadopitysi</em> McKenzie</td>
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</table>

**Lepidosaphes sciadopitysi** McKenzie

*Fig. 45*


*Lepidosaphes newsteadi* (Sulc), Britton, 1923, p. 379, as a misidentification. *Lepidosaphes* sp., Sleesman, 1945, p. 44.
Fig. 44.—Fiorinia externa Ferris

Fig. 45.—Lepidosaphes sciadopitysi McKenzie
Scale of Female.—Slender oystershell-shaped, brown or grayish brown, length 1.2-1.5 mm; exuviae yellow.

Female.—Spindle-shaped, slightly sclerotized at apex, abdominal segments slightly produced laterally and with three sets of sclerotized spurs; length on slide 0.7-0.8 mm.

Pygidium.—Rounded apically. Median lobes about as long as wide, notched on both sides, rounded apically; second pair bilobed, each lobule notched on outer margin and rounded apically. Gland spines well developed. Dorsal macroducts much smaller than marginal ones; submedian ducts in definite rows of 3-5 ducts, containing usually 2 or 3 ducts on sixth segment. Usually 2 submarginal ducts on fifth segment, more numerous on other segments. Only very few ventral ducts present. Vulva hardly visible, located about the middle of pygidium. Perivulvar pores in five groups as follows: median 3-4, anterior laterals 5-8, posterior laterals 4-7. Anal opening round, located just posterior to median group of perivulvar pores.

Scale of Male.—Not seen.


Other Material Examined.—PENNSYLVANIA: Andorra Nurseries, on the above host, and also on branches of Sophora japonica L., Feb. 22, 1944 (CBS), (PaDA).

According to McKenzie (1955) this species is also known in the United States from California, Connecticut, District of Columbia and from Long Island, New York.
The accompanying illustrations are based on the above material from *Sophora japonica* L.

**Lepidosaphes ulmi** (Linnaeus)

*Fig. 46*


There are hundreds of publications dealing with this species and its synonymy is much confused. Only the most important synonyms are listed here.

**Common Name.**—Oystershell scale.

**Scale of Female.**—Variable in form, usually elongate oyster-shell-shaped, strongly convex, brownish or gray in color; length 2.0-3.5 mm. Ventral scale well developed, white.
Female.—Elongate spindle-shaped, distinctly lobed laterally, color reddish yellow (rY 22.5-8/8) on Catalpa speciosa Warder, length on slide 1.2-1.5 mm. Segments 2-4 bear a sclerotized spur at margin.

Pygidium.—Wide, sclerotized at apex. Median lobes large and wide, notched on both sides, rounded apically; second pair bilobed, mesal lobule notched on outer margin and rounded apically, lateral lobule much smaller; third lobes lacking. Gland spines large and slender. Dorsal ducts quite small, except those on margin; dorsal ducts on sixth segment forming a continuous group extending from margin of pygidium almost to the anus; dorsal ducts on third to fifth segment divided into large submarginal and submedian groups. Few, hardly visible, scattered, ventral ducts. Vulva in the middle of pygidium. Perivulvar pores in five groups. Anal opening round, located close to anterior margin of pygidium.

Egg.—Ovoid, white; length 0.31 mm., width 0.154 mm.

First Stage Nymph.—Reddish yellow (rY 22.5-8/6).

Scale of Male.—Elongated, gradually narrowing toward anterior end, brownish; length 1.0-1.3 mm.


Additional Biological Data.—Overwinters in egg stage. Eggs were deposited during the second part of August and first part of September. Eggs hatched between May 10–30, 1961, in Central Ohio. Average number of eggs per female 49 (based on counts of 50 females). The eggs tend to stay together in clusters, probably due to the sticky surface. Males appeared on *Ptelea trifoliata* L., between June 21–30, 1961, in Licking Co., and on *Catalpa speciosa* Warder, between July 2–5, 1961, in Clark Co. *Phylloxera salicola* Pergande females and first stage nymphs were found using as shelter the empty scales of females on branches of a willow located at the side of a creek in Scioto Co., on July 16, 1961. Glenn (1920) described three forms of this species from Illinois.


Predators.—*Coccinellidae*: *Chilocorus bivulnerus* Muls., were noted feeding on second stage nymphs of the scale.

Acarina Associated.—*Acaridei*: *Acaridae*: *Thyrophagus entomophagus* (Laboulbene); *Oribatidae*: *Cymbaeremaeidae*: *Scapheremaeus marginalis* (Banks), *Oribatulidae*: *Dometorina* sp., and an undet. *Oribatulidae*. *Oribatidae*: *Cripoda elongata* Banks; *Prostigmata*: *Bdellidae*: *Octobdellodes* sp.n.

Economic Importance.—According to Sanders (1904b) the greatest damage is done on poplars and willows, and many poplars have been killed by its attack. Houser (1918) noted that under city conditions the damage is more severe.
The accompanying illustrations are based on material from *Syringa vulgaris* L., Columbus, Sept. 23, 1961 (E. D. Valentine).

**Lepidosaphes yanagicola** Kuwana

Fig. 47

*Lepidosaphes yanagicola* Kuwana, 1925, p. 19; Borchsenius, 1950, p. 182; Takahashi, 1955, p. 78; Porter et al., 1959, p. 66; Takagi, 1960, p. 76.

Scale of Female.—Elongate oystershell-shaped, gradually widening posteriorly, dark brown; length 1.8–2.0 mm. Exuviae orange yellow.

Female.—Spindle-shaped, slightly widening posteriorly, rounded at both ends, lobed laterally, pygidium and prepygidial segments usually heavily sclerotized; length on slide 0.9–1.1 mm. Each of the 3 prepygidial segments with a sclerotized marginal tubercle or spur.

Pygidium.—Semicircular. Median lobes large and widely separated, about as long as wide or slightly wider than long, notched on both sides, rounded apically; second pair bilobed, mesal lobule much larger than lateral and notched on outer side; third pair lacking. Gland spines large, about as long or longer than lobes. Dorsal ducts smaller, than marginal ducts. Submedian dorsal ducts arranged as follows: usually 4–9 ducts on second to fourth segments, usually 4–6 on fifth and 2–3 ducts on sixth segment. Usually 3 submarginal ducts on fifth and none on sixth segment. Occasionally one slender duct in front of second lobe. No ventral ducts were noted, probably due
Fig. 46. - *Lepidosaphes ulmi* (Linnaeus)

Fig. 47. - *Lepidosaphes yanagicola* Kuwana
to the heavy sclerotization of pygidium. Vulva large, posterior to middle of pygidium. Perivulvar pores in five groups as follows: median 4-7, anterior laterals 8-13, posterior laterals 7-11. Anal opening round, located close to anterior margin of pygidium.

Scale of Male.—Not seen. Kuwana (1925) described it as follows: "Small, of same color as the female; slightly wider towards the posterior end. Length about 1.0 mm."

Host and Distribution in Ohio.—First found in Ohio in 1950 (Porter et al., 1959); now widely distributed in the state. Occurs on bark, usually between the corky wings of twigs and branches. Host in Ohio: Euonymus alatus (Thunb.) Sieb., E. a. var. compacta Adams, E. fortunei var. vegeta (Rehd.) Rehd. According to Mr. James T. Walker (personal communications), this species has been reported from the following counties in Ohio: Ashland, Auglaize, Butler, Clark, Cuyahoga, Erie, Franklin, Geauga, Greene, Lake, Lorain, Lucas, Montgomery, Richland, Stark.

Material examined from Euonymus alatus var. compacta Adams, Wayne Co.: Wooster, OAES, March 3 and May 10, 1961 (R. B. Neiswander). According to Dr. Donald L. Schuder (personal communication) this species was collected on Pachysandra sp., in Cleveland, Feb. 26, 1954 (Charles Irish).

Additional Biological Data.—Porter et al., (1959), noted that the females overwinter and produce eggs from early June into July. Crawlers appeared by June 20. From late July all stages are present.
Economic Importance.—Several cases of heavy infestation and damage were reported from Ohio nurseries.

The accompanying illustrations are based on the above listed material from Wooster.

Notes.—This species is very similar to *Lepidosaphes corni* Takahashi (1957, p. 111), and according to Takagi (1960) the main distinguishing character is the shape of the pygidium. In *L. corni* the pygidium is trapezoid-like, while in *L. yanagicola* the pygidium is rounded. The presence of a slender submarginal dorsal duct in front of second lobe is more characteristic to *L. corni*, but occasionally occurs in *L. yanagicola*.

Genus *Lopholeucaspis* Balachowsky


Scale of Female.—Pupillarial; the adult female being retained within the second exuviae. Elongated, white or grayish, with first exuviae at apex.

Female.—Elongate spindle-shaped; with a continuous row of gland tubercles along the lateral margins of prosoma and the anterior abdominal segments.

Pygidium.—Lobes widely separated. Median lobes non-zygotic; second lobes not bilobed. Dorsal ducts few, small and scattered. Perivulvar pores in four or five groups. Anal opening round, located on the anterior half of pygidium.

Type of the Genus.—*L. japonica* (Cockerell)
Leucaspis japonica Cockerell, 1897a, p. 53; Fernald, 1903, p. 244; MacGillivray, 1921, p. 266; Britton, 1923, p. 370; Ferris, 1938, Ser. II:148; Sleesman, 1945, p. 45; Borchsenius, 1950, p. 176. Lopholeucaspi japonica (Cockerell), Balachowsky, 1953, p. 155.

Scale of Female.—Elongated, oystershell-shaped. Composed principally of the second exuviae, but usually concealed in grayish white wax coating, often same color as bark; length 1.5-2.0 mm. First exuviae apical, brownish.

Female.—Elongate spindle-shaped, tapering toward anterior end, length on slide 0.9-1.1 mm. Female retained within the enlarged and sclerotized exuviae of second stage. A continuous row of gland tubercles along the lateral margins of prosoma and the anterior abdominal segments.

Pygidium.—Rounded, membranous for most part. Two pairs of relatively large and acute lobes; second pair smaller. In the Cockerell (1897a) description and the figures of Ferris (1938) the lobes are trilobed. No trilobed lobes were found in the material examined by the author. Two slender fimbriate plates between median lobes, also between median and second lobes. Beyond second lobes is a series of short, broad, apically fimbriate plates, most with ducts at their base. The row of broad plates continues in a row of gland tubercles which extend almost to the anterior end of the body. Dorsal
ducts relatively small, numerous, scattered. Few ventral ducts present. Vulva located about the middle of pygidium. Perivulvar pores in an almost continuous arch; a small cluster of pores on the two prepygidial segments. Anal opening round, surrounded by a sclerotized area. There are other small and weakly sclerotized areas on the pygidium.

**Scale of Male.**—Not seen. According to Britton (1923) the male scale is whitish, without carinae, length 1.25-1.75 mm; exuviae brown.

**Host and Distribution.**—Occur on bark. Known from the bordering state of Pennsylvania, also from Connecticut, Long Island, and Maryland in the United States.

**Material Examined.**—MARYLAND: Baltimore, on Fagus sp., April 23, 1959, on Pyracantha sp., May 20, 1958, on Rosa sp., May 26, 1958 (LK); Ellicott City, on Acer sp., May 10, 1959 (LK). PENNSYLVANIA: Liqueon, on Acer saccharum Marsh., Feb. 6, 1944 (GBS); Villanova Nurseries, on Ligustrum sp., –, (GBS), (PaDA).

The accompanying illustrations are from the above material from Fagus sp.

Genus Phenacaspis Cooley and Cockerell

Scale of Female.—Elongate, usually oystershell-shaped, white, exuviae apical.

Female.—Elongate, spindle-shaped. Derm membranous, or only slightly sclerotized with the exception of pygidium.

Pygidium.—Median lobes yoked together, more or less divergent, and form a distinct notch in the pygidium. Dorsal ducts relatively large, arranged in rows. Perivulvar pores in five groups. Anal opening round, anterior from center of pygidium.

Type of the Genus.—P. nyssae (Comstock).

KEY TO SPECIES OF PHEKACASPIS

1  Mesal lobule of second lobes longer than median lobes ........................................... 2

1' Mesal lobule of second lobes not longer than median lobes ..................................... 3

2(1) Lateral lobule of second lobes vestigial;
mesal lobule of third lobes large, almost as large as the mesal lobule of second lobes;
submedian dorsal macroducts present from second to sixth segments, with 2-8 ducts on each segment;
known only from leaves of sycamore, Platanus occidentalis ........................................ occidentalis sp.n.

2' Lateral lobule of second lobes well developed, rounded apically; mesal lobule of third lobes small, only slightly projecting; submedian dorsal macroducts present only on fourth to sixth segments, usually with 1-4 ducts on each segment;
occurs on honey locust, *Gleditsia triacanthos* ................................ *spinicola* Dietz and Morrison

3(1') With two large dorsal submarginal macroducts just anterior to base of second lobe; occurs on black-gum or sour-gum, *Nyssa sylvatica* .......................................................... *nyssae* (Comstock)

3' Without such ducts ................................................................. 4

4(3') Median lobes large, divergent; occurs on sycamore .......................................................... *platani* (Cooley)

4' Median lobes small, divergent or almost parallel; occur on needles of conifers ................................................................. 5

5(4') Median lobes almost parallel, wide; the space between median lobes shorter than the width of a median lobe; setae laterad of median lobes much shorter than diameter of anal opening; occurs on different conifers, including pines .......................................................... *pinifoliae* (Fitch)

5' Median lobes strongly divergent, narrow; the space between median lobes wider than the width of a median lobe; setae laterad of median lobes about as long as or longer than the diameter of anal opening; known only from pines *heterophyllae* (Cooley)

*Phenacaspis heterophyllae* (Cooley)

*Fig. 49*

*Chionaspis pinifoliae heterophyllae* Cooley, 1897, p. 281, 1899, p. 34; Felt and Morrison, 1928, p. 198. *Phenacaspis heterophyllae*
Fig. 48.—Lopholeucaspis japonica (Cockerell)

Fig. 49.—Phenacaspis heterophyllae (Cooley)
(Cooley), MacGillivray, 1921, p. 347; Ferris, 1942, Ser. IV:406; Andresen, 1957, p. 81.

**Scale of Female.**—Elongate, strongly convex, white; length 2.0-3.2 mm; exuviae yellow.

**Female.**—Spindle-shaped, lobed laterally; length on slide 1.2-1.4 mm.

**Pygidium.**—Median lobes small and narrow, strongly divergent; the space between median lobes wider than the width of a median lobe. Second lobe short, both lobules of about equal in size and rounded apically. Mesal lobule of third lobe rounded apically, lateral lobule serrate on margin. Gland spines long and slender; those lateral from median lobes about as long or longer than the diameter of anal opening. Submedian dorsal ducts present on segments one to six; those on segments one and two are composed entirely of microducts; on segment three 3-5 macroducts, which are usually accompanied by 2-4 microducts; on segments four and five 3-5 macroducts on each side of the pygidium; on segment six usually 2 macroducts. Submarginal dorsal macroducts present on segments one to five; those on segments one and two are smaller than the others. A few ventral ducts located submarginally. Perivulvar pores in five groups; medians 5-9, anterior laterals 16-22, posterior laterals 14-25. Anal opening round or slightly oval.

**Scale of Male.**—Elongated, white, length about 1.0 mm; with a median carina.

Other Material Examined.—NORTH CAROLINA: Lucama, on *Pinus* sp., March 22, 1959 (MK).

Additional Biological Data.—This species overwintered in the egg stage (purple red eggs). Eggs started to hatch on April 21 (1960) in Hocking County. Since egglaying females were noted on May 19 (1960), it is assumed that this species has two yearly generations in Ohio.

The accompanying illustrations are based on the above listed material from *Pinus resinosa* Ait.

*Phenacaspis nyssae* (Comstock)

Fig. 50

*Chionaspis nyssae* Comstock, 1881, p. 316. *Phenacaspis nyssae* (Comstock), Cooley, 1903, p. 48; Fernald, 1903, p. 239; Dietz and Morrison, 1916b, p. 276; MacGillivray, 1921, p. 351; Ferris, 1937, Ser. I:92; Sleesman, 1945, p. 44.

Scale of Female.—Almost triangular, strongly broadened posteriorly, white; length 1.5 mm; exuviae yellowish.

Female.—Spindle-shaped, conspicuously lobed laterally, length on slide 0.8-0.9 mm.
Pygidium.—Triangular with a wide triangulate notch at apex. Median lobes large, long and narrow, strongly divergent, widely separated; second pair well developed, inner lobule much larger than the outer; third pair reduced to sclerotized serrate margin. Gland spines large and stout. Dorsal ducts all large. Submedian groups on fourth to sixth segments, containing 2-4 ducts on each segment. Submarginal ducts on third to sixth segments; characteristically 2 ducts on sixth segment, usually 2-6 ducts on the other segments. Only 2-3 ventral ducts present. Perivulvar pores in five small groups.

Scale of Male.—Not seen. According to Dietz and Morrison (1916b) the scale of male is elongate, slender, tricarinate, snow white, length 1.0-1.25 mm.

Host and Distribution in Ohio.—Known only from one location, from leaves of Nyssa sylvatica Marsh., Scioto Co.: Roosevelt Park, July 16, 1961 (MK).

The accompanying illustrations are based on the above material.

Phenacaspis occidentalis sp.n.

Fig. 51

Scale of Female.—Elongated oystershell-shaped, convex, thin, white. Length about 2.0 mm, exuviae light yellow.

Female.—Elongate spindle-shaped, distinctly segmented, length on slide about 1.0 mm.

Pygidium.—Median lobes large, deeply sunken into pygidium, mesal margins finely serrate. Median lobes forming a distinct, wide,
Fig. 50.—Phenacaspis nyssae (Comstock)

Fig. 51.—Phenacaspis occidentalis sp. n.
deep, and acute notch in pygidium. Second pair of lobes with prominent mesal lobule which is longer than median lobes, outer lobule very small; third pair with inner lobule large, broad, rounded apically, outer lobule very small, with serrate margin. Gland spines well developed. Submedian dorsal duct groups as follows: 3–6 small ducts on first segment; 1–2 small and 4–6 larger ducts on second segment; 2–3 small and 6–8 large ducts on third segment; 7–8 large ducts on fourth segment; 4 large ducts on fifth and 2 large ducts on sixth segment. Submedian dorsal duct groups composed of large ducts as follows: 3–4 on first segment; 4–5 on second segment; 6–8 on third segment; 2–4 on fourth segment; 3 on fifth segment. A few ventral ducts present. Perivulvar pores in five groups: median 10, anterior laterals 10–13, posterior laterals 12–13. Anal opening round.

The closest related species is *Phenacaspis spinicola* Dietz and Morrison, which differs from *P. occidentalis* as follows:

1. The median notch between the median lobes is much larger and the degree of median lobe divergence is more pronounced in *P. occidentalis*.

2. The outer lobule of second lobes is very small in the *P. occidentalis*, while in *P. spinicola* is well developed.

3. The inner lobule of third lobes is large, almost as large as the inner lobule of second lobes, broad, rounded apically in *P. occidentalis*, while this lobule is small and only slightly projecting in *P. spinicola*. 
4. Submedian dorsal macroducts are present only on the fourth to sixth segments and usually contain only 1-4 ducts in P. spinicola, while in P. occidentalis these ducts are present from the second to sixth segments and are more numerous, with 2-8 ducts on each segment.

5. Submarginal dorsal macroducts are present on the third to fifth segments in P. spinicola, while in P. occidentalis these ducts are present from the first to fifth segments.

6. The known host of P. spinicola is Gleditsia triacanthos L., while P. occidentalis is known only from Platanus occidentalis L., hence the specific name.

Material Examined.—One female and three second stage nymphs collected from leaves of Platanus occidentalis L., Indiana: Indianapolis, Aug. 2, 1961 (LH).

Holotype female deposited in the U.S. National Museum.

The accompanying illustrations are based on the above material.

Phenacaspis pinifoliiae (Fitch)

Fig. 52

Aspidiotus pinifoliiae Fitch, 1856, p. 488. Chionaspis pinifoliiae (Fitch), Comstock, 1881, p. 318; Cooley, 1899, p. 30; Osborn, 1900, p. 72; Fernald, 1903, p. 221; Sanders, 1904b, p. 49; Dietz and Morrison, 1916a, p. 268; Houser, 1918, p. 291; MacGillivray, 1921, p. 326; Miller, 1922, p. 60; Hollinger, 1923, p. 26; Britton, 1923, p. 365; Felt and Morrison, 1928, p. 198; Sleesman, 1945, p. 44. Phenacaspis pinifoliiae
Common Name. — Pine needle scale.

Scale of Female. — Elongated oval, almost parallel sided on spruce, usually broader on pine needles, convex, snow-white, length 2.5-3.0 mm. First exuviae almost colorless, second exuviae orange-yellow.

Female. — Spindle-shaped, lobed laterally, purplish red, length on slide 1.1-1.4 mm.

Pygidium. — Rounded and sclerotized apically. Median lobes small, rounded, sunken into the apex of pygidium, separated from each other by a distance equal to about one-third to one-half the width of a lobe. A distinct sclerosis yokes the median lobes. Second and third pair rounded apically, mesal lobule larger. Gland spines with long and slender ducts. Dorsal submedian ducts as follows: only small ducts on first to third segments; about 6-8 ducts on fourth segment; about 4 ducts on fifth segment; usually 3 ducts on sixth segment. Size of large ducts increases consecutively from fourth to sixth segments. Only one ventral duct was noted in the studied material. Vulva just posterior to anal opening. Perivulvar pores in five groups. Anal opening relatively large, round.

Egg. — Ovoid, color red (yR 7.5-5/10).

Scale of Male. — Elongated-oval, slightly broadened posteriorly, tricarinate, white. Length about 1.0 mm, width 0.4 mm; exuviae pale yellow.

Other Material Examined.—MARYLAND: Baltimore on *Picea* sp., June 19, 1958 (MK), Catonsville, on *Pinus* sp., April 30, 1959 (MK).

Additional Biological Data.—This species overwinters in the egg stage. Average number of eggs per female 29 (eggs of 20 females counted) in the material from spruce, Bridgeport, Indiana, March 25, 1961 (MK). Eggs started to hatch by the end of April (1960) in Franklin and Hocking Counties, and continued through the middle of
May. Males emerged between June 14-24, also Sept. 5-17 and Oct. 18-Nov. 1 (1960) in Columbus. There are two yearly generations in Ohio.

Parasites Reared.—Bilophidae: Aphytis near mytilaspidis (LeBaron), Aphytis sp., probably a new species according to Paul DeBach.

Acarina Associated.—Oribatei : Ceratozetidae : Trichoribates sp.; Oribatulidae : Zygribatula pyrostigmata (Ewing).

The accompanying illustrations are based on material from Picea pungens Engelm., Columbus, Ohio, June 10, 1961 (MK).

Phenacaspis platani (Cooley)

Fig. 53

Chionaspis platani Cooley, 1899, p. 36; Fernald, 1903, p. 223;
Phenacaspis platani (Cooley), MacGillivray, 1921, p. 345;

Scale of Female.—Oystershell-shaped, convex, white or dirty white. Length 1.8-2.0 mm; exuviae yellowish-brown.

Female.—Spindle-shaped, distinctly lobed laterally, length on slide 0.9-1.1 mm.

Pygidium.—Rounded on margin, sclerotized at apex. Median lobes large, serrate on their margin, divergent and forming a distinct notch at apex of pygidium; second and third pairs well developed, although their outer lobules obscure. Gland spines, with the exception of the mesal pair, relatively large, each with a long and slender duct. Submedian dorsal ducts as follows: a few small ducts
Fig. 52.—Phenacaspis pinifoliae (Fitch)

Fig. 53.—Phenacaspis platani (Cooley)
on first segment; usually 2 large and 4-6 small ducts on second segment; 6-8 large and 5-6 small ducts on third segment; about 7 large ducts on fourth segment; 5 large ducts on fifth segment; usually 3 large ducts on sixth segment. Submarginal dorsal ducts with 4-10 ducts on second to fifth segments. Few ventral ducts located submarginally. Vulva anterior to middle of pygidium. Perivulvar pores in five elongated groups. Anal opening round, located just anterior from vulva.

Scale of Male.—Not seen. Cooley (1899) described it as follows: "Length, 0.8-0.9 mm. Parallel-sided to oval in outline. Occasionally very feebly uniarinate but usually without carinae. Exuviae pale yellowish-brown, occupying about two-fifths of the length of the scale."

Host and Distribution.—Known only from Platanus sp. No material was collected in Ohio, but this species is listed from the bordering state of Indiana. Also known from Missouri, Kansas, and Texas.

Material Examined.—From trunk of Platanus occidentalis L., Missouri: St. Louis, March 25, 1961 (MK).

The accompanying illustrations are based on the above material.

Phenacaspis spinicola Dietz and Morrison

Fig. 54

Scale of Female.—Oystershell-shaped, widest behind the middle, thin, convex, white. Length 1.5-2.0 mm; exuviae light yellow.

Female.—Elongate spindle-shaped, distinctly lobed laterally, apex rounded; length on slide 0.9-1.1 mm.

Pygidium.—Triangular, rounded apically, deeply incised at apex. Median lobes large, with distinctly serrate margins; second pair with both lobules well developed and rounded apically, mesal lobule longer than median lobes; third pair poorly developed, only slightly projecting, inner lobule more or less triangular and rounded apically, outer lobule wide, with serrate margin. Gland spines well developed, each with an elongated duct. Submedian dorsal macroducts present only on fourth to sixth segments, usually containing only 1-4 ducts in each group, sometimes ducts are lacking on fourth and sixth segments. Submarginal dorsal duct groups on third to fifth segments, containing 3-7 ducts. Few ventral ducts present, most located behind the posterior lateral group of perivulvar pores. Vulva inconspicuous. Perivulvar pores in five groups.

Scale of Male.—Not seen. Dietz and Morrison (1916b) described it as follows: "Length about 0.8 mm; elongate, narrow, sides approximately parallel or slightly curved; white, more or less distinctly tricarinate, roughened above; exuviae pale yellow, occupying fully two-fifths of the total length of the scale."

Other Material Examined.—INDIANA: Tippecanoe Co., Battle
Ground, on Gleditsia triacanthos L., July 18, 1956 (D. L. Schuder),
(PC).

The accompanying illustrations are based on the above Indiana
material.

Genus Pseudaulacaspis MacGillivray

Pseudaulacaspis MacGillivray, 1921, p. 305; Ferris, 1937, Ser. I:108;
Borchsenius, 1950, p. 205; Balachowsky, 1954, p. 235;

Scale of Female.—Circular, convex, white; exuviae subcentral
or marginal.

Female.—Broadly oval or pyriform, widest on mesothorax,
margins strongly lobed.

Pygidium.—Median lobes strongly zygotic, large; second pair
biloced; third pair reduced to sclerotized points. Gland spines
large, some bifurcate at apex. Dorsal ducts in definite rows. Peri-
vulvar pores in five large groups. Anal opening in about the middle
of pygidium.

Type of the Genus.—P. pentagona (Targioni-Tozzetti).

Pseudaulacaspis pentagona (Targioni-Tozzetti)

Fig. 55

Diaspis pentagona Targioni-Tozzetti, 1885, p. 1-3; Lupo, 1938a, p.
152. Diaspis amygdali Tryon, Osborn, 1900, p. 72. Aula-
caspis pentagona (Targioni-Tozzetti), Fernald, 1903, p. 234;
Fig. 54.—Phenacaspis spinicola Dietz & Morrison

Fig. 55.—Pseudaulacaspis pentagona (Targioni-Tozzetti)
Common Name.—White peach scale.

Scale of Female.—Circular or subcircular, white to yellowish white, about 1.5-2.0 mm in diameter. Exuviae marginal or submarginal.

Female.—Broadly oval or pyriform, margins strongly lobed, yellow, length on slide 0.9-1.1 mm.

Pygidium.—Broad, robust, strongly sclerotized around apex. Median lobes zygotic, large and protruding, notched on both sides, with two setae between their bases; second lobes sclerotic, rounded at apex, with small outer lobule; third lobes only slightly developed. Large gland spines on margin of all abdominal segments, some on pygidium bifurcate and with two ducts. Dorsal ducts large, present in definite rows divided into submedian and submarginal series, from second to fifth segments, no duct between median lobes. Perivulvar pores in five large groups. Anal opening round, anterior to middle of pygidium.

Scale of Male.—Elongated, noncarinate, white, about 1.0 mm in length. Exuviae apical.

Host and Distribution in Ohio.—Occurs on bark. There are only two records from Ohio. According to Osborn (1900), this species
was found by Webster on "flowering cherry" received from Japan at Painesville, Aug. 16, 1917. On *Syringa vulgaris* L., Lucas Co., Sept. 1946 (C. R. Jones), det. H. Morrison, data from J. T. Walker.


The accompanying illustrations are based on the above listed material from Pennsylvania.

**Genus Quernaspis Ferris**

*Quernaspis* Ferris, 1937, Ser. I:118.

**Scale of Female.**—Oystershell-shaped, white, exuviae apical.

**Female.**—Elongate, spindle-shaped.

**Pygidium.**—More or less triangular. Median lobes fused into a single lobe without any trace of division; second lobes bilobed; third lobes vestigial. Marginal ducts large, with their mouths surrounded by wide, ring-like scleroses. Perivulvar pores in five large groups.

**Type of the Genus.**—*Q. quercus* (Cockerell).

*Quernaspis quercus* (Comstock)

*Chionaspis quercus* Comstock, 1881, p. 319; Fernald, 1903, p. 223.

*Fundaspis quercus* (Comstock), MacGillivray, 1921, p. 338.

Scale of Female.—Elongated, oystershell-shaped, white to gray, about 1.5 mm long; exuviae apical.

Female.—Spindle-shaped, length on slide about 1.0 mm.

Pygidium.—Triangular, margin sclerotized. Median lobes fused into a single broad lobe, without trace of division; second lobes bilobed; third lobes reduced to sclerotized points. Gland spines along margin of pygidium. Dorsal ducts present, marginal ducts large and their mouths surrounded by ring-like scleroses. Vulva located in middle of pygidium. Perivulvar pores in five large groups. Anal opening round, located just posterior to median perivulvar pores.

Scale of Male.—No males or male scales were found in Ohio. Comstock (1881) described the male scale as follows: "... snowy white, with the larval skin very light yellow. The texture of the scale is quite loose and the carinae prominent; length 1.25 mm (.05 inch)."

Host and Distribution in Ohio.—Occurred on twigs of Quercus macrocarpa Michx., at Plain City, July 9, 1960 (MK). According to Ferris (1937) this species is also known from California, Florida, Texas, and Mexico.

The accompanying illustrations are based on the above listed material.
Genus *Unaspis* MacGillivray


**Scale of Female.**—Oystershell-shaped or pyriform, brownish; exuviae terminal.

**Female.**—Spindle-shaped, tapering toward the head.

**Pygidium.**—A median furrow between anus and median lobes. Three pairs of lobes; median pair non-zygotic, second and third pair deeply bilobed. Dorsal ducts numerous; marginal ducts slightly larger than other dorsal ducts. Perivulvar pores in five groups or absent. Anal opening round, on the anterior half of pygidium.

**Type of the Genus.**—*U. acuminata* (Green).

*Unaspis euonymi* (Comstock)

*Chionaspis euonymi* Comstock, 1881, p. 313; Fernald, 1903, p. 216; Sanders, 1904b, p. 45; Houser, 1918, p. 293; MacGillivray, 1921, p. 325; Miller, 1922, p. 60; Hollinger, 1923, p. 23; Britton, 1923, p. 363; Felt and Morrison, 1928, p. 198; Lupo, 1938, p. 272; Sleesman, 1945, p. 44. *Unaspis euonymi* (Comstock), Ferris, 1937, Ser. I:130; Rao, 1949, p. 62; Borchorstius, 1950, p. 196; Balachowsky, 1954, p. 294; Schuder,
Fig. 56. - *Quernaspis quercus* (Comstock)

Fig. 57. - *Unaspis euonymi* (Comstock)

**Common Name.**—Euonymus scale.

**Scale of Female.**—Oystershell-shaped, broad, dark brown with gray margin; length 1.6-2.0 mm. Exuviae yellow.

**Female.**—Spindle-shaped, tapering anteriorly, laterally lobed, widest at second abdominal segment; live specimens orange yellow (yR 17.5-7/10); length on slide 1.2-1.4 mm.

**Pygidium.**—Broad, sclerotized at apex. A median furrow extends from anus to median lobes. Median lobes close together, definitely non-zygotic, elongated, tapering toward apex; second and third pair well developed, deeply bilobed; fourth pair indicated by a sclerotized area. Gland spines slender, usually 3-4 on the margin of fourth segment, others in pairs. Dorsal ducts numerous, all of about equal size, scattered, some arranged in more or less definite rows. Few ventral ducts present. Perivulvar pores in five small groups as follows: median 4-5, anterior laterals 6-8, posterior laterals 4. Anal opening round, its diameter about the same as the length of median lobes.

**Scale of Male.**—Elongated, tricarinate, white, length 0.8-1.2 mm.


Euonymus bungeana Maxim., Columbus: OSU, Feb. 27, 1961 (MK).


Additional Biological Data.—Mated females overwintered in Central Ohio during the winter 1960-61. Larvae of the first generation appear in May and may continue to emerge throughout June; those of the second generation emerge during the second half of July. Males emerged between Sept. 20—Oct. 8 (1960) in Columbus. At least two yearly generations occur in Ohio. This species has a tendency to cover the surface of twigs in a coherent layer.

Parasites Reared.—Eulophidae: Aspidictiphagus sp., and Prospaltella sp.

Acarina Associated.—Acaridei: Acaridae: Thyreophagus entomophagus (Laboulbenia); Mesostigmata: Phytoseiidae undet.; Tarsonemini: Tarsonemidae undet.
Economic Importance.—Neiswander (1958) reported from Ohio:
"The euonymus scale is one of the more troublesome pests of ornamental plants because it multiplies rapidly and is difficult to control."

The accompanying illustrations are based on material from the already listed Celastrus scandens L.
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AUTOBIOGRAPHY

I, Michael Kosztarab, was born in Bucharest, Romania, July 7, 1927. I received my secondary-school education in the public schools of Rákoskeresztur and Budapest, Hungary. I graduated from the Municipal School of Horticulture, Budapest, in 1947; received my degree of "Ingénieur Horticuluteur" from the Hungarian University of Agricultural Sciences, Budapest, in 1951, where I specialized in Horticultural Entomology. I worked in Budapest for the Hungarian Bureau of Plant Protection, between 1947 and 1950 and I was appointed to teach as an assistant professor at the College of Horticulture and Viticulture, Hungarian University of Agricultural Sciences, Budapest, between 1951 and 1956. I worked as a consulting entomologist for the Insect Control and Research, Inc., Baltimore, Maryland, between 1957 and 1960. Since 1960 I have been employed as research assistant by the Ohio Biological Survey while completing the requirements for the Doctor of Philosophy degree.

I have accepted a position as Associate Professor in Entomology at the Virginia Polytechnic Institute.