

PROCEEDINGS
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NOTES ON AND A KEY TO THE SPECIES OF
CINARA (FAMILY APHIDAE) LIVING ON
PINUS EDULIS

By F. C. HOTTES

In 1919 Wilson gave notice that he had under preparation a Monograph of the *Lachninae* of North America, a group to which the genus *Cinara* belongs, but at that time looked upon as a synonym of *Lachnus*. We now know that Wilson's projected Monograph was already moribund, but for years his announcement kept alive the hope of its ultimate publication, and perhaps prevented others from undertaking the project. Since that time many new species have been described within the genus *Cinara* and it is felt that something less pretentious than a Monograph will serve a useful purpose until such a time when one can be undertaken.

Because species of the genus *Cinara* have either specific or closely allied species of *Coniferae* as hosts, it has seemed logical to use the host species as media to divide the species of the genus into more workable groups, hence this section of species which have *Pinus edulis* and *Pinus monophylla* for their host plants.

The genus *Cinara* was erected by Curtis in 1835. It has *Aphis pini* Linnaeus as type, by action of the International Commission on Zoological Nomenclature. (Opinion number 399, 1956.) For various reasons the name *Cinara* was not used by systematists for almost a hundred years, species being placed in the genus *Lachnus* erected by Burmeister in 1835. Lack of space here prevents full discussion concerning the use of these two generic names, and their type species in the past and present, but those desiring to pursue the subject further may find the articles by Hottes as published in the Bulletin of Zoological Nomenclature, 9(6): 166-182, 1954 and the rul-

ings of the Commission as published in the same Journal in 1956 useful.

More recently Börner has proposed a number of genera which aphidologists in America would normally place in the genus *Cinara*. At the present I do not accept or reject the genera which Börner coined from the genus *Cinara* as used in America, but it would seem that most if not all of these genera would serve a more useful purpose if viewed as subgenera.

A KEY TO APTEROUS VIVIPAROUS FEMALES OF THE GENUS *CINARA* WHICH HAVE *PINUS EDULIS* AND *PINUS MONOPHYLLA* AS HOSTS

1. Fourth segment of the rostrum .30 mm or more in length 2
Fourth segment of the rostrum less than .25 mm in length 3
2. Fourth segment of the rostrum longer than the third antennal segment *C. puerca* Hottes
Fourth segment of the rostrum shorter than the third antennal segment *C. tanneri* (Knowlton)
3. Hairs on ventral surface of first metatarsal segment longer than width of segment 4
Hairs on ventral surface of first metatarsal segment shorter than width of segment 5
4. Cornicles with base varying from .27-.37 mm
..... *C. atra* (Gillette and Palmer)
Cornicles with base varying from .18-.21 mm *C. poketa* Hottes
5. Width of base of cornicles .25 mm or less 6
Width of base of cornicles .27 mm or more 7
6. Metathoracic tibiae with extensive pale area *C. caliente* Hottes
Metathoracic tibiae without pale area *C. poketa* Hottes
7. Hairs on outer surface of metathoracic tibiae varying from more than 45 degrees to 90 degrees 8
Hairs on outer surface of metathoracic tibiae set at angle of 45 degrees or less 13
8. Fourth antennal segment without sensoria *C. nitidula* Hottes
Fourth antennal segment with at least one sensorium 9
9. Hairs on metathoracic tibiae fine 10
Hairs on metathoracic tibiae coarse 11
10. Hairs on metathoracic tibiae almost at right angles, hairs on tibiae and antennae not numerous *C. rustica* Hottes
Hairs on metathoracic tibiae not almost at right angles, hairs on tibiae and antennae numerous *C. pinata* Hottes
11. Third antennal segment not over .33 mm in length
..... *C. nitidula* Hottes
Third antennal segment over .35 mm in length 12
12. Dorsum of abdomen, anterior to transverse pigmented areas, free from pigmented spots *C. terminalis* (Gillette and Palmer)

- Dorsum of abdomen, anterior to transverse pigmented areas, with irregular pigmented areas *C. wahtolca* Hottes
13. Hairs on metathoracic tibiae not over .04 mm in length 14
 Hairs on metathoracic tibiae over .04 mm in length 15
14. Hairs on metathoracic tibiae blunt at end, hairs on dorsum of abdomen extremely short and blunt --- *C. atra* (Gillette and Palmer)
 Hairs on metathoracic tibiae sharp pointed, hairs on dorsum of abdomen not extremely short, sharp pointed
 *C. apachea* Hottes and Butler
15. Hairs on vertex of head blunt, extremely short
 *C. atra* (Gillette and Palmer)
 Hairs on vertex of head not extremely short 16
16. Cornicles with base measuring up to .60 mm --- *C. edulis* (Wilson)
 Cornicles with base measuring less than .40 mm 17
17. Pale area on metathoracic tibiae measuring about .45 mm, pigmented areas anterior to transverse pigmented areas large and block-like *C. pinona* Hottes
 Pale area on metathoracic tibiae .60 mm or more, pigmented areas anterior to transverse pigmented areas absent or fragmented *C. metalica* Hottes

Cinara apachea Hottes and Butler

Cinara apachea Hottes and Butler 1955. Proc. Biol. Soc. Washington, 68: 65-66. Original descriptions of alate and apterous viviparous females.

Hottes, 1955. Proc. Biol. Soc. Washington, 68: 70 and figs.

Holotype and morphotype in the United States National Museum.

Size range apterous viviparous females 2.93-3.00 mm.

This species, known only from the first collection, may be easily identified in the mounted state. The short, heavy, strongly curved hairs on the metathoracic tibiae are spaced so close as to be almost fur-like. The cornicles have a very irregular margin which is much closer to the orifice in the posterior region than elsewhere. Hairs on the cornicles are scarce. The hairs on the anterior margin of the metathoracic tibiae are spine-like. Specimens of this species may be taken on the twigs among the needles of young vigorous trees. Repeated trips have been made to the type locality for more material without success.

Cinara atra (Gillette and Palmer)

Lachus ater (Gillette and Palmer), 1924. Ann. Ent. Soc. America, 17: 37-39, figs., plates XII and XIII. Original description of all forms.

Type in United States National Museum.

Size range apterous viviparous females 2.00-3.00 mm.

This black or dark brown species is free from all powder. Apterous specimens of this species have the thorax rather long and narrow, distinctly neck-like. Body hairs are very sparse and extremely short and

squarely cut at the end. Hairs on the tibiae and tarsal segments are subject to much variation as to length and condition at the end, being squarely cut at the end if short or sharp pointed if long. Hairs on the outer margin of the tibiae often differ from those on the inner margin as to length and condition at apex. When in good view and not worn, the hairs on the ventral surface of the first metatarsal segment are longer than the width of segment with the terminal hairs strongly bent or hooked.

Specimens of this species seem to show a preference for young, vigorous trees where they feed on the smooth bark of small branches. The colonies are never large.

Cinara caliente Hottes

Cinara caliente Hottes, 1955. Proc. Biol. Soc. Washington, 68: 197-199, figs. Original description of all forms.

Holotype, morphotypes and allotype in the United States National Museum.

Size range apterous viviparous females 2.02-2.17 mm.

This trim little species is probably more widely distributed than collection records indicate. Because of its small size and protective coloration which is exactly the same color as the needle-free color of the bark of twigs upon which it feeds, this species is extremely difficult to detect. It is one of the most easily determined species of the group feeding on *Pinus edulis* and *Pinus monophylla*. It has extensive pale areas on the metathoracic tibiae and femora, and the third antennal segment is mostly pale. The cornicles are small and almost hair free, with the outer margin very irregular. In Colorado, I have only taken it in the type locality north of Delta. In September 1959, I took it near Springerville, Arizona; these specimens were almost black. R. C. Dickson has sent me material from California taken on *Pinus monophylla*. The California material for the most part lacks the wart-like pigmented areas on the dorsum of the abdomen. This material is slightly larger than the Colorado material, has the outer margin of the cornicles more regular and a few more hairs on the cornicles.

Cinara edulis (Wilson)

Lachniella edulis (Wilson), 1919. The Canadian Entomologist, 51: 44-45. Original description apterous and alate viviparous females.

Lachnus edulis (Wilson). Palmer, Ann. Ent. Soc. America, 19: 314-317, pls. XXVII and XXVIII. Descriptions of all forms.

Cotypes, Granovsky and Colorado Agricultural Experimental Station Collections.

Size range apterous viviparous females 3.00-4.00 mm.

This species, the first to be described from *Pinus edulis*, has also been recorded from *Pinus monophylla*. It is widely distributed. I am not sure that all records for this species apply to it. Some colonies of this species

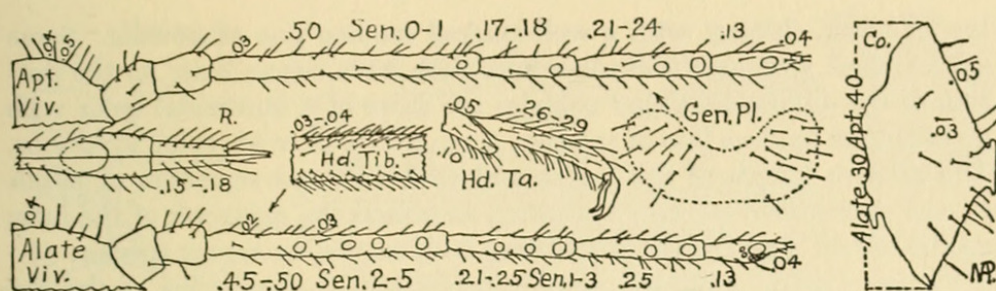


FIG. 1

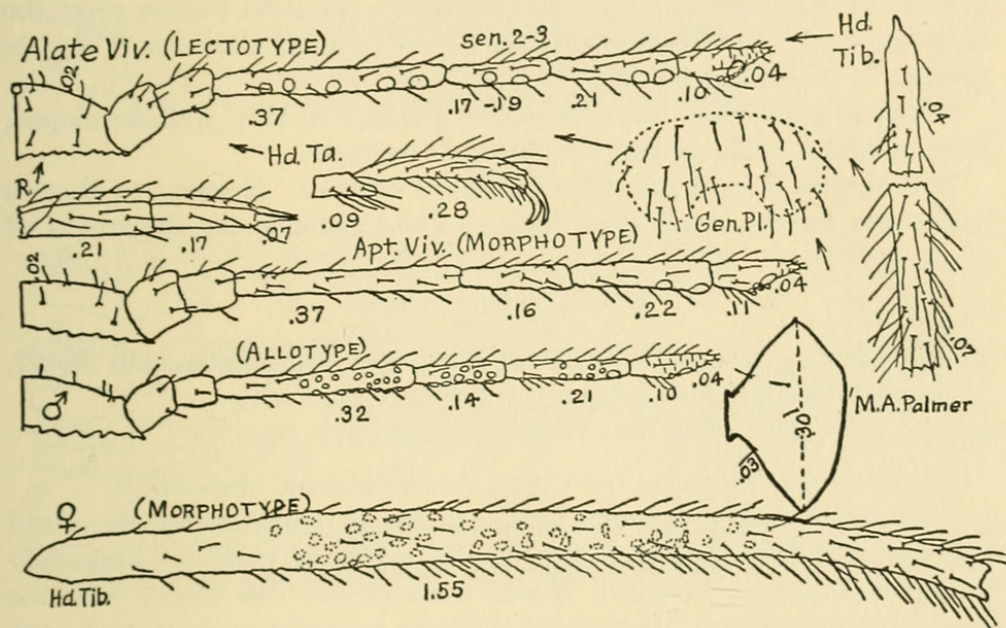


FIG. 2

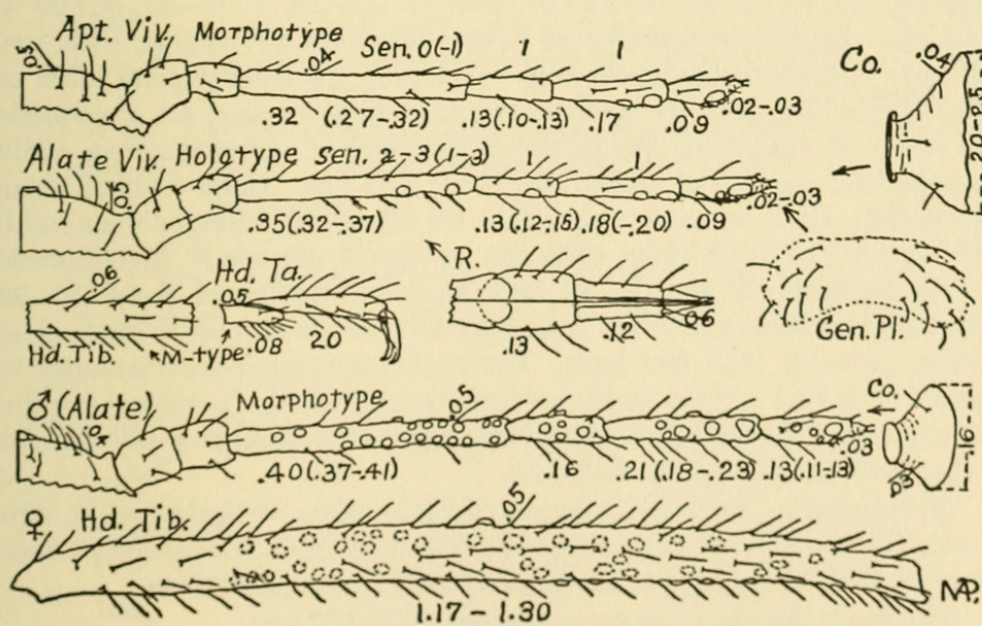


FIG. 3

are jet black, shining, with a well-marked median line of powder. Some are jet black without the median line; such have coarse hairs on the dorsum of the abdomen. Other colonies are more of a gun-metal color with an indistinct median line of powder. I am aware of other color variations. The relative length of the fourth and fifth antennal segments of *edulis* as now determined are also confusing, as well as the character of the hairs on the tibiae. Perhaps we are dealing with several emergent species.

Palmer (1926) indicates powder anterior to the cornicles of the apterous viviparous female in her figure, but makes no mention of these patches in her text—in fact, ruling them out. In 1952 Palmer gives the common name “The Black and White Spotted Pinyon Pine Aphid” to this species. It is hardly suitable.

When in good view the mesosternal tubercle is very well developed, being almost as wide as long with the apex truncate.

This species is as a rule found in large colonies. It seems to show a preference for the needle-free bark of older branches or the trunks of young trees.

Cinara metalica Hottes

Cinara metalica Hottes, 1956. Proc. Biol. Soc. Washington, 69: 85–87.

Original description of oviparous female and alate male.

Hottes, 1956. Proc. Biol. Soc. Washington, 69: 222, figs.

Holotype and allotype in the United States National Museum.

Apterous viviparous female: Similar in size to oviparous female. Head and thorax lightly pruinose, abdomen to region of cornicles irregularly pruinose. Cornicles brownish bronze more or less two toned, with the constricted area darker. Dorsum of abdomen posterior to cornicles bronze and highly polished. Antennal segments with the following lengths: III .28–.42 mm (as a rule .39 mm or less), IV .15–.18, V .18–.21, VI .09 + .04 mm. Sensoria distributed as follows: II none, IV none or with one, V one. Mesosternal tubercle well developed; not truncate, but more or less nipple-like. Hair on antennal segments rather sparse, set at an angle of about 45 degrees or slightly more; not much if any longer than width of segment. Length of hind tibiae about 2.55 mm. Hairs on hind tibiae numerous, set at an angle of less than 45 degrees and shorter than width of segment (longest about .045 mm to almost .06 mm). Metathoracic tarsal segments .09 and .18–.21 mm. Cornicles two toned about .30–.32 mm with the outer rim very irregular; as a rule with one or more clear areas, provided with few hairs. Transverse pigmented areas anterior to cauda provided with a single row of hairs along the posterior margin. Pigmented areas anterior to transverse pigmented areas as a rule absent; when present, fragmented and small.

Morphotype: Apterous viviparous female taken at Springerville, Arizona, the type locality, but reared at Grand Junction, Colorado, 26 September 1956. Deposited in the United States National Museum.

Size range apterous viviparous females 3.37–3.60 mm.

This species may be easily identified in the field. No other species on

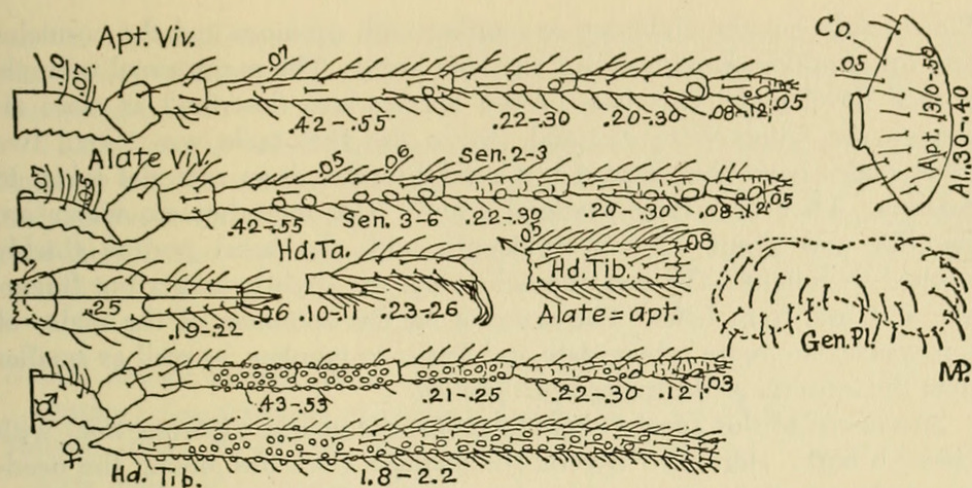


FIG. 4

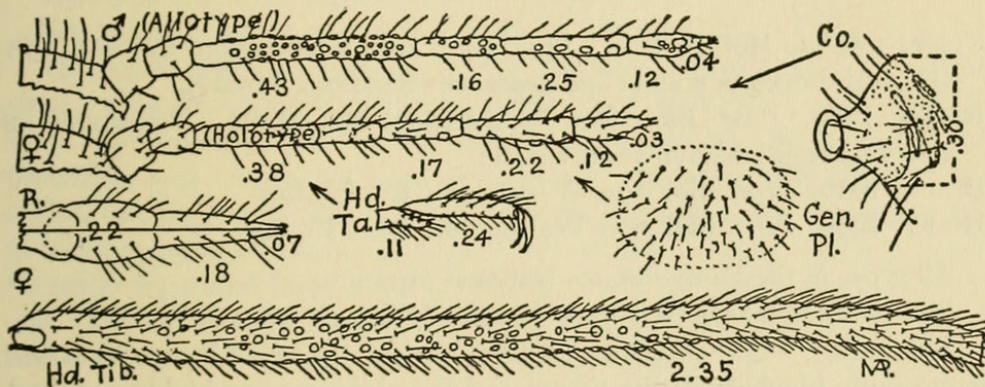


FIG. 5

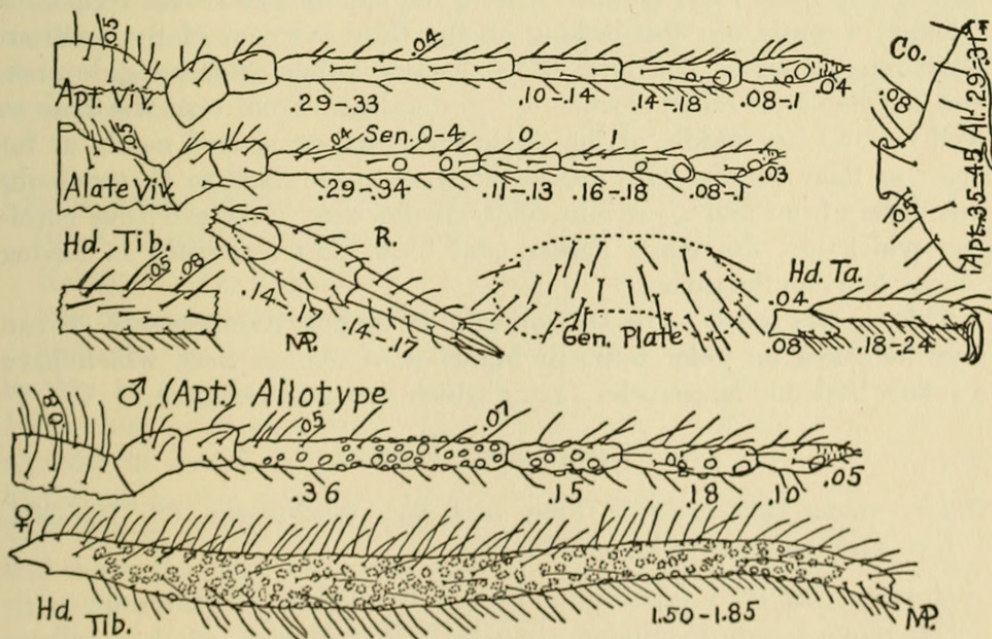


FIG. 6

Pinus edulis has the abdomen so mottled with pruinose and the cornicles and tip of abdomen with such a metallic luster. The mesosternal tubercle is well developed. The male of this species was described as alate although the wings were vestigial. Since the first male was taken, two other males have been reared in Grand Junction from material taken in Arizona. They also have vestigial wings. The mesothoracic wings are flap-like and about .15 mm in length with the basal portion thickly clothed with hairs. The metathoracic wings are slightly longer but finger-like and free from hairs. The sensoria on the antennae of the males of this species are more tuberculate and fewer in number, as well as smaller than the sensoria of the males of *C. pinona*.

Specimens of this species seem to prefer the young, vigorous trees with greenish bark. Here they live on the younger branches among the needles. Colonies of this species are often mixed with *C. rustica* Hottes.

Cinara nitidula Hottes

Cinara nitidula Hottes, 1954. Proc. Biol. Soc. Washington, 67: 256-258.

Original description alate and apterous viviparous females.

Hottes, 1956. Proc. Biol. Soc. Washington, 69: 91-92. Description of apterous male and oviparous female.

Hottes, 1956. Proc. Biol. Soc. Washington, 68: 72, figs.

Hottes, 1956. Proc. Biol. Soc. Washington, 69: 223, figs.

All types in the United States National Museum.

Size range apterous viviparous females 2.02-2.29 mm.

This rather small species varies from various shades of brown to almost if not quite black; both the thorax and the abdomen are highly polished, only the sides of the thorax being provided with powder. The fourth antennal segment lacks sensoria in both the apterous and alate viviparous females; sensoria are also lacking on the third segment of the apterous viviparous females. The hind tibiae have a rather extensive pale area, and the hairs are rather coarse and upstanding. From near the base to well beyond the middle of the tibiae the hairs are spaced nearly as far apart as their length. This species appears to be allied to *C. terminalis* but differs from that species in color, smaller size, more extensive cornicles which are also much darker, and from most *terminalis* in having shorter hairs on the tibiae.

This species seems to be very specific in its host requirements. It can only be taken on older terminal branches of mature trees which have a yellow bark and large scales among which they may be taken.

Cinara pinata Hottes

Cinara pinata Hottes, 1955. Proc. Biol. Soc. Washington, 68: 199-202, figs. Original description of all forms.

Holotype and other types in the United States National Museum.

Size range apterous viviparous females 2.97-3.36 mm.

The most outstanding feature of this species is the abundance of hairs

on the antennal segments, on the third segment averaging about 45, and the short, thick, stubby sixth antennal segment which is provided with numerous hairs.

This species is rather common in its type locality where it lives in large colonies on the smaller terminal branches among the needles. I have only taken it on older trees where the branches have a yellowish bark and large scales, and when these qualifications are met, it may be easily reared.

Cinara pinona Hottes

Cinara pinona Hottes, 1953. Proc. Biol. Soc. Washington, 66: 153-155.

Original description of apterous and alate viviparous females.

Hottes, 1954. Proc. Biol. Soc. Washington, 67: 90-91. Description of alate male and oviparous female.

Hottes, 1955. Proc. Biol. Soc. Washington, 68: 104 figs. of all forms.

Holotype and other types in the United States National Museum.

Size range apterous viviparous females 3.14-3.26 mm.

This dark brown species has been seen frequently in its type locality since being described; it has also been taken in Mesa Verde National Park. Specimens of this species seem to prefer older trees whose bark is brownish, and whose twigs are more or less yellowish with large yellow scales, but they may also be taken on younger trees. The specimens live in large colonies on the twigs among the needles. Living specimens may be easily separated from *C. metalica* because of the high polish and color and lack of metallic luster on the cornicles and apex of abdomen. Mounted specimens are more difficult to differentiate. The males of *pinona* are alate; the males of *metalica* have the wings vestigial so far as known. I suspect that this species has been confused with *C. edulis* in collections. It may be easily separated from *edulis* by the smaller size, smaller cornicles and much smaller mesosternal tubercle, as well as shorter antennal segments. The tibiae have the same color pattern but are not so dark.

Cinara poketa Hottes

Cinara poketa Hottes, 1956. Proc. Biol. Soc. Washington, 69: 220-221 figs. Original description of apterous viviparous female.

Holotype in the United States National Museum.

Size of apterous viviparous female 2.60 mm.

Since this species was described I have made several trips to the type locality in Arizona for more material, all unsuccessful, until the fall of 1959 when I collected what I have determined as this species a mile or so north of Grand Canyon National Park. The specimens were brought to Colorado alive and from them oviparous females have been reared. This species as indicated in the original description is allied to *C. atra* and shows the same variations as *atra* as to hair length on the tibiae and character of the hairs at the apex. *C. poketa* has the cornicles much smaller and the hairs on the vertex much finer than shown by these structures in *atra*. Like *atra*, *poketa* has a narrow thorax.

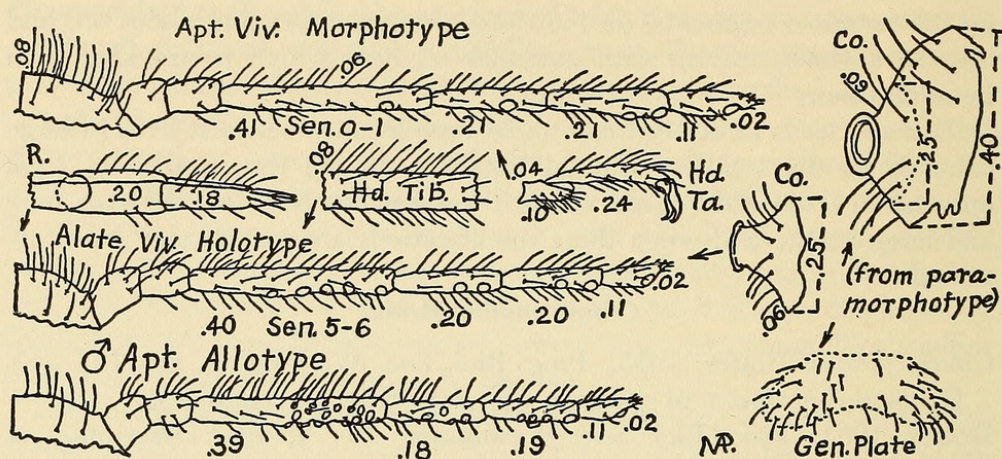


FIG. 7

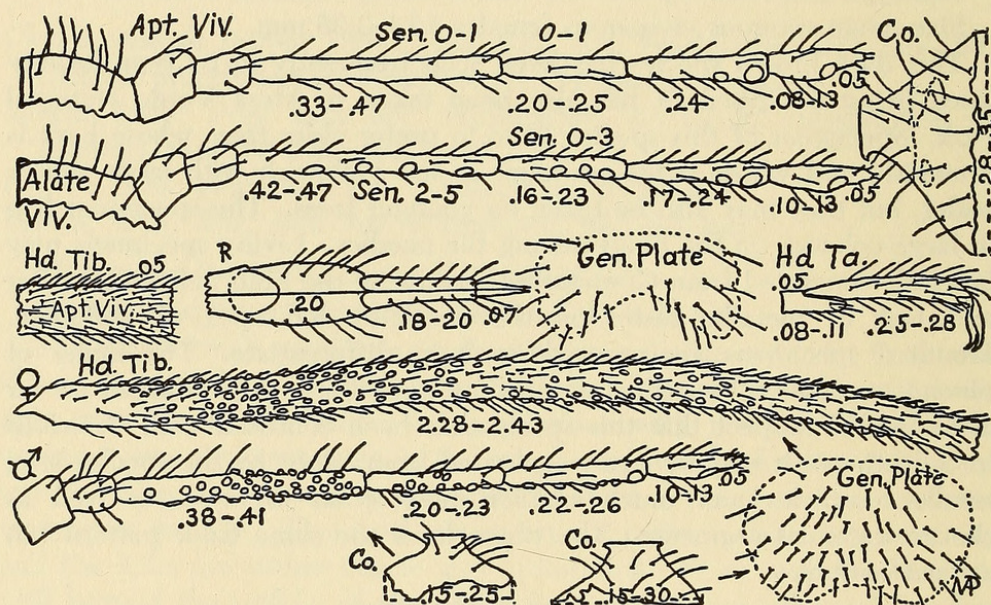


FIG. 8

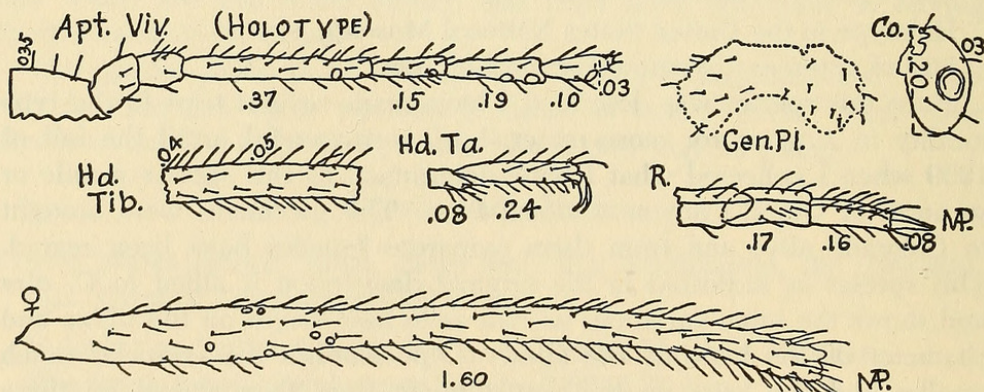


FIG. 9

Oviparous female: Females of this form are much like the apterous viviparous females. The metathoracic tibiae are rather swollen on the basal half, the sensoria are extremely difficult to differentiate and one has the feeling that there are more present than the four or five which may be seen with difficulty. Palmer shows the sensoria much more numerous and extending almost to the end in *C. atra*.

Morphotype: Oviparous female reared from specimens taken in Arizona in September on *Pinus edulis* taken at Grand Junction, Colorado, 20 October 1959. Deposited in the United States National Museum.

Cinara puerca Hottes

Cinara puerca Hottes, 1954. Proc. Biol. Soc. Washington, 67: 251-253.

Original description of apterous viviparous female.

Hottes, 1955. Proc. Biol. Soc. Washington, 68: 69-73, figs. Description of alate viviparous female.

Holotype and morphotype in the United States National Museum.

Size range apterous viviparous female 3.00-4.36 mm.

This species is closely allied to *C. tanneri* (Knowlton) and differs from that species in having the fourth segment of the rostrum longer than the third antennal segment, a shorter third antennal segment, and the cornicles not fragmented, and with more hairs. *C. puerca* lives in sheds of either soil or fragmented bark, constructed by ants, or beneath loose scales of bark, or within deep fissures between large scales of bark on the trunks. I have collected this species in Arizona just outside Grand Canyon National Park.

Cinara rustica Hottes

Cinara rustica Hottes, 1956. Proc. Biol. Soc. Washington, 69: 83-85.

Original description oviparous and apterous viviparous females.

Hottes, 1956. Proc. Biol. Soc. Washington, 69: 222, figs.

Hottes, 1957. Proc. Biol. Soc. Washington, 70: 14, figs. Description alate viviparous female.

Holotype and morphotypes in the United States National Museum.

Allotype apterous male described herewith deposited in the United States National Museum.

Apterous male: Color of body uniform gray due to light pruinescence. Length from vertex of head to end of cauda varying from 2.35-2.40 mm. Lengths of antennal segments as follows: III .38 mm, IV .15 mm, V .23 mm, VI .10 + .03 mm. Sensoria distributed as follows: III 12-18 plus primary, IV 4-7 plus primary, V 5-8 plus primary, VI one secondary. All sensoria are small and slightly tuberculate. Width of base of cornicles .33 mm. Length of metathoracic tibiae 1.46 mm. Specimen taken on *Pinus edulis*, Grand Junction, Colorado, 20 October 1959, reared from material taken at Springerville, Arizona, the type locality, early in September.

Range in size of apterous viviparous females 3.22-3.37 mm.

C. rustica is a very distinct species. Specimens are very easily identi-

fied in the field or mounted. Live specimens have the head and thorax and abdomen to just posterior to the cornicles gray due to a light but uniform amount of powder. The region just posterior to the cornicles is a dull chocolate brown. Mounted specimens may be determined by their comparatively short, not numerous, hairs on the metathoracic tibiae which are upstanding. The hairs on the antennae and tibiae are fine

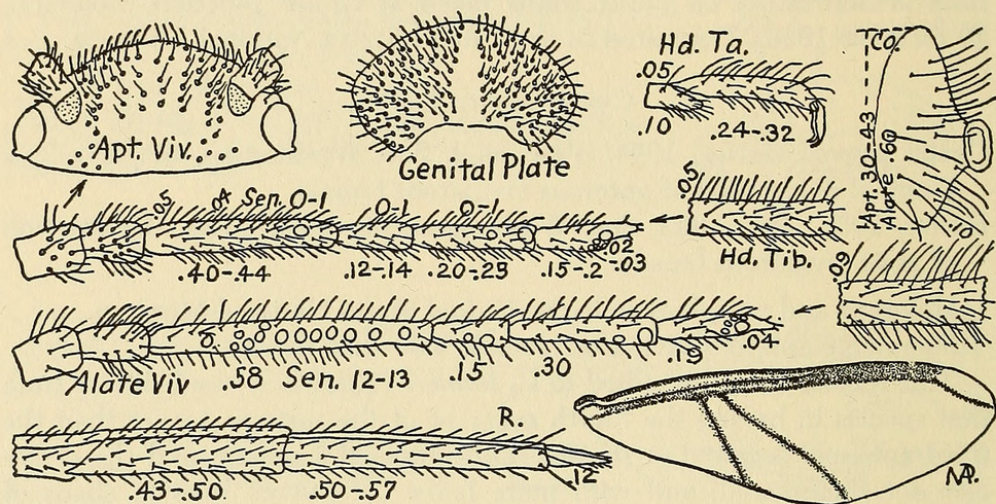


FIG. 10

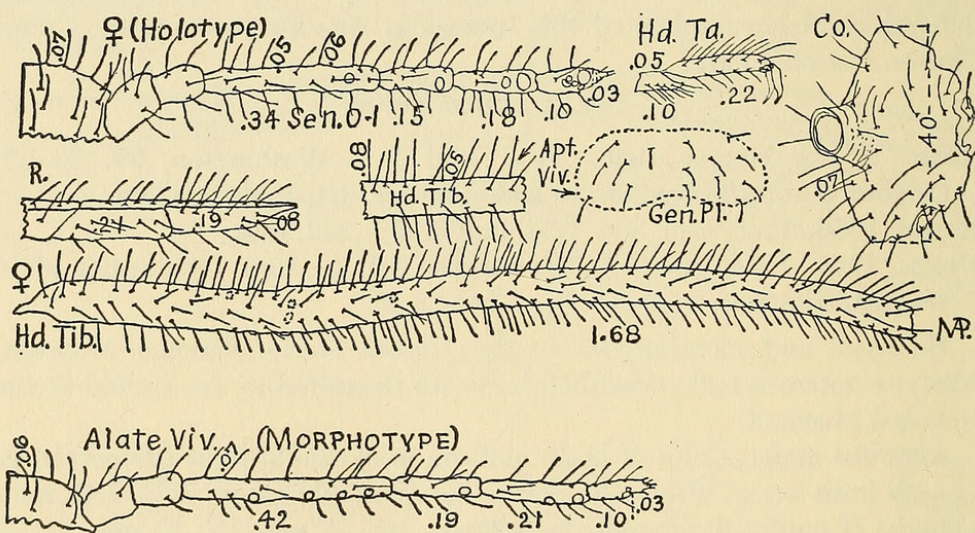


FIG. 11

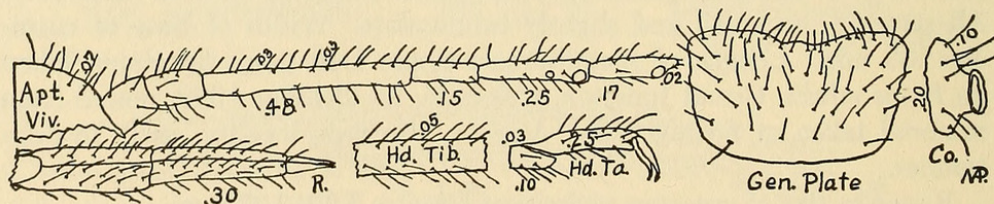


FIG. 12

and rather widely spaced. Colonies of this species are never large, they show a preference for young, vigorous trees where they live on the needle free of more mature twigs, or on the trunks of young trees.

Cinara tanneri (Knowlton)

Lachnus edulis tanneri Knowlton, 1930. The Canadian Entomologist, 62: 155-156, figs. Original description apterous viviparous female. Description of alate not of this species.

Palmer, 1952. Aphids of the Rocky Mountain Region, p. 49. Description of apterous viviparous female.

Hottes, 1954. Proc. Biol. Soc. Washington, 67: 253.

Hottes, 1955. Proc. Biol. Soc. Washington, 68: 68, figs.

Lectotype selected by Hottes, but indicated by Knowlton. In Knowlton collection.

Size of apterous viviparous female 4.00 mm.

The material from which Knowlton described this species consists of a mixture of *tanneri* as restricted by Palmer in 1952 and *edulis*. The cornicles of *tanneri* often consist of two distinct parts: a restricted portion as shown by Palmer in the figure published by Hottes which may exist alone, or a restricted portion separate from, but associated with a fragmented basal portion made up of one or more parts which together make up from one fourth to one half of what would be the normal base. The hairs on the cornicles of this species are sparse; those on the antennae and tibiae comparatively so. The fourth segment of the rostrum varies in length from .30-.37 mm but is always shorter than the third antennal segment. Tanner took his material on *Pinus monophylla*. Knowlton has taken it on *Pinus edulis* under loose bark.

Cinara terminalis (Gillette and Palmer)

Lachnus terminalis (Gillette and Palmer), 1924. Ann. Ent. Soc. America, 17: 19-21, figs. Original description all forms.

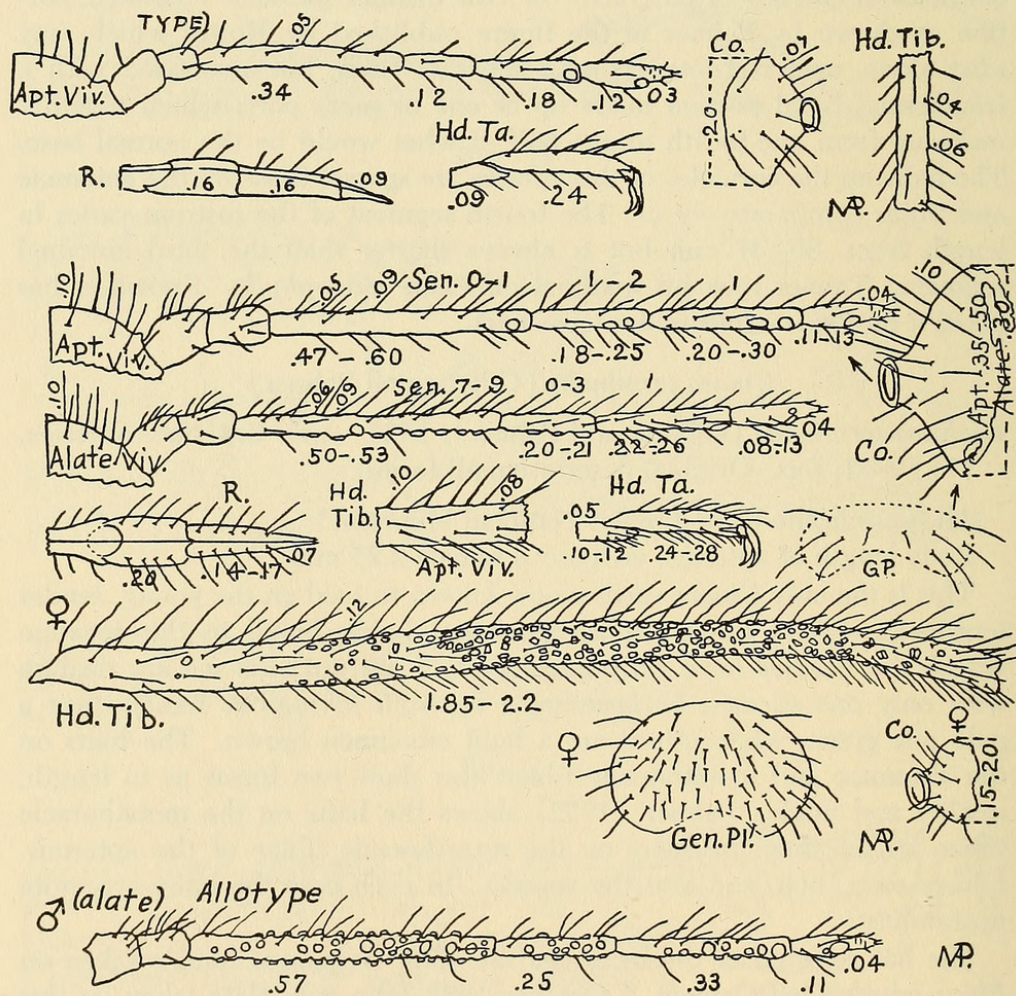
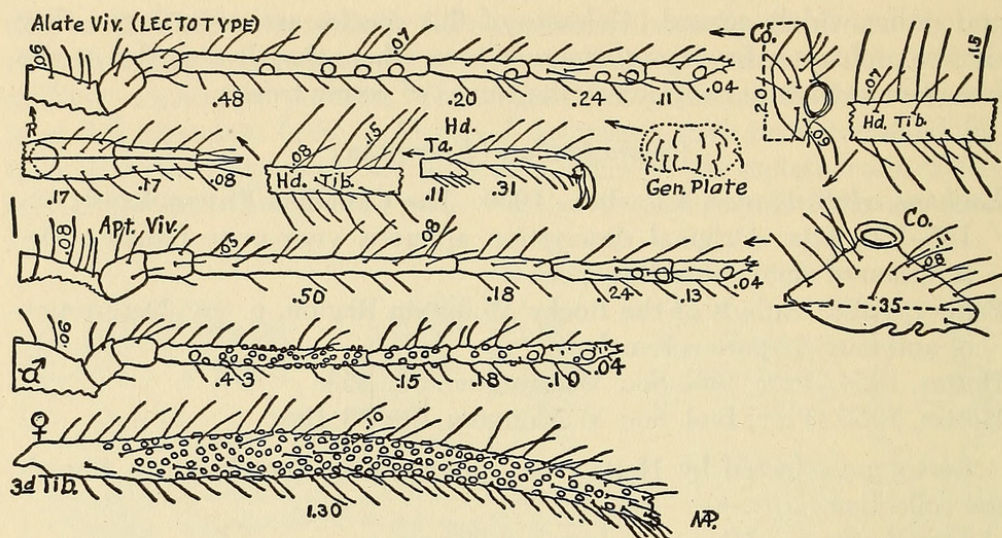
All types in the United States National Museum.^o

Body length of apterous viviparous female 2.25 mm.

This is the only *Cinara* species now known to feed on the young, tender terminal twigs of *Pinus edulis*, specimens being found in this location before the needles have fully developed. I am not sure we are dealing with only one species, because some apterous viviparous females are a pale pea green, while others are a light cinnamon brown. The hairs on the antennae and metathoracic tibiae also show two forms as to length, quality and angle. Palmer (1952) shows the hairs on the metathoracic tibiae longer than the hairs on the metathoracic tibiae of the apterous. I have seen such, and also the reverse. In each case the hairs are quite upstanding.

She has selected as the lectotype the alate viviparous female taken on *Pinus edulis*, Owl Canyon, 5 October 1922 (the only alate taken on this

^o Note from Prof. Palmer.



date). "The only fundatrix listed in original description is a nymph, so there is no morphotype of this form. The only summer vivipara mentioned in original description are short haired 'so have to be ruled out till we know otherwise.' The male listed is long haired and I designated as allotype the one of Oct. 18, 1922. Specimen taken in 1923 (in original description is erroneous). The oviparous female mentioned in description Oct. 18, 1922 I seem to have picked for morphotype. The one of Oct. 27, 1921 is recorded as the one drawn from in original publication, but slide is so poor and specimen so faded that it seems inadvisable to use it."

Cinara wahtolca Hottes

Cinara wahtolca Hottes, 1953. Proc. Biol. Soc. Washington, 66: 155-157.

Original description of alate and apterous viviparous females.

Hottes, 1954. Proc. Biol. Soc. Washington, 67: 90. Description of oviparous female.

Hottes, 1956. Proc. Biol. Soc. Washington, 69: 91. Description of alate male.

Hottes, 1955. Proc. Biol. Soc. Washington, 68: 104, figs.

Hottes, 1956. Proc. Biol. Soc. Washington, 69: 223, fig. of male antenna.

Holotype and other types in the United States National Museum.

Range in size of apterous viviparous females 2.86-2.36 mm.

There is no need to confuse this species with any other species living on *Pinus edulis* or *Pinus monophylla*, yet I have seen slides determined as *edulis* or *terminalis*. Living specimens may have the body quite powdery so that it presents a distinctly gray appearance. At other times specimens are quite free from powder and when such are dark gray. Mounted specimens show the tibial hairs distinctly longer than the tibial hairs of *edulis*, more upstanding, and distinctly spine-like. The tibial hairs in the apterous form are as a rule longer than the tibial hairs of *terminalis* in like form and less upstanding. Neither *edulis* nor *terminalis* have the pigmented spots on the posterior dorsum of the abdomen.

Specimens of this species show a decided preference for young, vigorous trees whose bark is gray or green. On such trees they live on the trunk and the needle-free limbs and small branches. In Arizona, the colonies are large. I have observed *Pinus monophylla* in Nevada heavily infested; Dickson has taken this species in California on the same host.

EXPLANATION OF FIGURES

Plate I: Fig. 1.—*Cinara apachea* Hottes and Butler. Fig. 2.—*Cinara atra* (Gillette and Palmer). Fig. 3.—*Cinara caliente* Hottes.

Plate II: Fig. 4.—*Cinara edulis* (Wilson). Fig. 5.—*Cinara metalica* Hottes. Fig. 6.—*Cinara nitidula* Hottes.

Plate III: Fig. 7.—*Cinara pinata* Hottes. Fig. 8.—*Cinara pinona* Hottes. Fig. 9.—*Cinara poketa* Hottes.

Plate IV: Fig. 10.—*Cinara puerca* Hottes. Fig. 11.—*Cinara rustica* Hottes. Fig. 12.—*Cinara tanneri* (Knowlton).

Plate V: Fig. 13.—*Cinara terminalis* (Gillette and Palmer). Fig. 14.—*Cinara wahtolca* Hottes.



Hottes, F. C. 1960. "Notes on and a key to the species of *Cinara* (Family Aphidae) living on *Pinus edulis*." *Proceedings of the Biological Society of Washington* 73, 199–214.

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