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Eriophyid Studies XI

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ERIOPHYID STUDIES XI

H. H. KEIFER, State Department of Agriculture

Eriophyid Studies X appeared in the Bul. Cal. Dept. Agr., Vol. 29, No. 3, p. 160, Oct. 23, 1940. The present installment is in two parts: an account of the blueberry budmite; and, second, the description of new Eriophyids. In the second part, eight mites are figured, of which five are considered as new species. Of the remaining three mites, one has been figured in Eriophyid Studies III.

PART I

The Blueberry Budmite, *Eriophyes vaccinii* K.[1]

During the last few years cultivated blueberry bushes in southeastern North Carolina have been suffering from reddish roughening and stunting of the fruit clusters. This injury, which was first noticed a few years ago, increased in severity until in 1939 it was feared that commercial blueberry growing in North Carolina was seriously threatened.

Examination of the deformed fruit clusters revealed the presence of numerous Eriophyid mites. Collections of these damaged fruit clusters were made in March and April of 1939 from cultivated Rancocas plants on the Huntington property near Atkinson, N. C., where the damage was severe, and forwarded to the writer via the United States Bureau of Entomology and Plant Quarantine. The mite was described as *Eriophyes vaccinii* n. sp., Bul. Cal. Dept. Agr. Vol. 28, p. 329, July 7, 1939. Arrangements were subsequently made for the writer to survey the eastern coastal section of the United States, under the auspices of the United States Bureau of Entomology and Plant Quarantine for the purpose of gaining preliminary data on this budmite. This survey was carried on throughout May and part of June 1940.

ACKNOWLEDGMENTS

The survey was arranged by D. L. Van Dine, in charge of the Division of Fruit Insects, Bureau of Entomology and Plant Quarantine, U.S.D.A. Dr. B. A. Porter, Senior Entomologist was also concerned. Many helpful suggestions were made by Dr. G. M. Darrow,[2] Senior Pomologist in charge of small fruit breeding, Bureau of Plant Industry, United States Department of Agriculture, who is principally concerned with the importance of the blueberry budmite. Dr. Darrow has furnished data on budmites in Massachusetts, and contributed observations in western New York and in Michigan.

[1] See also Fulton—Jr. Ec. Ent. Vol. 33, No. 4, p. 699, August 1940.

[2] Additional specimens of infested blueberries have been received from Dr. G. M. Darrow in 1941 as follows:

Midway, Ga., Mar. 20, *Vaccinium elliottii*
Jacksonville district, Fla., Mar. 21, *V. amoenum* (?)
Tallahassee district, Fla., Mar. 24, *V. elliottii*
Appalachicola district, Fla., Mar. 24, *V. fuscatum*
Valdosta, Ga., Mar. 27, *V. fuscatum*

Local help was given by G. A. Meckstroth, Associate Pathologist, Bureau of Plant Industry, and by Dr. B. B. Fulton of the North Carolina State College in southeastern North Carolina; Mr. W. J. Reid, Assistant Entomologist, Bureau of Entomology and Plant Quarantine, of Charleston, in eastern South Carolina; Sam Fredson at Brunswick, Georgia; Drs. H. H. Zimmerley and H. G. Walker of the Virginia Truck Experiment Station near Norfolk, in southeastern Virginia; C. S. Beckwith and C. A. Doehlert of the State Cranberry and Blueberry Research Laboratory in the Camden district of New Jersey; and last by L. J. Padget, Senior Plant Quarantine Inspector of the Bureau of Entomology and Plant Quarantine, and staff, at Gulfport, Mississippi.

The botanical determinations of the Vacciniaceous hosts of the blueberry budmite were made by Dr. W. H. Camp of the New York Botanical Gardens, through the office of Dr. C. H. Muller, Assistant Botanist, Division of Plant Exploration and Introduction.

Description and Relationships

The blueberry budmite is a white, minute, wormlike, four-legged Arachnid, about 200 microns or 1/125 of an inch long. It is therefore invisible to the unaided eye. It belongs to the species group in the genus *Eriophyes* possessing shield setae directed backwards. Specifically, this budmite is characterized by the shield pattern with a pair of obscure curved lines toward the rear center between the shield setae, by the nature of the granules below the dorsal tubercles, by the stumpy legs without a foretibial seta, and by the longitudinal furrows on the female genital coverflap. The lack of a foretibal seta is one of the best diagnostic features as few mites are without it. The nearest relative of *Eriophyes vaccinii* which the writer has so far seen is the redberry mite of western *Rubus* namely *Eriophyes essigi* Hassan. This latter mite also lacks the foretibial seta but differs in shield pattern and the genital coverflap furrows.

Injury Caused by the Mite

The typical injury caused by the blueberry budmite on wild plants of the genus *Vaccinium* is an unnatural succulence and epidermal roughening or blistering at the bases of the fruit bud scales, causing them to hang in a tight rosette at the base of the fruit stem. The base of the fruit stem is also usually blistered, retaining the juvenile red color of growing Vacciniaceous tissue. This surface roughening is in some respects comparable to the inside of certain leaf galls formed by other species of Eriophyids on other kinds of plants. Thus there is in the case of the blueberry budmite work an approach to gall formation at the base of the fruit clusters, which deformity can be considered a pseudo-gall.

The above described plant modification does not prevent the cluster from developing fairly normal fruit, though often on shortened stems. Frequently, but in a minority of cases, the red blistering extends to the calyx and petals (the blueberry calyx is attached to the outside of the ovary forming a berry with calyx teeth on the blossom end), roughening and deforming the berry. The petals, when blistered, have a tendency to partly fuse with the calyx. Severely attacked fruit clusters on certain wild plants remained in early summer only as drying rosettes

with the blistered and curled fruit stems lacking all signs of fruit. Normal fruiting bodies on other parts of these same plants were heavy with fruit at that time.

The fruiting clusters of cultivated blueberry plants in North Carolina are damaged on the average more severely than is the case with wild plants. More often than not the rosetting is accompanied by fruit roughening or deformation of the entire cluster. In New Jersey the rosetting of cultivated plants was not only less general than in North Carolina, but less often involved the fruit.

The mite seems to cause little injury to the vegetative parts of the plant. In Georgia, stems of cultivated plants were observed that not only had every fruit cluster completely deformed, but also had retarded leaf growth. This was exceptional. Near Burgaw, North Carolina, on June 1st the examination of terminal leaf buds near badly damaged fruit clusters on cultivated plants revealed a slight blistering of the bud. No uncultivated plant showed any vegetative damage by the mite.

The above indicates the damage by the blueberry budmite on several species of *Vaccinium*. Mites were observed on the Vacciniaceous *Gaylussacia baccata* that had caused rosetting, but no blistering. In this case the fruit was developing normally.

Life History of the Mite

While there is much to be learned on the particulars of the life history of the budmite, some of the general features seem to be discernible and can be suggested. In this case the term 'life history' does not refer to the activities of any one individual as that would be practically impossible to determine, but rather to the mass action of the population on the average rosetted blueberry plant.

The adult females overwinter in the outer fruit bud scales, like pear leaf-blister mite. As the spring temperature rises the females start egglaying and on the loosening of the bud they penetrate to the bases of all the bud scales producing rosetting and blistering by their feeding. The spring brood develops between the scales of the rosettes or between any other close together surfaces produced by the deformity, including in severe cases the base of deformed petals. This breeding continues, with full grown mites continually leaving the deformities until the pseudo-galls begin to dry in early summer. There is evidently an elapsed period of time between the total evacuation of the rosettes and the late summer formation of new fruit buds. The mites eventually make their way to the new fruit buds, from whatever cover they can find in leaf axils and terminal buds in the meantime. Additional reproduction must take place in the fruit buds during the fall.

The blueberry budmite feeds and breeds entirely under cover and the pseudo-gall is developed to furnish protection and suitable feeding tissue for the young mites. The particulars of summer and fall activity of the mites, how much time elapses between the drying of the spring rosettes and the development of the fall fruit buds, and what goes on in these fall fruit buds, remain to be investigated.

Scouting for Blueberry Budmite

The spring of the year seems to be one of the best if not the best time to examine blueberry bushes for budmite. The presence of the

mite can be quickly detected on any bush during that period by the rosette of tight bud scales at the base of some or many of the fruit (flower) clusters. Occasionally, uninfested fruit clusters will be found with clinging bud scales. These scales either drop off at a touch or are separated along the fruit stalk. Further, and conclusive evidence of mite presence can be gained by examining the suspected fruiting body with a 10-power hand lens. If either the mites are seen as minute white worms among the scales, or blistering of the epidermis is evident, or both, the presence of the mite is established.

Eriophyid mites that produce no plant deformity are most easily found with some exceptions during the summer and early fall when they have established a large population. Gall formers may be detected as soon as the deformities start in the spring. The injury caused by the blueberry budmite is in some respects a gall, and since it affects the fruiting body, which is the first part of the plant to develop in the spring, this injury discloses the presence of the mite at a very early period. However, unlike more highly organized plant galls, the scale rosette of the blueberry budmite seems to function as a mite breeder no later than early summer, so the mites must sequester themselves on other parts of the plants for the remainder of the year. When the scale rosette has dried and dropped from the plant the only other recourse in determining the presence of the mite is to examine buds.

Since Eriophyids are invisible to the unaided eye, a sparce population of a mite on its host, when no deformation has been made, may not be discoverable. It is presumed that the feeding of a single female of the blueberry budmite in an opening blueberry fruit bud, would produce a visible deformity since Eriophyid leaf galls on various plants are easily seen and each is the work of one original individual or "stem mother." The blueberry budmite survey was therefore based on the presence of the typical deformity caused by the mite, namely the fruit bud scale "rosetting." The fact that the mite was found at the geographical extremes of the survey, and at most places visited in between, indicates this to be a sound procedure. Statements to the effect that the blueberry budmite was absent from any particular area should not, however, be considered to exclude the possibility that a very sparse, and for some reason nondeforming population was present, if other considerations indicate the mites could be there.

Distribution and Hosts

The blueberry budmite, a native North American species, has been found by the writer to occur on wild and cultivated Vacciniaceous plants, principally high bush types of the genus *Vaccinium*, on the Atlantic Coast from Bridgeport, Connecticut, to Brunswick, Georgia, and at Gulfport, Mississippi. More recently (August) Dr. Darrow has advised of the presence of the mite on cultivated plants near East Wareham, Massachusetts. The inland range of the mite remains to be thoroughly investigated. The writer found the mite on the Vacciniaceous *Gaylussacia baccata* at about 2,000 feet elevation on the skyline drive at the top of the ridge just west of Sperryville, Virginia. Dr. Darrow states that cultivated and wild blueberries in western New York and in Michigan do not indicate the presence of the mite.

The above data imply that this budmite has a coastal range approximately the same as that of its host plants; from eastern Texas to Florida, and north to Maine and Canada.

The mite was not found on plants outside the Vacciniaceae. Eriophyids are, according to the species, nearly always confined to one species of plant, or a few closely related species. *Eriophyes vaccinii* was found on six species of *Vaccinium,* several hybrids and on *Gaylussacia baccata.* This indicates either an unusual ability of the mite to take advantage of different species, or that these species of plants are genetically quite close.

The impression was gained that considerable variation occurs among wild plants in regard to resistance to the attack of the budmite. However, apparent resistance may be either actual resistance, previous conditions unfavorable to the mite, unfavorable micro-environment, or local food-plant strains of the mite.

In some localities none of the wild blueberry plants showed mite damage and the mite was presumably absent. In other areas many native plants showed rosetting of the fruit budscales, or rosetting with flower and fruit damage. At least part of the plants in all places visited were unaffected. On the Huntington property at Atkinson, North Carolina, wild plants of both *Vaccinium australe* and *atrococcum* showing mite rosettes were in the minority. In southern Virginia a badly damaged *australe* was found interlocked with an *atrococcum,* the latter showing almost no rosetting. Blueberry bushes in deep shade, especially in shady bogs, proved to be usually normal and presumably mite-free. Shrubs identified as *Vaccinium australe marianum* in a shady bog east of Washington, North Carolina, showed no rosetting, whereas plants of this same hybrid on nearby semisunny sand flats showed many mite-altered fruit clusters. In other words, plants on dry sand flats, in open woods or on the margin of clearings, were most likely to show mite injury. A shady bog near Beltsville, Maryland, contained many blueberry bushes, all lacking signs of mites. A similar bog in the vicinity of Clayton, North Carolina, with a considerable blueberry population, yielded but one damaged shrub after some search. Mites were harder to find in rolling country due partly to the concentration of host plants in heavily forested ravines or bogs. Plants in heavy shade tend to fruit less vigorously than those in more open woods and this may account for the scarcity of mite injury in these places, since the mites are primarily dependent on the fruiting bodies. Blueberry sprouts in burned woods in South Carolina and Georgia were undamaged and yielded no mites.

The problems of resistance and micro-environments, being complicated studies, are properly the subject of a long-time investigation.

The susceptibility or resistance to mite attack of cultivated varieties of blueberries was not investigated. Since these commercial varieties in large part have no botanical standing (Pioneer, Cabot and Scammel are straight *Vaccinium australe*), since these varieties show great variability in the mite damage they sustain between New Jersey and North Carolina, and since the writer was unable to learn the varietal names of part or all of the plants in most cultivated fields visited, little information was gained along this line. Rancocas, Pioneer and Cabot varieties are all susceptible to the mite, both in

North Carolina and New Jersey, though usually undamaged or less severely damaged in the latter state. Cultivated plants showing the greatest damage were noted on the property of the Brunswick Peninsula Corp. eight miles north of Brunswick, Georgia. These plants, while referable to *V. australe,* were of no recognized commercial variety, having been transplanted from the wild. Bushes with every fruit cluster deformed, and even showing retardation in leaf growth, occurred in this field. However, most of the plants were not severely damaged, though many were infested. At Atkinson, North Carolina, and in other nearby localities, the 1940 fruit damage was not as great as that in 1939, though deformed, red bunches were still much in evidence. Cultivated blueberry plants fruit better on the average than wild plants and grow in little or no shade. Very few wild plants were observed growing in places receiving sun throughout the day.

The mite or its damage were not recognized in New Jersey prior to this survey. One field of bushes in New Jersey on the Braddock property at Chairville near Medford was observed to be generally infested and strongly rosetted, but the fruit in the infested clusters was much less severely affected than on the average in the infested clusters in North Carolina. Most of the fields visited in the area south of Pemberton, New Jersey, had extremely light infestations, explaining why the mite had not been recognized there. Wild bushes, within a few feet of the uninfested cultivated bushes in this area south of Pemberton, showed general infestation, though not severe on the average. The mites are as plentiful among the wild New Jersey bushes as among the North Carolina wild bushes. It is now realized that this mite injury has been observed in New Jersey for many years, but as it was never a problem it was not investigated.

The explanation of the difference in mite damage sustained by the same varieties of cultivated blueberries between southern New Jersey and southeastern North Carolina is not apparent from the results of this survey. It has been suggested that this may be a climatic factor as the bushes are mite infested in both states. The results of the host plant findings indicate the wild shrubs around the North Carolina plantings are largely *australe,* the species from which part or all of the cultivated berries were derived. In New Jersey such wild infested bushes as were found were *atrococcum* and *corymbosum,* but no conclusions can be drawn as to the significance of this fact on the basis of this data.

The hosts and localities of the blueberry budmite, as uncovered by the survey, are listed below. The abbreviation "aff." means "affinity to." The designation "X" indicates a genetic cross. No localities are listed for uninfested shrubs unless specifically indicated.

Gaylussacia baccata (Wang.) K. Koch. Low bush

Smithfield district, Va., May 20, 1940
Fruit budscale rosette and flower damage but no blisters

West of Sperryville, Va., skyline (about 2000 ft. elev.), June 4, 1940
Fruit budscale rosette, but no further damage. Similar damage was noted on what was likely this host near Pemberton, N. J., but no mites were observed.

Vaccinium amoenum Ait. High bush

Brunswick, Ga., May 13, 1940
Slight damage on cultivated bush
Severe damage on wild bush

Brunswick, Ga., 10 miles south, May 14, 1940
Some damage, rosette and blistering on wild bush

Vaccinium angustifolium laevifolium
Arnold Arboretum, Boston, Mass., July 31, 1940. G. M. Darrow

Vaccinium atrococcum (A. Gray) Heller. High bush
This species, which presumably does not cross with *australe* (see below) because of diploid chromosome condition (Darrow), is probably not a genetic component of any cultivated variety. It is generally infested by the budmite but seems to be usually resistant to severe injury. All bushes observed were uncultivated. All bushes seen south of North Carolina were uninfested.
Atkinson, Pender Co., N. C. May 4 and 6, 1940
Moderate infestation. Some fruit damage near large blueberry field, Huntington property.
Clinton, Sampson Co., N. C. 8 miles south. May 7, 1940
Ash, Brunswick Co., N. C. May 9, 1940
Valhalla, Edenton, N. C. May 18, 1940
Slight infestation in deep shade.
Petersburg, Va., 10 miles north. May 20, 1940
Slight infestation, in rolling country.
Viola, Delaware. May 24, 1940
Scrapetown, Pemberton district, N. J. May 27, 1940
Rowayton, Norwalk, Conn. May 29, 1940
Redding Ridge district, Conn. May 29, 1940
Mohansic Park, Peekskill district, N. Y. May 29, 1940
Port Republic, Md., May 30. (B. A. Porter Coll.)

Vaccinium australe Small. High bush
This blueberry is of particular interest as it is the species from which most, or all, of the cultivated berries have been derived. Part of these cultivated bushes are entirely *australe*, part hybrids. No wild bushes were collected north of central Delaware, nor south of Walterboro, South Carolina. Bushes throughout this area were infested, many severely.
Magnolia, Duplin Co., N. C. May 3, 1940
This was the Pioneer, Scammel and Cabot varieties, Crabbe property.
Atkinson, Pender Co., N. C. May 4 and 6, 1940
These wild plants were in partial shade near the large Huntington blueberry field: none were found showing generally severe attacks and some were uninfested.
Clinton, N. C., 5 miles south, May 7, 1940
By W. L. Peterson field
Clinton, N. C. May 7, 1940
Wilson Mills, Clayton district, N. C. June 1, 1940
Many bushes in a shady semibog; but one bush found infested.
Brunswick, Ga., 8 miles north. May 13, 1940
Cultivated bush on property of Brunswick Peninsula Corp. Most severe infestations seen.
Cypress Chapel, Nansemond Co., Va., May 18, 1940
Suffolk, Va., 4 miles south, May 20, 1940
Surry, Va., 3 miles west, May 20, 1940
New Bohemia, Petersburg, Va., May 20, 1940
Chickahominy River at highway No. 1, Richmond, Va., May 22, 1940
Blackbird district, Dela., May 24, 1940
In oak woods, all the others being in pine woods.

Vaccinium aff. australe Small. High bush
Magnolia, Duplin Co., N. C., May 3, 1940
Rancocas variety on Crabbe property.
Clinton, N. C., 5 miles north, May 7, 1940
Burgaw, N. C., 5 miles west, May 8, 1940
Rancocas on Ingram property.
Brunswick, Ga., 8 miles north, May 13, 1940
Plant in Brunswick Peninsula Corp. field.
Brunswick, Ga., 8 miles north, May 13, 1940
Hybrid on Fredson property.
Chairville, Medford, N. J. May 26, 1940
Rancocas in Braddock field. The plants in this field showed strong rosetting on nearly all the plants but the fruit was relatively uninjured.

Vaccinium australe X amoenum Ait (?). High bush.
Meggett, Charleston, S. C., May 11, 1940

Vaccinium australe X myrsinites X arkansanum. High bush
Wilson Nursery, Lyman, Gulfport, Miss., June 10, 1940
This bush was known as "rabbiteye" in the above locality and was but slightly infested in one part of the rows.

Vaccinium australe X marianum Wats. High bush.
Clinton, N. C., 5 miles south. May 7, 1940
Cultivated plants on W. L. Peterson property.
Washington, N. C., 6 miles east. May 18, 1940
Wild bushes on dry semishady sand flat. Part of these bushes were heavily infested

Vaccinium corymbosum L. High bush
Chairville, Medford, N. J. May 26, 1940
This wild bush adjacent to the Braddock property was severely damaged

Vaccinium corymbosum form **caesariense** (Mack.) Camp. High bush
Pine Grove, Medford, N. J. May 26, 1940

Vaccinium corymbosum form **glabrum** (Gray) Camp. High bush
Bridgeville, Del., 5 miles northwest. May 24, 1940

Vaccinium elliottii Chapm. High bush
This is a small-leaved, more southern species
Summerville at Ashley River Bridge, S. C., May 11, 1940
Wilson Nursery, Lyman, Gulfport, Miss. June 10, 1940
Uncultivated bushes in partial shade
McHenry, Stone Co., Miss., June 10, 1940
In scrub oak stand in rolling country, toward the top of a low hill

Vaccinium vacillans var. crinitum *Fern.* High bush
Easton district, northwest of Bridgeport, Conn., May 29, 1940

Vaccinium sp. Cultivated bushes
East Wareham, Mass., July 31, 1940, Darrow

Uninfested Vacciniums

While the main object of the survey was to find the blueberry budmite, and while less attention was paid to the Vacciniaceous plants not harboring the organism, some data has accrued concerning plants not infested. This data is offered for what it is worth. Bushes were examined in the vicinity of Myrtle Beach, S. C., May 10, Norfolk, Va., May 19, and Beltsville, Md., June 4, 1940, that were uninfested and were not sampled.

Gaylussacia frondosa (L) HG. Low bush
Atkinson, Pender Co., N. C. May 4, 1940
Common in the brush around the Huntington blueberry plantings
Has noticeably glandular leaves

Polycodium melanocarpum (Mohr) Small. Low bush
Wilson Nursery, Lyman, Gulfport, Miss., June 10, 1940

Polycodium stamineum (L). Low bush
Port Republic, Md., May 30, 1940. (B. A. Porter)

Vaccinium amoenum Ait. High bush
Walterboro, S. C., 4 miles east. May 11, 1940

Vaccinium aff. amoenum Ait. High bush
Coastal Plains Sta., Willard, N. C. May 8, 1940
Known at this station as "rabbiteye"
Brunswick, Ga., 4 miles northwest, May 13, 1940
Large heavy fruiting cultivated bushes on the W. A. Fraser property and said to have originated in the Glen St. Mary's Nursery. These bushes had leaves similar to the Rancocas variety of the culture farther north

Vaccinium atrococcum (Gray) Heller. High bush
Atkinson, Pender Co., N. C., May 4, 1940
Franklin, Sampson Co., N. C., May 7, 1940
Summerville, S. C., May 11, 1940
This was a high bush in deep shade
Brunswick, Ga., 8 miles north, May 13, 1940
This was a sprout after a forest fire on the Fredson Place
Kemblesville district, Pa., May 24, 1940
In a shady bog in rolling country
Oxford district, Pa., May 24, 1940
In shady bog
Amissville, Va., June 4, 1940
In heavy shade along creek

Vaccinium australe Small. High bush
Atkinson, N. C., May 4 and 6, 1940
Huntington property, wild bush, partial shade.
Elizabethtown, N. C., 3 miles south, May 9, 1940
Walterboro, S. C., 4 miles north, May 11, 1940
Small bushes
Beacon's Castle, Surry Co., Va., 3 miles south, May 20, 1940
Large bushes in heavy shade with flat leaf-sprays, fine fruit

Vaccinium aff. australe Small. High bush
Blackbird district, Delaware, May 24, 1940
Bush with flat leaf sprays

Vaccinium australe X myrsinites X arkansanum. High bush
Lyman, Miss., 2 miles west, June 10, 1940
Cultivated bushes known as "rabbiteye" and said to have originated in the Wilson Nursery

Vaccinium australe X marianum Wats. High bush
Washington, N. C., 4 miles east, May 18, 1940
Very tall bush in shady bog. Bushes of this same genetic makeup on sand-flats 2 miles east were infested.

Vaccinium elliottii Chapm. High bush
Pireway, Brunswick Co., N. C. May 9, 1940
This was a small bush in a shady bog.
Lyman, Gulfport, Miss., June 10, 1940
In heavy shade

Vaccinium myrsinites Lam (?). Low bush
Brunswick, Ga., 8 miles north, May 13, 1940
Low bush on Fredson place.

Vaccinium tenellum Ait. (or possibly a low phase of *V. amoenum* Ait.) Low bush
Walterboro, S. C., 4 miles east, May 11, 1940

Vaccinium torreyanum Camp. Low bush
Mathias district, West Virginia, June 4, 1940
This small blueberry was very common on the hills and ridges in western Virginia. No mites were found on it

PART II

Eriophyes paramackiei Keifer, new species

Plate 157, Fig. 8

Female 150-230 μ long, 35-40 μ thick, wormlike, whitish. Rostrum 9 μ long, slightly downcurved. Shield 42 μ long, 30 μ wide, median line short, at posterior edge, admedian lines distinguishable on rear half; sides granular; dorsal tubercles 17.5 μ apart, on rear margin; dorsal setae 4.5 μ long, projecting backward. Forelegs 22 μ long, tibia 4.5 μ long, tarsus 5 μ long, claw 6 μ long, slightly tapering, featherclaw 3 rayed. Hindlegs 21 μ long, tibia 4 μ long, tarsus 5 μ long, claw 7 μ long. Sternal line moderately long, the coxae somewhat microtuberculate. Abdomen with 60-65 rings, some ventrad reduction in ring number; all rings completely microtuberculate, the tubercles rounded. Lateral seta 24 μ long, on about ring 6-7; first ventral 36 μ long, on about ring 19; second ventral 12 μ long, on about ring 33; third ventral 17.5 μ long, on about ring 4 from rear; accessory seta present. Female genitalia 18.5 μ wide, 10 μ long, coverflap with about 8 to 10 rows of tubercles, seta 7.5 μ long. Male not studied.

Type locality Sacramento, California. **Collected** March 4, 1941, by the writer. **Host** *Quercus agrifolia* Nee, Coast Live Oak. **Relation to host:** The mites produce clusters of stunted twigs along the stems. These clusters grow slowly from year to year, harboring numerous mites in the buds along the short stems. **Type slide,** so designated, as above. **Paratype slides,** four in number, as above. This species is correlated with *E. mackiei* K., which produces erineum pockets on the leaves of this same host, but differs in the shield pattern and coverflap structure. It is also correlated with *E. waltheri* K., which produces similar stunted twigs on *Nothofagus*, but that species lacks the foretibial seta. The attacked trees from which *paramackiei* was taken show the twig and bud clusters throughout the lower sections. The upper parts of these trees do not look thrifty.

Eriophyes ilicifoliae Keifer, new species

Plate 158

Female 110-130 μ long, 30-35 μ thick, short-wormlike, light yellow. Rostrum 24 μ long, downcurved, antapical seta 6.5 μ long. Shield 23.5 μ long, 35 μ wide, admedian lines present to rear, sides with curved rows of granules; dorsal tubercles 14.5 μ apart, a little ahead of rear margin; dorsal setae 19 μ long, pointing ahead and upward. Forelegs 24.5 μ long, tibia 4.5 μ long, tarsus 6.5 μ long, claw 6 μ long,

slightly knobbed, featherclaw 4 rayed. Hindlegs 22.5 μ long, tibia 4 μ long, tarsus 6 μ long, claw 6.5 μ long. Sternal line short, coxae granular. Abdomen with about 50 rings, some ventrad reduction in ring number, the microtubercles strong and somewhat acuminate. Lateral seta 19 μ long, on about ring 6; first ventral 20 μ long, on about ring 17; second ventral 7 μ long, on about ring 28; third ventral 19 μ long, on about ring 4 from rear; accessory seta present. Female genitalia 18 μ wide, 12.5 μ long, coverflap with about 10 furrows, seta 9.5 μ long.

Male not seen.

Type locality: Rockville, Solano Co., California. **Collected** September 17, 1940, by the writer. **Host:** *Prunus ilicifolia* Walp., Hollyleaf cherry. **Relation to host:** The mites inhabit the terminal buds, maintaining a sparse population. **Type slide,** so designated, with the above data. This mite is correlated with *E. piri* Pgst., but has a distinctly different shield pattern.

Eriophyes essigi Hassan

Plate 159

Hassan—Cal. Univ. Publ. Ent., Vol. 4, p. 380, 1928
See also Index V of American Economic Entomology

Female 120-140 μ long, 28-30 μ thick, wormlike, whitish or very light amber. Rostrum 20 μ long, rather small; basal seta present, subapical seta apparently absent. Shield 23 μ long, 24.5 μ wide, median, admedian and a long submedium line present; many short lines and a lateral clear or marked lobe; side granulations; dorsal tubercles 17.5 μ apart, on rear margin; dorsal setae 19.5 μ long, projecting backward. Legs rather short and stocky. Forelegs 23.5 μ long, tibia 3.5 μ long, tibial seta absent, tarsus 5.5 μ long, claw 5.5 μ long, slender, tapering, featherclaw 4 rayed. Hindlegs 20.5 μ long, tibia 3 μ long, tarsus 5.5 μ long, claw 8.5 μ long. Anterior coxae fused with each other and with suboral plate, granular; hind coxae granular. Abdomen with about 65-70 rings, some ventrad reduction in ring number; tubercles pointed. Lateral seta 13.5 μ long, on about ring 7; first ventral 44 μ long, on about ring 19; second ventral 30 μ long, on about ring 38; third ventral 12.5 μ long, on about ring 6 from rear; accessory seta present, minute. Female genitalia 16.5 μ wide, 9.5 μ long, coverflap with two concentric, irregular half-rings and basal granules; seta 8 μ long.

Male 105-135 μ long, 25-30 μ thick.

Localities: Sacramento, California, June 19, 25, 26, 1940; Folsom, California, June 23, 1940; Paradise, California, July 2, 1940; Berkeley, California, July 10, 1940; all collections by the writer. **Host:** *Rubus vitifolius* C & S., blackberry and Mammoth blackberry. **Relation to host:** The mites were collected from the berries, but are also found in the buds at other times of the year. Further examples of these mites have been examined from Puyallup, Washington, on *Rubus* sp. This description is published to definitely characterize the red-berry mite. It is chiefly distinguished by the shield pattern, lack of foretibial seta, and transverse markings on the female genital coverflap. It's nearest known relative seems to be the blueberry budmite, *Eriophyes vaccinii* K.

Eriophyes aloinis Keifer, new species

Plate 160, Fig. 9

Female 190-220 μ long, 45-59 μ thick, wormlike, whitish to purplish. Rostrum 29 μ long, somewhat downcurved. Shield 40 μ long, 50 μ wide, median line present to rear, admedians complete; sublaterals distinct, curved, inter-branched; dorsal tubercles 27.5 μ apart, on rear margin; dorsal setae 35 μ long, projecting backward. Forelegs 31 μ long, tibia 6 μ long, tarsus 7 μ long, claw 11 μ long, attenuate, featherclaw 6 rayed. Hindlegs 29 μ long, tibia 4.5 μ long, tarsus 6.5 μ long, claw 10 μ long. Abdomen with 68-75 rings, completely microtuberculate, the tubercles slightly pointed. Lateral seta 34 μ long, on about ring 6; first ventral 52 μ long, on about ring 21, second ventral 50 μ long, on about ring 40; third ventral 33 μ long, on about ring 7 from rear; accessory seta present. Female genitalia 25 μ wide, 18.5 μ long, coverflap basally tuberculate with 7 to 9 furrows, seta 10 μ long.

Male not seen.

Type locality, North Hollywood. **Collected** November 18, 1940, by V. E. Williams. **Host:** *Aloe spinossissima,* Aloe. **Relation to host:**

The mites cause severe warting of the inner sides of the leaves. **Type slide,** so designated, with the above data. **Paratype slides,** five in number, as above. This mite is very close to *Eriophyes tulipae* K., but differs in details of the submedian shield lines, in having one less ray on the featherclaws, and in being heavily streaked with purplish when full grown.

Eriophyes medicaginis Keifer, new species

Plate 161

Female 150-180 μ long, 40-50 μ thick, wormlike, light yellow. Rostrum 23 μ long, somewhat downcurved, antapical seta 5 μ long. Shield 30 μ long, 35-40 μ wide, design obsolete, some acuminate tubercles at side; dorsal tubercles 27 μ apart, on rear margin; dorsal setae 24 μ long, projecting backward. Forelegs 32 μ long, tibia 7.5 μ long, tarsus 8 μ long, claw 8 μ long, tapering, featherclaw 5 rayed. Hindlegs 28.5 μ long, tibia 5.5 μ long, tarsus 6.5 μ long, claw 8.5 μ long. Abdomen with about 60 rings, the dorsal half-rings, faintly microtuberculate, anteriorly, practically nontuberculate on posterior third; ventral half-rings strongly set with acuminate microtubercles, and contrasting sharply with dorsum along side of body. Lateral seta 46 μ long, on about ring 7; first ventral 63 μ long, on about ring 19; second ventral 23.5 μ long, on about ring 36; third ventral 27 μ long, on about ring 6 from rear; accessory seta present. Female genitalia 21 μ wide, 15 μ long, coverflap with 10-12 furrows, seta 16 μ long.

Male 130-170 μ long, 35-45 μ thick.

Type locality, Sacramento, California. **Collected** February 20, 1940, by the writer. **Host:** *Medicago sativa* L., Alfalfa. **Relation to host:** The mites are found in the leaf axils. No damage appears to result from their presence. **Type slide,** so designated, with the above data. **Paratype slides,** one slide as above. This mite is characterized by the distinct change in microtuberculation along the lateral line. No *Medicago* mites so far described seem to be so characterized. The figures on the plate were drawn from mites taken in Fillman County, Oklahoma, September 17, 1940, by S. E. Lewis. The Oklahoma mites were found on plants showing a peculiar flower deformation, but this disease could not be correlated with the mites.

Anthocoptes hesperus Keifer, new species

Plate 162

Female 120-135 μ long, 40-45 μ wide, 35-45 μ thick, yellow to orange color, spindleform. Rostrum 30 μ long, curved down, setae moderate in size. Shield 40 μ long, 40 μ wide, a median broad ridge; dorsal tubercles 29.5 μ apart, on rear margin; dorsal setae 9.5 μ long, projecting backwards. Forelegs 29.5 μ long, tibia 7 μ long, tarsus 7 μ long, claw 7.5 μ long, knobbed, featherclaw 5 rayed. Hindlegs 27.5 μ long, tibia 4.5 μ long, tarsus 6.5 μ long, claw 7.5 μ long. Sternal line short. Abdomen with broad smooth back plates; the posterior 6-8 rings are distinct from those anterior; about 16 tergites; 50-55 sternites. Lateral seta 21.5 μ long, on about sternite 8; first ventral 48μ long, on about sternite 18; second ventral 12.5 μ long, on about sternite 32; third ventral 34 μ long, on about sternite 5 from rear; accessory seta present, small. Female genitalia 23.5 μ wide, 12.5 μ long, coverflap with about 10 furrows, seta 18 μ long.

Male 110-120 μ long, 40 μ wide, 35 μ thick.

Type locality, South Laguna, Orange County, California. **Collected** September 4, 1940, by the writer. **Host:** *Ceanothus cuneatus* Hook., Buckbrush. **Relation to host:** The mites are leaf vagrants, principally on the under surface. **Type slide,** so designated, as above.

Phyllocoptes eurynotus Nal.

Plate 163

Nalepa—Denk. Akad. Wiss. Wien, Vol. 62, p. 632, 1895
Nalepa—Marcellia, Vol. 25, p. 135, 1929

Female 160-200 μ long, 65 μ wide, 50 μ thick, light amber, spindleform. Rostrum 24.5 μ long, projecting down, antapical seta 8.5 μ long. Shield 53 μ long,

65 μ wide, design absent, anterior lobe prominent, two minute spines, sides of shield somewhat granular. Dorsal tubercles 40 μ apart, on rear margin; dorsal setae 15 μ long, projecting backward. Forelegs 36 μ long, tibia 9.5 μ long, tarsus 6.5 μ long, claw 7 μ long, knobbed, featherclaw 4 rayed. Hindlegs 32 μ long, tibia 8 μ long, tarsus 7 μ long, claw 7.5 μ long. Sternal line rather long, weakly divided posteriorly. Abdomen with broad, smooth tergites, a little roughened laterally, sternites strongly microtuberculate; about 29 tergites; about 60 sternites. Lateral seta 21 μ long, on about sternite 7; first ventral 40 μ long, on about sternite 23; second ventral 20 μ long, on about sternite 41; third ventral 30 μ long, on about sternite 4 from rear; accessory seta present. Female genitalia 25.5 μ wide, 18 μ long, coverflap with 14-16 furrows; seta 21 μ long.

Male 150 μ long, 55 μ wide, 45 μ thick.

Locality, Stockton, California. **Collected** October 4, 1940, by P. F. Wright. Host: *Apium graveolens* L., Celery. **Relation to host:** The mites brown the leaflets and stalks. This mite was described from another Umbelliferous plant, *Torilis infesta* Koch., but the mites on hand show no appreciable difference from the description of *eurynotus.*

The identity of the peach silver mite, *Phyllocoptes cornutus* Banks, is assumed to have been established in Eriophyid Studies III on the basis of the food plant. However, the writer has since felt that the taxonomy of this mite was still in an incomplete condition. To study the species further, silvered peach leaves were examined in late September and early October, 1940, but few living mites were present, the population being represented mainly by dry male carcasses. These leaf mites were of the type figured previously, that is, the back plates regularly divided into three or four sternites laterally.

To get more specimens, twigs from the same tree that was the source of the leaves were collected, and proved to be harboring numerous clusters of living mites, either within the outer bud scales, or between the bud and stem. Microscopic examination of these mites disclosed that they were all structurally of one species, all females, and all noticeably different from the dead carcasses on the leaves. The difference, in this case, is that the back plates of the abdomen are narrower and many do not divide laterally. Those that divide laterally only give way to one, rarely two, extra sternites. The microtubercles are somewhat suppressed, but still evident.

After considerable searching to eliminate the possibility that the leaf form was hiding somewhere on the stems, the conclusion was reached that the mites found hibernating are *Phyllocoptes cornutus.* While based on circumstantial evidence, this conclusion seems quite reasonable.

This mite, then, exhibits an alternation of generations, with the summer leaf form of both sexes, and the winter hibernating form of females only. Nalepa has speculated on probable polymorphism among Eriophyid mites, without, as far as the writer is aware, ever coming to any definite conclusion as to its existence or explanation.

The writer is now engaged in a series of experiments to obtain direct evidence as to polymorphism among certain species of Eriophyids and the results will be recorded in a later article.

The description of the winter alternate of the peach silver mite follows.

Phyllocoptes cornutus Banks

Plate 164

Banks—Proc. Ent. Soc. Wash., Vol. 7, p. 141, 1905
Keifer—Bul. Cal. Dept. Agr., Vol. 27, No. 3, p. 306, Sept. 7, 1938

Female 150-165 μ long, 50-55 μ wide, 40-45 μ thick, flattened spindleform, amber. Rostrum 24.5 μ long, projecting down. Shield 46 μ long, 50 μ wide, the pattern distinguishable toward the rear, no small spines below anterior lobe. Dorsal tubercles 34 μ apart, on rear margin; dorsal setae 17.5 μ long, projecting caudad. Forelegs 32 μ long, tibia 8.5 μ long, tarsus 7.5 μ long, claw 8 μ long, knobbed, featherclaw 4 rayed. Hindlegs 32 μ long, tibia 7 μ long, tarsus 7.5 μ long, claw 7.5 μ long. Sternal line distinct, ending between setae II. Abdomen completely microtuberculate, the tubercles considerably heavier on the sternites; most of the tergites not dividing laterally; about 40 tergites; 50-55 sternites. Lateral seta 26 μ long, on about sternite 7; first ventral 60 μ long, on about sternite 19; second ventral 17.5 μ long, on about sternite 33; third ventral 30 μ long, on about sternite 4 from rear; accessory seta present. Female genitalia 23.5 μ wide, 14.5 μ long, coverflap with about 12 furrows, seta 30 μ long.

No males present.

Locality, Sacramento, California. **Collected** September 30, October 1, 1940, February 3 and 6, 1941. **Host:** *Amygdalus communis* L., Peach. **Relation to host:** The hibernating stage of the silver mite crawls under the bud scales or behind the buds for the winter. The terminal buds harbor some, but larger clusters are found in and around lateral buds, between one and ten inches down the stem. In some localities, where the big beak plum mite *(Diptilomiopus prunorum),* is found on peach, the hibernating silver mites occur in maximum numbers along the terminal 6 or 8 inches of the twigs, and the greatest number of hibernating plum mites are found next down the twig. Thus, as examination of these twigs proceeds down the stem, first one species of mite is encountered in and around the buds, and then a second species comes into view, the first becoming scarce or absent.

The summer leaf form of *cornutus* possesses a pair of minute spines just under the frontal shield lobe. This characteristic is of group significance, as many *Phyllocoptes* species have these spines. The hibernating alternate of *cornutus* lacks these spines.

HOST LIST

LILIACEAE
- *Aloe humilis* Haw. var. *spinosissma*
  - *Eriophyes aloinis* n. sp., severe warting of leaf surfaces

FAGACEAE
- *Quercus agrifolia* Nee, Coast Liveoak
  - *Eriophyes paramackiei* n. sp. "witch's broom" and bud deformation

ROSACEAE
- *Prunus ilicifolia* Walp., Holly leaf cherry
  - *Eriophyes ilicifoliae* n. sp. in terminal buds
- *Rubus vitifolius* C. & S., Blackberry
  - *Eriophyes essigi* Hassan, "redberry" disease; also in buds
- *Amygdalus communis* L., Peach
  - *Phyllocoptes cornutus* Banks in buds

LEGUMINOSAE
- *Medicago sativa* L., Alfalfa
  - *Eriophyes medicaginis* n. sp. in lateral leaf axils

RHAMNACEAE
- *Ceanothus cuneatus* Hook., Buckbrush
  - *Anthocoptes hesperus* n.. sp., leaf vagrant

UMBELLIFERAE
- *Apium graveolens* L., Celery
  - *Phyllocoptes eurynotus* Nal.; browning of leaves and stalks

FIG. 8. Photograph of damage by *Eriophyes paramackiei* n. sp.

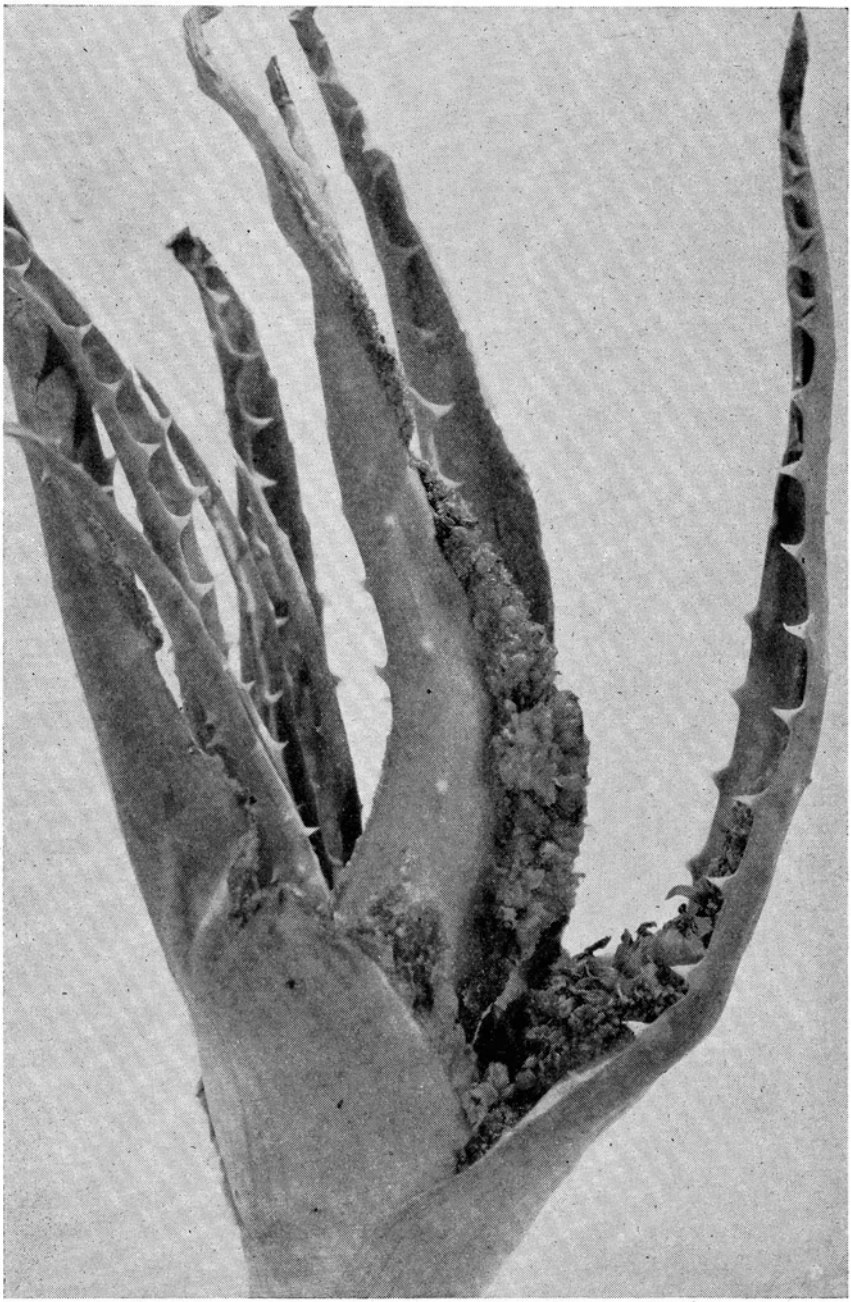

FIG. 9. Photograph of damage by *Eriophyes aloinis* n. sp.

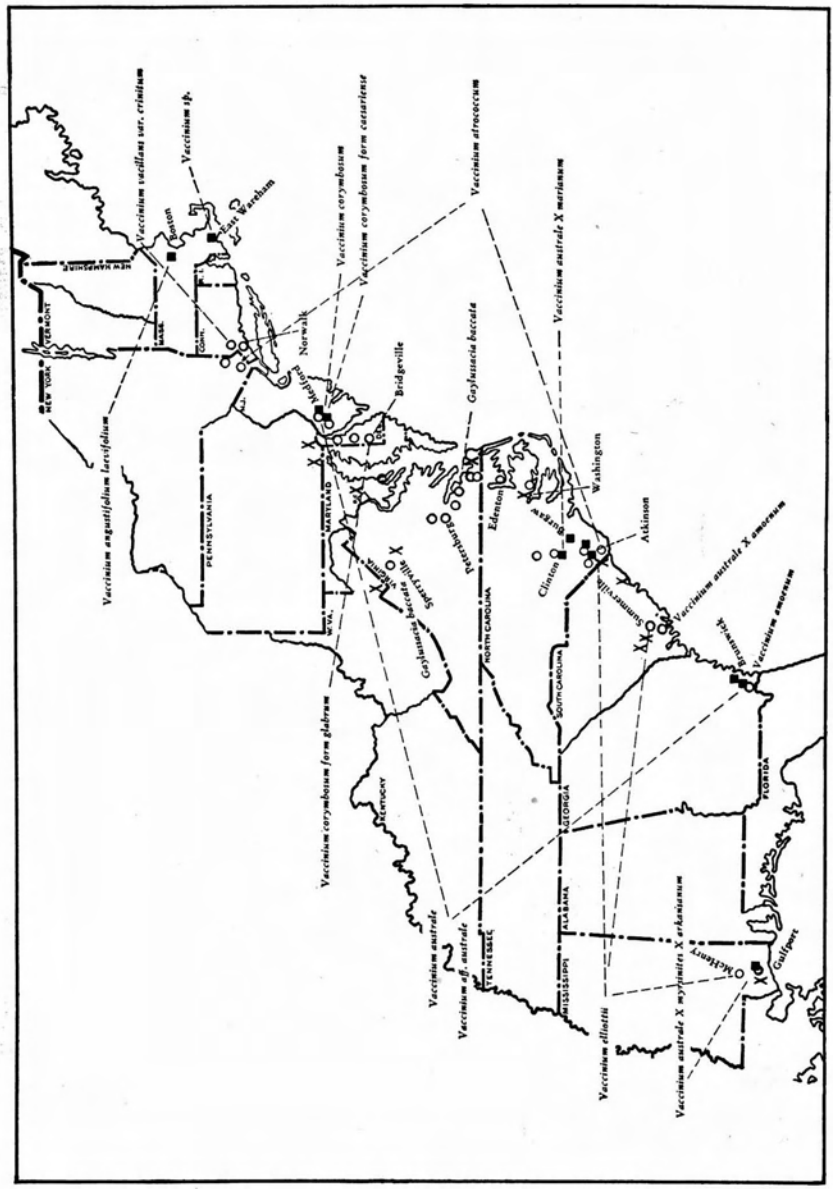

Plate 156, Map showing distribution of Blueberry Budmite.

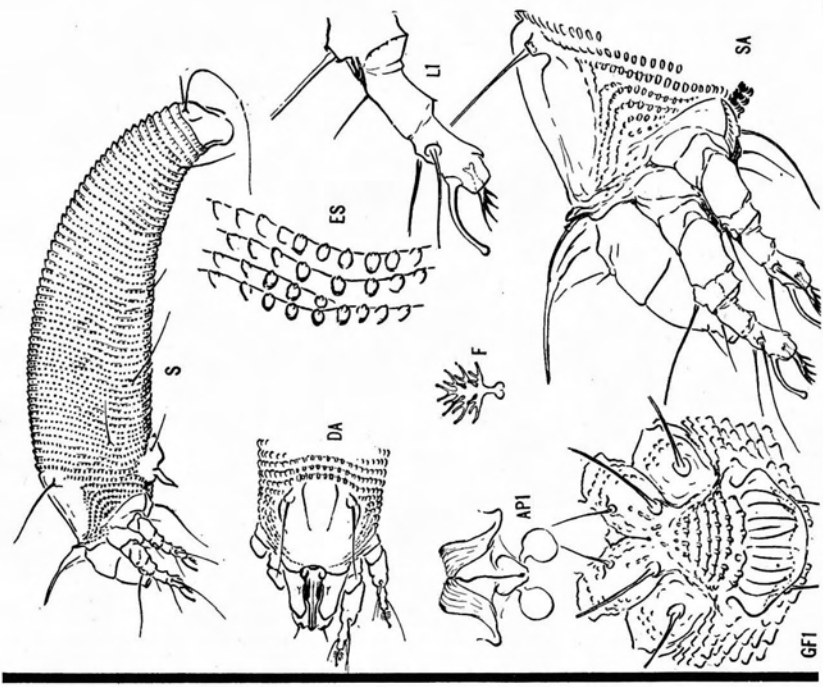

Plate 158, *Eriophyes ilicifoliae* n. sp.

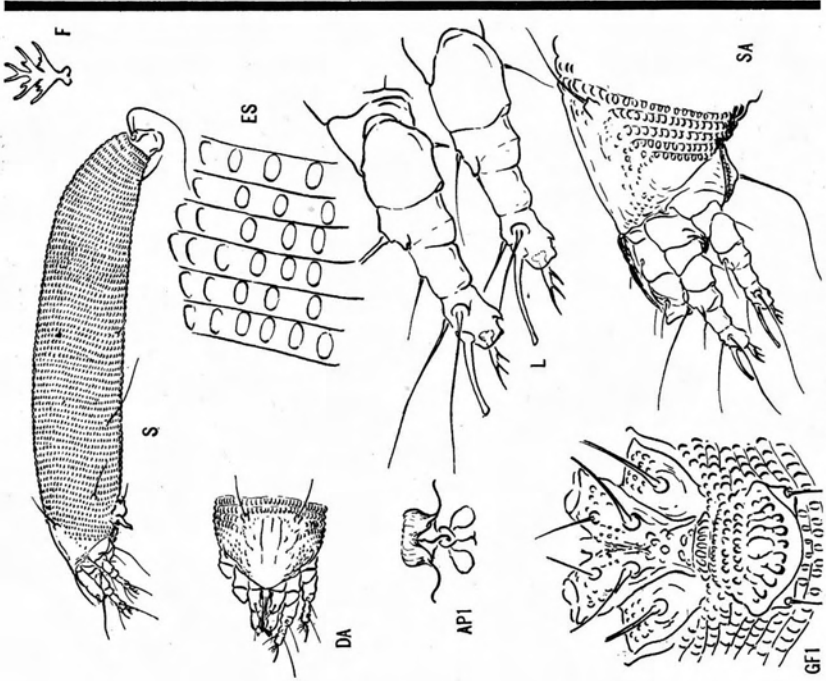

Plate 157, *Eriophyes paramackiei* n. sp.

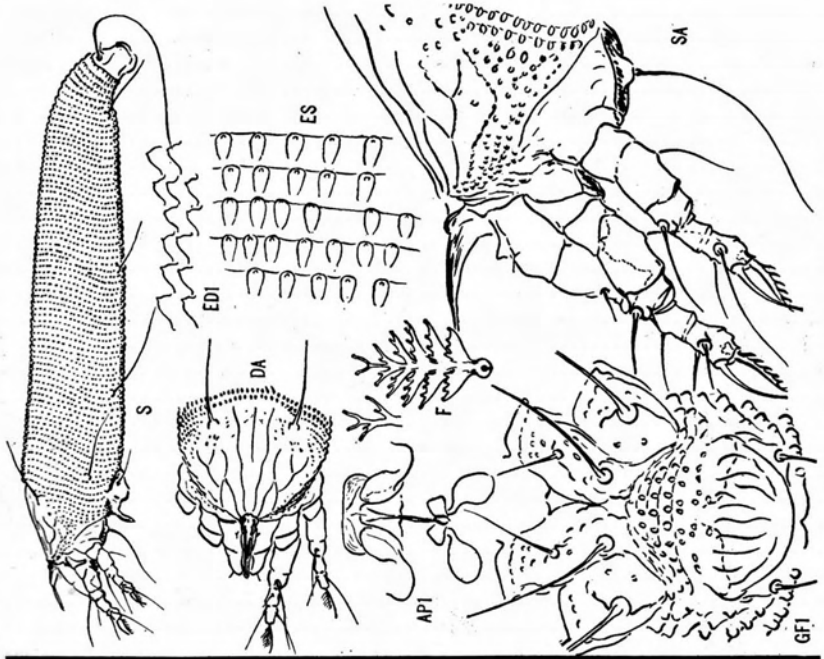

Plate 160, *Eriophyes aloinis* n. sp.

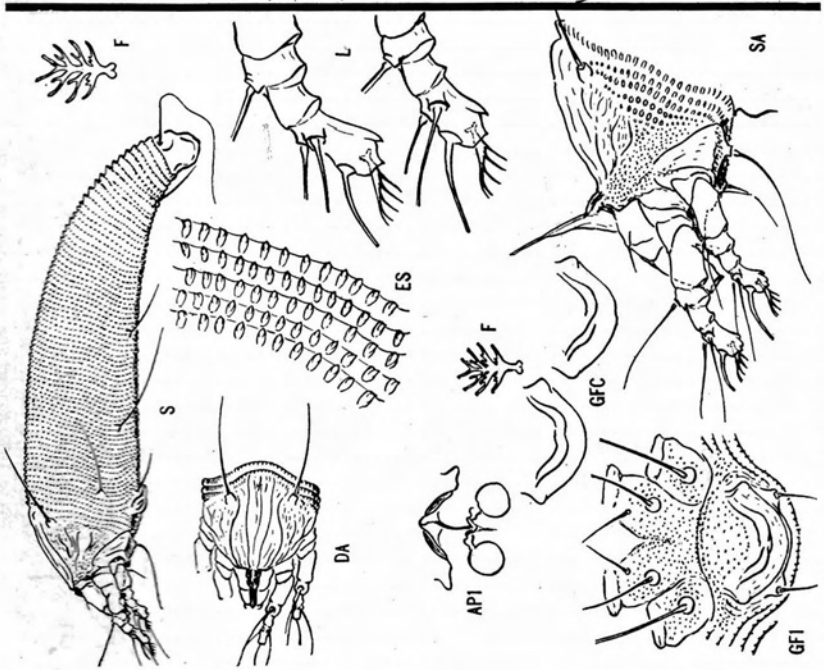

Plate 159, *Eriophyes essigi* Hassan

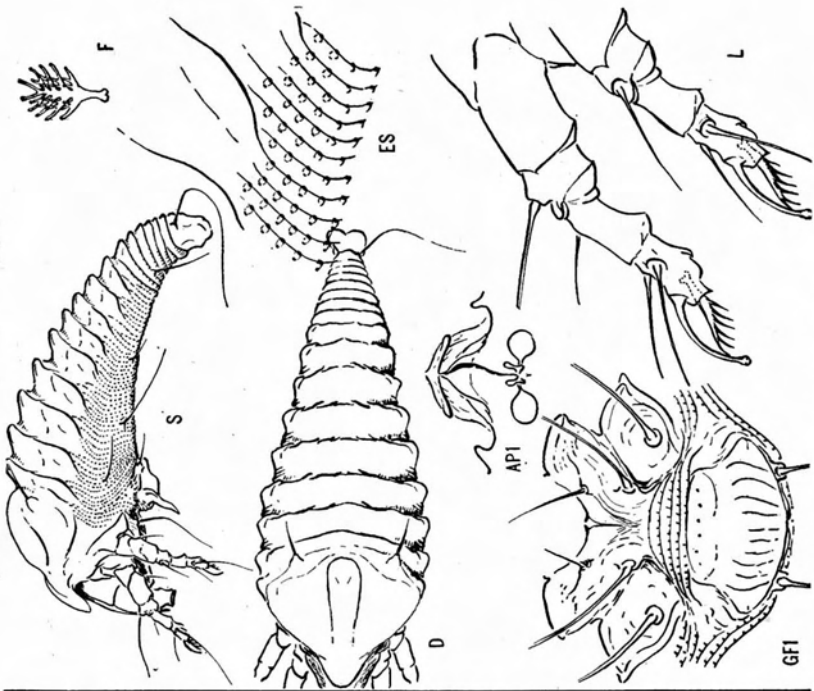

Plate 162, *Anthocoptes hesperus* n. sp.

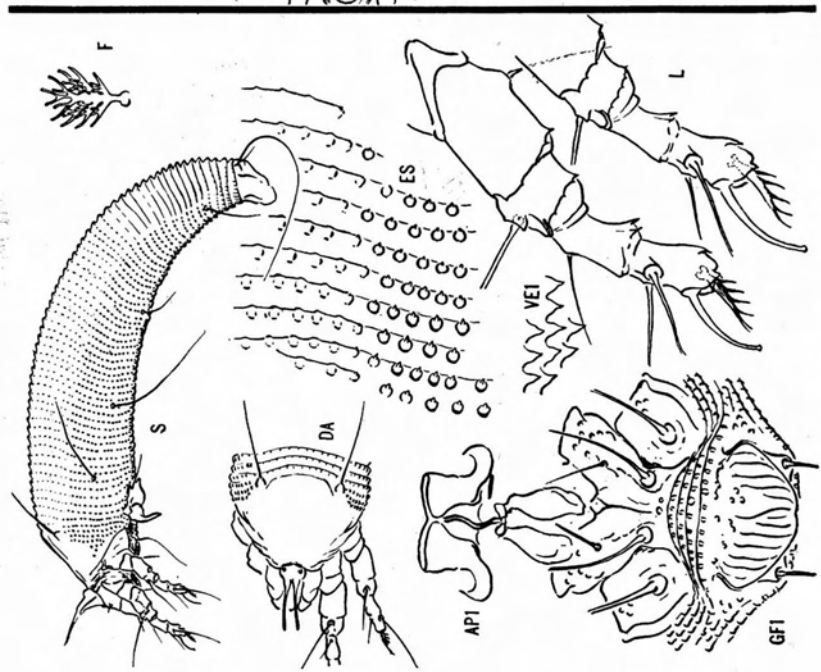

Plate 161, *Eriophyes medicaginis* n. sp.

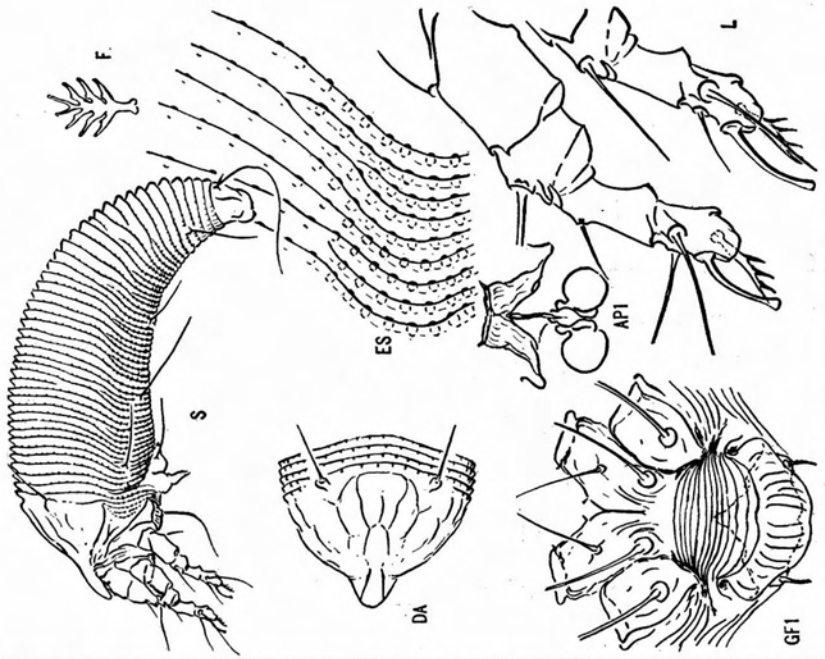

Plate 164, *Phyllocoptes cornutus* Banks.

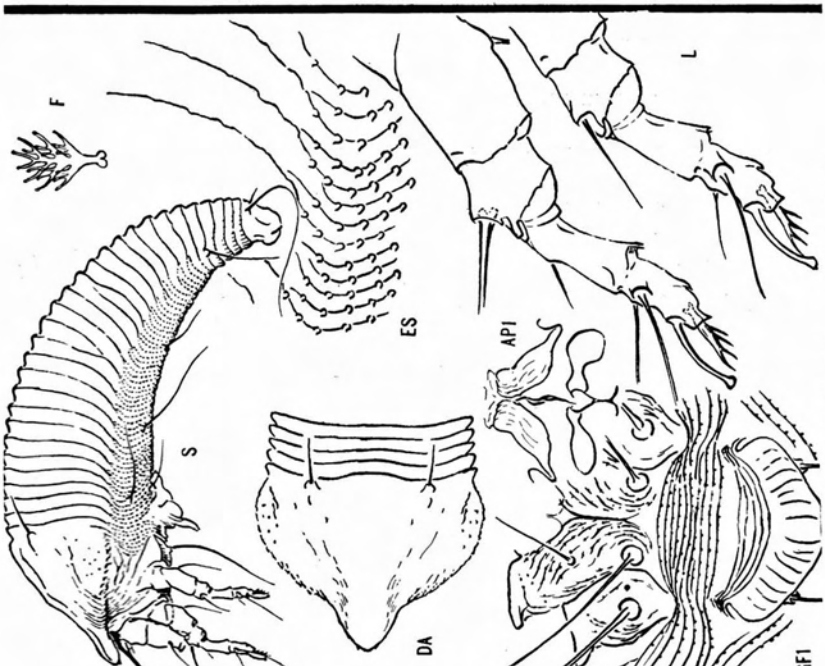

Plate 163, *Phyllocoptes eurynotus* Nal.

DESIGNATIONS ON PLATES

AP1 Internal female genitalia.

DA Dorsal view of anterior section of mite.

ED1 Dorsal skin in side view.

ES Detail of side skin.

F Featherclaw.

GF1 Female genitalia and coxae from below.

GFC Female genital coverflap showing variation.

L Left legs.

L1 Left foreleg.

S Side view of mite.

SA Side view of anterior section of mite.

VE1 Side view of ventral skin structure.

Plate 156, p. 211. Solid squares indicate locations of mite-infested cultivated bushes; circles indicate mite-infested wild bushes; X indicates uninfested bushes which were examined.

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