

DESCRIPTIONS OF FOUR NEW FORMS OF  
ERIOPHYES.<sup>1</sup>

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Preliminary to a study of four Eriophyid galls occurring very commonly in Massachusetts, New York, and New Jersey, it was necessary to determine the taxonomic position of the causative parasites. As a result of examinations of many specimens from each gall collected over a period of several months these mites were determined to be new forms of *Eriophyes* and a detailed description was made to indicate the relationship of each of these forms. Comparisons with already known and described species are given in the case of each mite hereafter described, together with a figure showing the more characteristic distinguishing features.

The material from which the present data were taken was collected primarily in the Arnold Arboretum, Forest Hills, Mass.; additional material was collected from southern New York and northern New Jersey. The mites and the host or hosts with which each is associated are as follows: *Eriophyes celtis*, sp. n. on *Celtis occidentalis* L. and *Celtis occidentalis canina*; *Eriophyes rudis dissimilis*, subsp. n. on *Betula lutea* Michx. f.; *Eriophyes eucricotes multistriatus*, var. n. on *Lycium halimifolium* Mill.; and *Eriophyes fraxinivorus americanus*, var. n. on *Fraxinus americana* L.

The taxonomy of the Eriophyidæ has been and still is a problem. The rules for the systematic separation of the forms have been given in some detail by Nalepa (1924) but have been the source of disagreement between himself and Cotte (1925). Part of the trouble hinges on the question of the importance of physiological differences. What status

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shall be given to a form that is similar to another but is limited to a different host species? Shall we regard it as a variety, a species, or what?

The discussion of varieties Nalepa brushes aside with the remark: "Für den prakticken Cecidologen ist die Kenntniss der Varietäten der Arten and Unterarten bedeutungslos." According to his dictum one must distinguish between the fluctuating variations of a species within itself and the constant variations in a biological sense. Then: "Als Varietäten werden wir grundsätzlich nur jene Variationen des Arttypus bezeichnen, die das gleiche Cecidium auf verschiedenen, jedoch verwandten Wirtspflanzenarten verursachen." And ". . . erzeugen die Subspecies verschiedene Gallenformen auf ihrer gemeinsamen Wirtspflanze."

Cotte protests that much of Nalepa's work is useless and that a system of taxonomy can be acceptable only if fixed by common consent, not by one person. He condemns the subjugation of morphological to biological characters practiced by Nalepa, a new host is not sufficient evidence to establish a new variety. The objections of Cotte are justified provided Nalepa's rule is followed without any further confirming data. If distinct morphological characters are not forthcoming to distinguish the form in question, then controlled observations on the physiological limitation of this form to a certain host plant are necessary to justify establishing it as a variety or subspecies of another similar or even identical morphological form on a closely related species of host.

Where it has not been possible to control the infestation and so determine whether the mite forming an identical or similar gall is limited to the specific host and where the morphology of the mite itself is relatively close to a known species, but still different, after allowing for the variations within the species, I have considered it to be a variety of the species already described from a similar gall on a plant of the same host family. This is the case with the two new varieties presented in this paper. In the case of the one new subspecies, *E. rudis dissimilis*, the separation is based on differences of morphology in the mite and the gall form with which it is associated as well as its limitation to the

single host. It was possible in the case of *E. celtis* to check the limitation of the mite to the specific host and find that it was not adaptable to the host which is affected by what would appear to be morphologically a closely related form.

For a key to the genera of the family and the features used in classification one is referred to the work of Nalepa or of Hassan.

#### TECHNIQUE

The importance of reliable permanent preparations and the fact that the methods for making permanent collections have long been unsuccessfully sought justifies giving some attention to the methods and media used when new members of the various genera or species are described. It is very easy to obtain great numbers of these mites by drying a quantity of galls in open vials ringed inside at the top with glycerine to prevent the mites escaping. If these vials are then placed in a desicator out of any strong light or heat most of the mites will leave the galls in a few hours and will be found wandering about the sides of the vials (s. Nalepa, 1906 and Hassan, 1928). The question then arises how they can be kept permanently and studied at any time under the microscope. Various media have been tried and found quite useless for anything more than immediate study. In all these media (glycerine, glycerine and acetic acid, glycerine jelly, balsam, euparal, gum arabic solutions, water, alcohol, etc.), the mites are more or less distorted and shrunken or become almost transparent, so that in a short time the mounts are useless and new specimens are needed. Until recently, it was necessary to use alcohol for permanent collections and make new mounts from this material each time one desired to study the mites in question. The alcoholic material becomes hardened and breaks so easily that the specimens are useless for taxonomic work a few years after collection. Other media have the same or additional drawbacks. Apart from the temporary nature of these collections there are the factors of distortion and shrinkage to be considered, as well as the improbability of being able to re-examine the same specimens at any time.

Recently, Hassan (1928) developed a method for making permanent mounts of the Eriophyidæ by modifying a

method for manipulating small organisms. The mites are killed and cleared by heating them in a 10% solution of potassium hydroxide that is poured over them in the collecting vials after the plant tissues have been carefully removed. This solution containing the cleared mites is poured through a short piece of small glass tubing having at one end a guncotton plug in which the mites are caught as the solution passes through. The mites and the plug are then washed thoroughly with distilled water before the alcohols of various grades are passed through the tube to dehydrate and harden the specimens. After treating with absolute alcohol the guncotton plug is removed together with the entangled specimens from the tube and placed in a vial containing a solution of absolute alcohol and ether in equal proportions by volume. In this solution the guncotton dissolves and the mites settle to the bottom of the resulting weak solution of celloidin thus formed. A drop or two of this solution and great numbers of the mites can be easily removed by a pipette to a slide smeared with albumen fixative; the alcohol and ether evaporate rapidly leaving the mites embedded in a thin layer of celloidin. After reaching this stage the slides can be kept indefinitely before proceeding or they can be colored immediately in acid fuchsin, dehydrated, and cleared in carbol-xylol before sealing on a cover glass with balsam or euparal. This method has two disadvantages that necessitate careful checking of the specimens thus mounted and those freshly mounted in other media. The first of these results from the destruction of the body contents by the use of potassium hydroxide solution, thus removing the most reliable indicator of the maturity of the females, that is, the content of eggs within their bodies. Since the classification is based primarily on the mature females it is important that only mature individuals should be used when making measurements for descriptive purposes. Secondly, there is a disadvantage in the position the specimens assume when mounted by this method; the setæ and any slight curvature of the body become fixed during the hardening process and cause the specimens to roll upon their sides when transferred to the slides. The lateral aspect thus presented in these mounts makes it dif-

ficult, if not impossible at times, to determine the dorsal and ventral characters accurately.

An easier and quicker method that gives better temporary mounts for studying the specimens to be described and for checking the characters of specimens mounted in celloidin, is the iron-acetocarmine method of Belling (1926), which is used widely in cytology for studying pollen mother cells. Large numbers of mites and their eggs can be dislodged by dipping small pieces of the galls into a drop or two of this stain placed in the center of a slide. This must be done rapidly and a cover glass placed on immediately to prevent evaporation of the stain. The mites are fixed without distortion and only sufficient of the stain enters the body, unless the mite has been crushed during removal from the gall to the slide, to make the contents distinguishable. If the cover glasses are sealed on by several applications of gold size, euparal, or balsam, it is possible to keep such mounts a reasonably long period. They have the advantage of being very thin and specimens are spread out to display the ventral and dorsal aspects in most cases, rather than the lateral aspects presented in the celloidin mounts. The darker background of the stain together with the slight internal staining of the body makes it easier to distinguish many of the morphological characters. Neutral red may be used with much the same result as the acetocarmine. The advantages of these mounts are counterbalanced by their fragility and probable lack of permanence, though specimens mounted in this manner have been kept for a year in a state of good preservation.

### ***Eriophyes celtis*, sp. n.**

Hosts: *Celtis occidentalis* L., *Celtis occidentalis canina*.

In 1903 Di Corti described a mite, *Eriophyes bezzii*, from specimens found in colonies in deformed buds of *Celtis australis* L. The gall resulting from the parasitism of these mites is limited, according to his descriptions, to the arresting of the buds and their subsequent swelling. In the north-eastern United States there is a common gall consisting of a bud deformation associated with a witch's broom develop-

ment, that has been reported many times on *Celtis*. It has been attributed to the work of mites by some reporters and to the work of a fungus by others. No mites have ever been described from the gall though they were observed to be present in the buds. Kellerman and Swingle (1888) first observed this gall on the hackberry and attributed it to the activity of a fungus, which they described as *Sphærotheca phytoptiphila*, associated with a species of gall mite. Reuter, in 1903, cited it as an interesting case of coparasitism on the basis of their investigations, while Cook (1904), Chadwick (1907), and Felt (1917) considered the mites alone responsible but did not study the gall or mites. In examinations of these galls I have always found an abundance of the mite, *E. celtis*, and usually the mycelia of a fungus as well in the swollen buds where the gall formation has its origin. Only experimentation will be able to decide as to the part played by each of the factors present in these galls. It seems very likely that the mites are mainly responsible, since the fungus, if it is the one described by Kellerman and Swingle, belongs to a group not associated with witch's broom formations.

The morphological characters of the mites found in these deformed buds of *C. occidentalis* differ quite distinctly from those of *bezzii* described by Di Corti. The body size is nearly twice as large, although part of this difference may be attributed to the shrinkage of Di Corti's specimens which were preserved in alcohol. The shield has a clear design of ridges and is more nearly semi-circular than semi-elliptical; the sternal ridge is bifurcate, not simple; and the setæ are all much longer and have different relative lengths. The accessory setæ are present, not lacking as in *bezzii*. Figure 1 illustrates the characters that are given in the following description of *celtis*.

The cylindrical body of the mature female is more than four times as long as broad, about 270 microns in length and 60 microns in width. The thoracic shield is semicircular with three distinct ridges usually in the center field projecting above the plane of the shield and giving it a jagged anterior border; in the side field a ridge curves back from

the region of the anterior border of the shield to the region above the setal tubercles near the posterior border. The dorsal setæ (c. 34 microns) arise from the prominent tubercles at the posterior border of the shield. The legs are short and comparatively stout; the tibia and tarsus are equally long (c. 6 microns); the feathered claw is large and five-rayed; the bristle claw of the first pair of legs is as long as the feathered claw while that of the second pair slightly overreaches it; the epimera are short; the sternal ridge is distinctly bifurcate and reaches to the level of the inner corner of the epimera. The first pair of thoracic setæ are short (c. 10 microns) and stiff, the second pair are of medium length (c. 30 microns), and the third pair are very long (c. 50 microns). The abdomen tapers slightly in the posterior fourth and ends in a small telson that bears the long flagellate caudal setæ (c. 120 microns) and the short (c. 6 microns), acicular accessory setæ. The rings of the abdomen are broad, about 60 in number, and there are numerous tubercles relatively close together on the ventrum but usually lacking on the dorsum. The last five rings are without any tubercles but have longitudinal striations ventrally. The epigynum is broad (c. 30 microns) with a smooth anterior flap and an arched, slightly keeled, posterior one. The genital setæ (c. 25 microns) are more or less posterior to the plane of the genital opening. The lateral setæ arise about three striæ posterior to the plane of the epigynum and are about the same length as the dorsal setæ (c. 34 microns). The first pair of ventral setæ are the longest (c. 75 microns), the second pair are the shortest (c. 20 microns) and the most nearly median of the ventral setæ, the third pair are about 38 microns long and comparatively coarse. Measurements of other setæ: outer setæ c. 30 microns, maxillary setæ c. 6 microns, claw bristle of the first pair of legs c. 8 microns, of the second pair of legs c. 10 microns, femoral setæ c. 12 microns.

Although it does not at any time effect a witch's broom formation, there is another factor to be considered in the deformation of the buds of the same hosts as those of *E. celtis*. This is the hemipteron, *Pachypsylla gemma* Riley, which often causes galls involving the deformation of buds

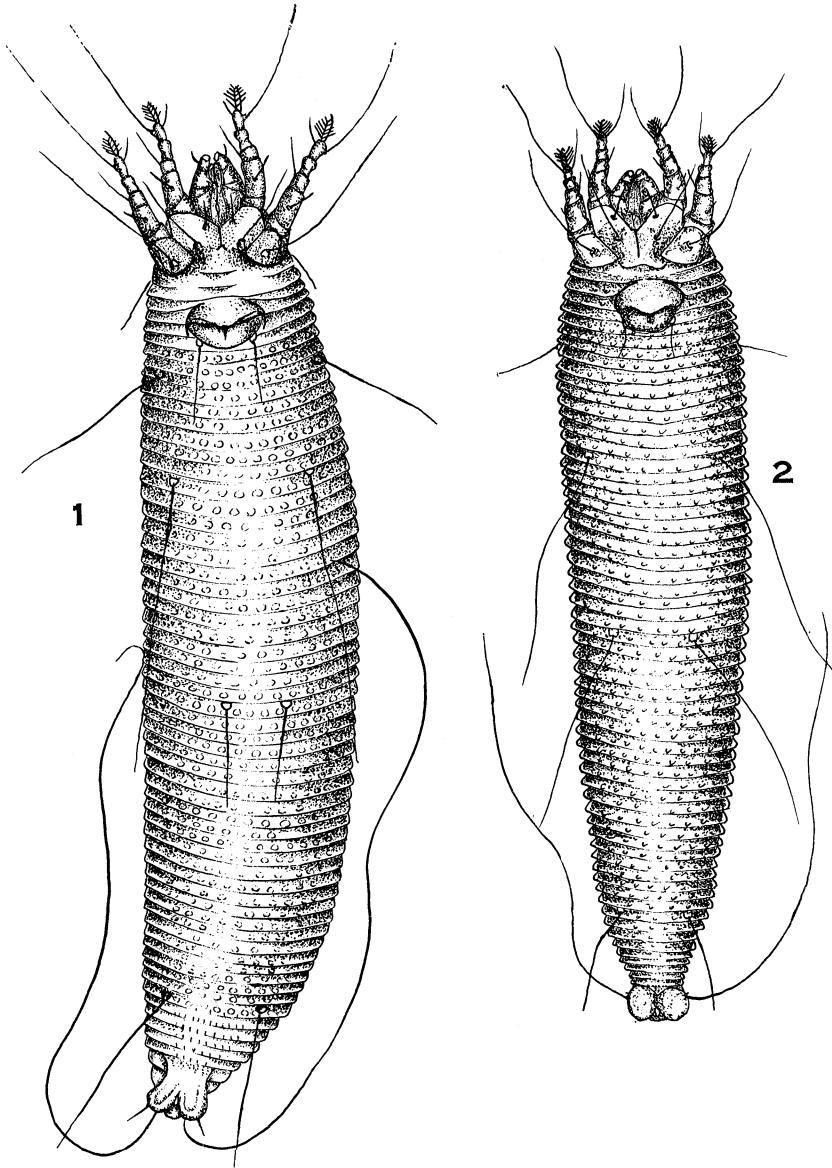


Fig. 1. Ventral view of *Eriophyes celtis* sp. n.

Fig. 2. Ventral view of *Eriophyes rudis dissimilis* subsp. n.



into woody capsules. In one case it was observed that both it and the mites had attacked the rudimentary leaves of the same bud. The close association and limitation of these two parasites to the same host and same portion of the host may possibly be used to explain the very wide distribution of the mites over the same plant and over all the host plants in the neighborhood, even when these are widely scattered. The mature mites may be disseminated by the winged *Pachysylla* females when the latter seek out the new buds in the early spring migration. This migration period of the hemipteron coincides nicely with the requirements of the mites for favorable infestation, occurring as it does before the buds expand.

In a mixed group of species of *Celtis* (*C. australis*, *C. Bungeana*, *C. Douglasii*, *C. laevigata*, *C. occidentalis*, and *C. occidentalis canina*) in the Arboretum it was possible to experiment with the limitation of the mite to its host plant. To make sure that it was not because it could not reach the other species of the same genus of host plant artificial infestations were carried out. None of the other species of the host unaffected under natural conditions reacted to the mites placed in their buds, or else the mites failed to find the host suitable and did not attack it. These infestations merely substantiate the condition of limitation or specialization of a species to a single host species, a condition that appears to be very general in the Eriophyidæ.

***Eriophyes rudis dissimilis* subsp. n.**

Host: *Betula lutea* Michx. f.

The typical species of this mite was described by Canestrini from *Betula verrucosa* Ehrh. and *Betula pubescens*. Nalepa (1898) attributed to it the formation of both the erineum of the leaves and the bud deformation of these hosts. Later, in 1919, he differentiated the form producing the bud deformation and associated with a witch's broom formation on *B. verrucosa* as a subspecies, *calycophthirus*, of the typical *rudis* found in the erineum. In their list of galls and producers Ross and Hedicke (1927) give *B. nana*,

*pubescens*, *urticifolia*, and *verrucosa* as hosts of this subspecies; it has also been considered as the cause of the bud deformations of *B. lutea*. However, the mite found in the deformed bud masses of this latter host differs distinctly from either the typical species or the subspecies described by Nalepa. It has a larger body size, more striæ, and a pair of accessory setæ setting it off from the typical species. From the subspecies mentioned it differs in the possession of the accessory setæ, larger body size, and shortened shield. The gall produced by *dissimilis* is quite different from that of the other two forms mentioned and appears to be limited to the single host from all reports and collections, as well as not being associated with a witch's broom formation. The early descriptions of the gall were made without any attempt to give the species of mite causing it. In 1909 Stebbins described the gall again from the same host and attributed it to a new species of mite, *Eriophyes betulæ*, without examining the mite and giving a description of it. Unfortunately, the name thus chosen had already been used by Nalepa to designate the species of mite producing the pouch gall on *Betula verrucosa* in middle Europe and southern Tyrol. Figure 2 represents the morphological characters of the mite whose description follows.

The body is cylindrical, tapering gently from the thoracic shield to the telson; the female measures about 240 microns in length and about 55 microns in width. The thoracic shield is semi-elliptical, clearly delimited posteriorly and rounded off anteriorly; the center field has three full length wavy ridges traversing it, the two outer ones diverge toward the posterior border of the shield; on the side there is usually an indistinct ridge from the region of the anterior border curving back about the setal tubercles near the posterior border. The dorsal setæ are coarse and about 20 microns in length. The rostrum is short, stout, and ventrally curved. The legs are relatively short; the tarsus and tibia are equally long (c. 5 microns); the claw bristle (c. 10 microns) is curved and slightly overreaches the feathered claw of the second pair of legs and equals that of the first pair; the feathered claw is large and four-rayed; the outer setæ are

long (c. 25 microns) and fine; the inner setæ are very short. The sternal ridge reaches to the region of the inner corner of the epimeron and is not forked. The first pair of thoracic setæ are short (c. 8-microns), the second are anterior to the plane of the posterior end of the sternal ridge and about 30 microns in length, the third pair are the longest (c. 45 microns). The abdominal rings, about 80 in number, have a distinct row of small, well separated tubercles along their posterior border but in the last five these are replaced by ventral longitudinal striations. The epigynum is about 20 microns in width and lies immediately posterior to the cephalothoracic region; the lower flap is hemispherical and slightly keeled; the upper is smooth and either flat or slightly arched. The genital setæ are lateral and about 12 microns in length. The lateral setæ are below the plane of the epigynum, are fine, and are about 20 microns in length. The first pair of ventral setæ are the longest, about 60 microns, the second are the most median in arrangement and about 50 microns in length, the third are the coarsest and shortest (c. 20 microns). The short, broad telson bears the long caudal setæ (c. 90 microns) and the very minute accessory setæ (c. 4 microns).

**Eriophyes eucricotes multistriatus var. n.**

Host: *Lycium halimifolium* Mill.

The typical form of this species was described by Nalepa in 1892 from specimens collected from pustules of the leaves of *Lycium europæum* L. and *Lycium mediterraneum* Dun. occurring in southern Europe and Algiers. The mite from *Lycium halimifolium* produces a gall very similar to that of the typical species, namely, a pustule on the leaf, but in addition attacks the young twigs, petioles, floral leaves, stamens, and ovaries of the host. Besides its apparent limitation to a different host there are constant morphological characters that distinguish *multistriatus* from the typical form: the abdominal striæ are uniformly greater in number, the tuberculation of the abdominal rings is both dorsal and ventral in distribution, is finer and more abundant, and

the stature of the mite is larger. Figure 3 illustrates most of the distinctive characters which are given in the following description of this variety.

The mature female is orange-yellow and measures about 250 microns in length and 70 microns in width, compared to 210 microns by 50 microns in the typical species. The thoracic shield is very small, triangular, and either smooth or traversed by indistinct ridges. The dorsal setæ arising from large tubercles at the posterior edge of the shield are long (c. 40 microns) and slender. The legs are relatively short and weak; the feathered claw is five-rayed, the claw bristle of the first pair of legs is shorter than that of the second but still exceeds the length of the feathered claw. The sternal ridge is not forked and does not reach quite to the line of the inner corner of the epimeron anterior to which the second pair of thoracic setæ (c. 20 microns) arise. The third pair of thoracic setæ are the longest, about 60 microns, the second pair are the shortest, as usual, and anterior to the plane of the anterior end of the sternal ridge. The rings of the abdomen are relatively narrow, about 80 in number, with abundant fine tuberculations both dorsally and ventrally—the typical form has 60 rings with widely separated tubercles. The epigynum is very small, about 16 microns broad, with an unmarked cover-flap. The lateral setæ are about as long as the dorsal ones and are approximately in the plane of the epigynum. The first pair ventral setæ are the longest (c. 65 microns); the second pair are the shortest and most median (c. 30 microns); while the third pair are relatively coarse and about as long as the dorsal setæ. This last pair of setæ reach over the telson which is comparatively small and bears the long flagellate caudal setæ (c. 120 microns) and accessory setæ that are coarse and about 7 microns in length.

This variety of mite was very convenient for carrying out experimental infestations to determine the connection between the mites and the various abnormalities observed in the plants tissues. Experiments were carried on in the greenhouse during the winter with plants grown from seeds and cuttings. Unaffected plants of *Lycium* were readily in-

fested by mites taken from old galls on the leaves of others. Beginning with a single gall the infestation spread over the young plant so rapidly that by the time it had grown several inches in height the expanding leaves had their surfaces entirely covered with the developing pustules. Young plants growing from seed in the same pot as the infested cutting showed galls on their first foliage leaves but not on the cotyledons. The spread of the infestations can readily be followed upward over the new hosts. Other species of Solanaceous plants, *Solanum capsicastrum*, *Nicotiana Langsdorffii*, *Datura Wrightii*, and *Capsicum pyramidale* were used in these experimental infestations without any positive results.

**Eriophyes fraxinivorus americanus var. n.**

Host: *Fraxinus americana* L.

In 1885, Karpelles described a mite, *E. fraxini*, which he found abundant in the galls commonly known as "Klunkern" occurring on ash and described by Löw in 1874. These galls were found to arise from the deformation of the floral parts of *Fraxinus excelsior* L. and *Fraxinus viridis* Bosc. into a monstrous ball-shaped mass covered with an almost colorless pubescence and resembling the upper parts of the cauliflower. In America there has been some confusion and uncertainty concerning the relationship between like masses of tissue and the gall mites. Felt (1906) reported fringed, lobulated balls of deformed staminate flowers of the white ash and considered the mite that he found in them as a new species, *E. fraxiniflora*, without describing it or comparing it with that already described by Karpelles from a similar gall in Europe. Another gall arising from the deformation of the terminal buds of the white ash where development is arrested and a mass of small twisted leaf ends replaces the normal foliage was first reported by Garman in 1882. Failing to find any mites in his specimens he considered it was probably a fungoid growth. On the basis of Felt's assurance that mites were found in the masses arising from staminate flowers this other foliose mass was also listed as resulting from mite parasitism without any search for or study of the mites themselves.

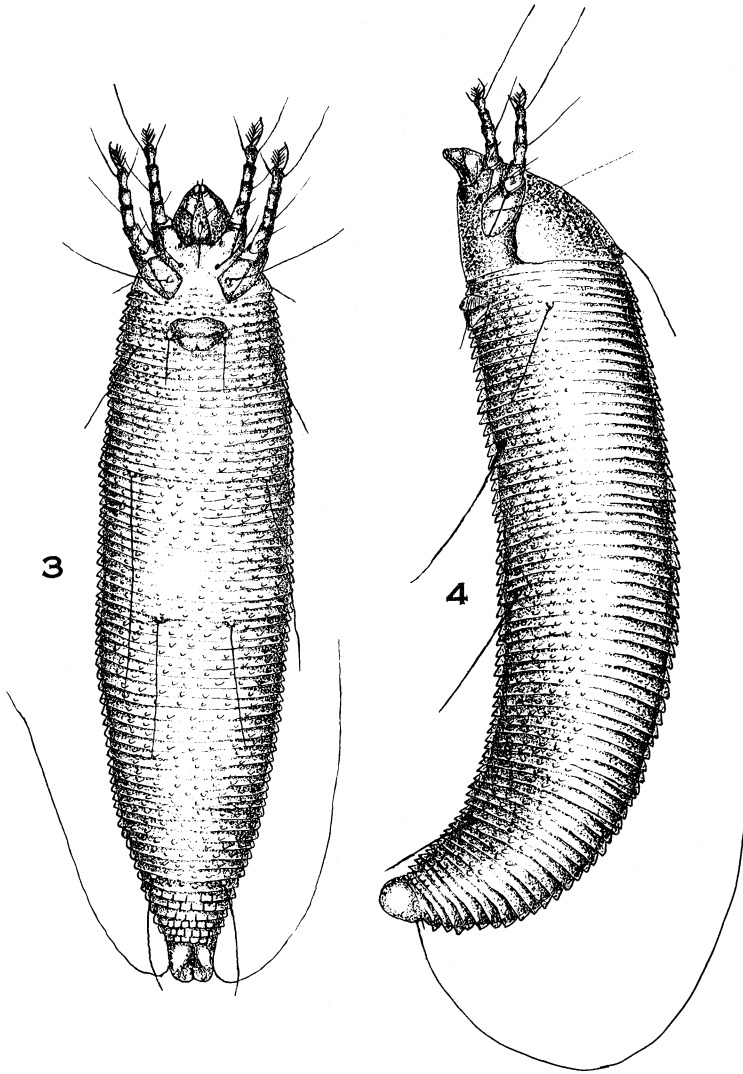


Fig. 3. Ventral view of *Eriophyes eucricotes multistriatus* var. n.

Fig. 4. Lateral view of *Eriophyes fraxinivorus americanus* var. n.

The gall of *americanus* is the one characterized by a mass of fasciated foliage tissue that Garman noted. I was not able to obtain any of the flower galls described by Felt so could not determine if the same variety of mite is responsible for the two deformations. Large numbers of mites were collected from the foliose masses and determined as a variety of the typical form first described by Karpelles as *fraxini* but known now as *fraxinivorus* Nal., since the former name had been used by Garman two years prior to Karpelles to designate the mite producing capsule galls on ash leaves. Figure 4 is a lateral view of the variety *americanus* whose description follows.

This mite is to be distinguished from the typical species, apart from the differences of host and parts involved, by the unforked sternum, greater number of striae, differences in the relative lengths of the ventral setae, shorter accessory setae, and much greater body size.

The body is long, about 250 microns in length and 55 microns in width for the female, and has a small cephalothorax. The thoracic shield is semi-elliptical, smooth, or traversed by indistinct longitudinal ridges. The dorsal setae arise near the posterior border and are about 30 microns in length. The legs are short and slender, the tarsi are longer than the tibiae; the feathered claw is four-rayed; the bristle claw, about 10 microns, is longer than the feathered claw of either pair of legs; the patellar setae are about 24 microns in length; the inner setae of the tarsi are about 4 microns, the outer ones about 25 microns long. The first pair of thoracic setae are very short and lie forward of the plane of the anterior end of the sternum; the second pair are median in length and lateral to the posterior end of the sternal ridge which is not forked; the third pair are the longest, about 40 microns. The abdomen has 75-80 rings that are tuberculated rather finely on the ventrum but with more sparsely distributed tubercles on the dorsum; the last five rings are without such tubercles and are longitudinally striated ventrally. The abdomen ends abruptly in a short telson that bears the very short accessory setae, about 6 microns, and the caudal setae that are about half the length

of the body. The epigynum is comparatively small with the anterior flap longitudinally striated and the posterior one slightly keeled. The lateral setæ are in the same plane as the epigynum and about 30 microns in length. The first pair of ventral setæ are the longest (c. 44 microns), the second pair are about the same length as the lateral setæ but coarser, the third pair are rather coarse and the shortest (c. 20 microns) of the three pair.

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