

Review of Trialeurodes Cockerell

Currently 55 species in the world are assigned to the genus Trialeurodes (Mound & Halsey 1978), which is one of the largest groups in the family Aleyrodidae. Although other Trialeurodes species have been described, they were synonymized with other Trialeurodes species or reassigned to other genera. The genus evolved primarily in the New World. Russell (1948) reviewed the species in North America and treated 38 valid species; since then, no new species has been described from the New World. Bink-Moenen (1983) treated two species in her revision of the African Whiteflies. David & Subramaniam (1976) treated three species in their major publication on the whiteflies of India. Miyatake (1980) included two species in his list of the whiteflies of Japan. In various publications Takahashi (1932, 1933, 1940, 1943, 1951, 1955, 1960) described 12 species from the Orient, Madagascar, Reunion Island and Europe; however, nine species do not belong in the genus, two are synonyms of other species of Trialeurodes, and only one species is apparently valid. Four species from Malaya, one from Trinidad, one from Australia and two from Africa described by Corbett (1935a, 1945b, 1935c, 1936) are either synonyms of other Trialeurodes species or do not belong in the genus. Bondar (1923, 1928) described three species from Brazil; only one is considered valid. Two species described from Chile by Baker and Moles (1923) do not belong in the genus. Other species treated in this paper were described by Signoret (1882), Bink Moenen (1976), and Maskell (1890). In a catalog on the whitefly of the world, Mound & Halsey (1978) list 55 species in Trialeurodes. Based on the examinations of specimens and reviews of literature, 44 are considered here to be good species, two are treated as junior synonyms of two other Trialeurodes species, two are considered probably congeneric, and seven apparently do not belong in the genus.

For each species a synoptic description, the distribution in the world and by states in this country, and host plants are provided. A key to the species based on examined specimens treats 44 species. Specimens of Trialeurodes elaphoglossi Takahashi from Reunion Is., and Trialeurodes meggatti Singh from Burma were not available and because certain pertinent, morphological characters are not mentioned in the descriptions, these two species were not included in the key. Although Bink-Moenen (1983) synonymized Trialeurodes ricini (Misra) with Trialeurodes rara Singh, the two are treated here as separate species because they are often found together on the same leaf. The seven species that do not belong in the genus are listed in the text and although not reassigned to other genera, they are not treated further.

A comprehensive taxonomic study of the world species has never been published. The intent here is to further define the parameters of Trialeurodes and to provide information on the synonyms, distribution, host plants, and economic importance for all species in the world, and to provide a key to the species.

General Distribution

Trialeurodes vaporariorum (Westwood) is almost cosmopolitan in distribution, Trialeurodes rara Singh and Trialeurodes ricini (Misra) are reported from the Orient and Africa, and Trialeurodes packardi (Morrill) has been introduced into Japan from North America. The other 40 species are known only from their native habitats; 37 species from North and South America, one species from the Netherlands, one species from the Mediterranean area, and one species from New Zealand.

Economic Importance

Some Trialeurodes species are destructive pest of cultivated plants. The best known is Trialeurodes vaporariorum (Westwood), the greenhouse whitefly, which damages numerous plants in glasshouses and out-of-doors and recently was found to be a vector of certain viral diseases of vegetable crops. In Asia and Africa, Trialeurodes rara Singh and Trialeurodes ricini (Misra) are pests of castor (Ricinus communis) and cotton (Gossypium hirsutum). In the United States, Trialeurodes packardi (Morrill) is a serious pest of cultivated strawberry (Fragaria sp.), and Trialeurodes abutiloneus (Haldeman) is a serious pest of numerous cultivated plants, such as beans, cotton, eggplant and hibiscus and a vector of yellow dwarf virus of sweetpotato (Russell 1963).

1 Submedial setae present on prothorax, mesothorax and metathorax; body oblong.....ericae Bink-Moenen

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figure 1

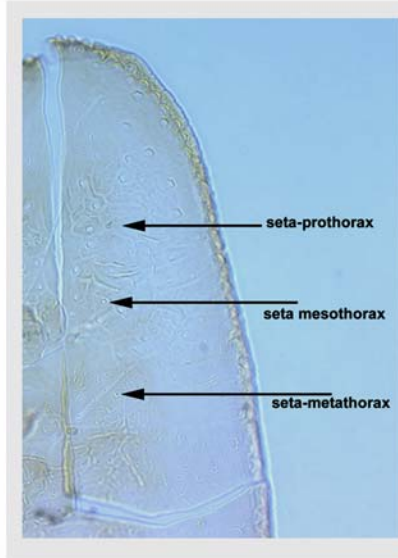


figure 1

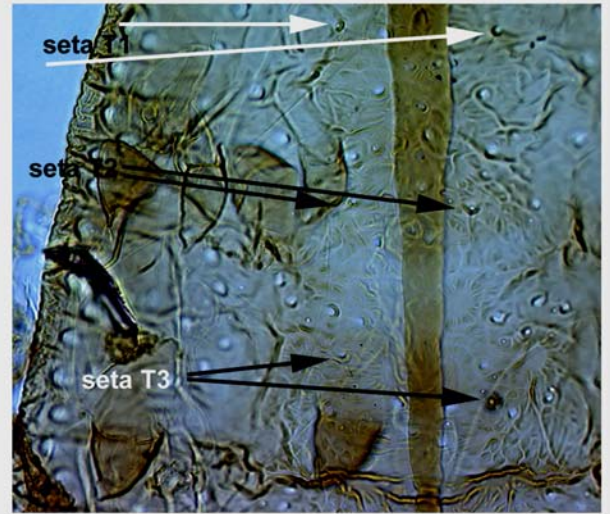


figure 1'

- 1' Less than 3 submedial setae or one cephalothorax absent; body oval.....2
- 2(1) Marginal crenulations relatively broad, no more than 18 and usually fewer than 13 in 100 um; anterior marginal setae present.....3

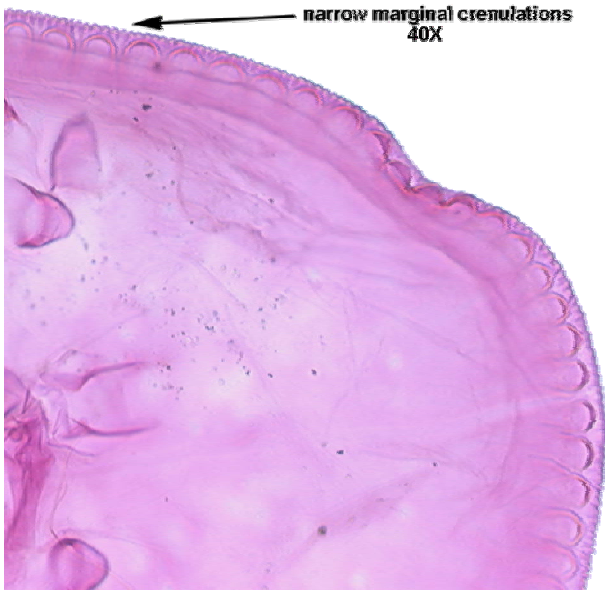


figure 2'

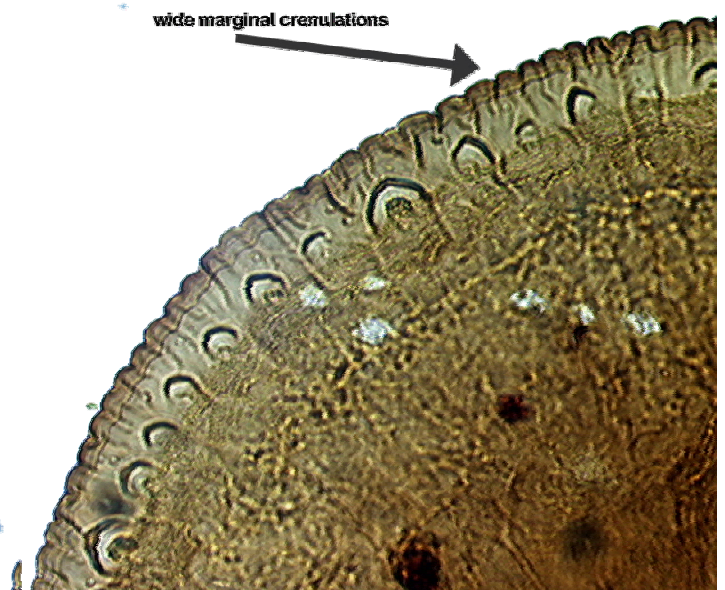


figure 2

- 2' Marginal crenulations relatively narrow, as few as 20 but usually at least 22 in 100 um; anterior marginal setae present or absent.....30
- 3(2) Median section of seventh abdominal suture as far cephalad as sixth suture or beyond so that only 7 segments are visible in median area of abdomen.....4

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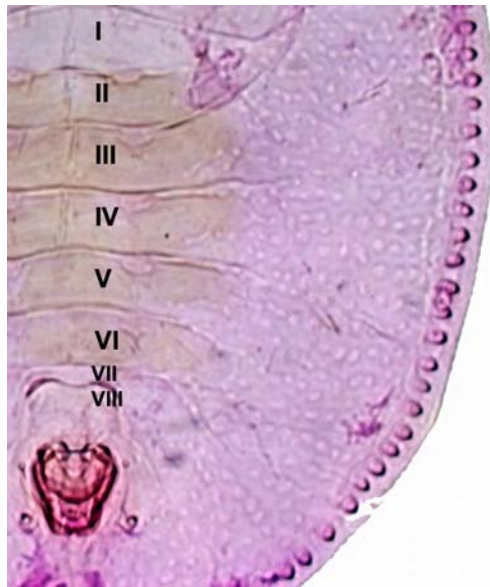


figure 3'

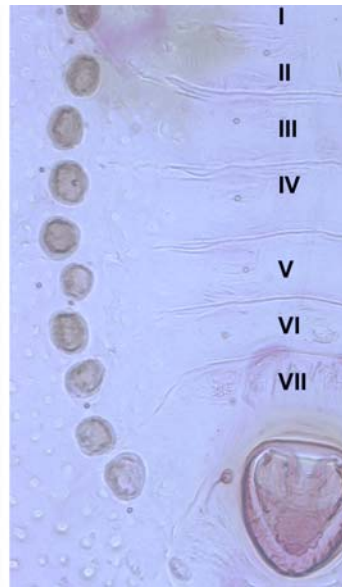


figure 3

- 3' Median section of seventh abdominal suture posterior to sixth suture so that 8 segments are visible in median area of abdomen.....8
- 4(3) Submarginal papillae elongate oval or conical, longer than wide, in single closely set row, tips reaching margin; disc pores on mesal base of submarginal papillae; subdorsal tubercles on cephalothorax and abdomen; inner base of legs without teeth.....5

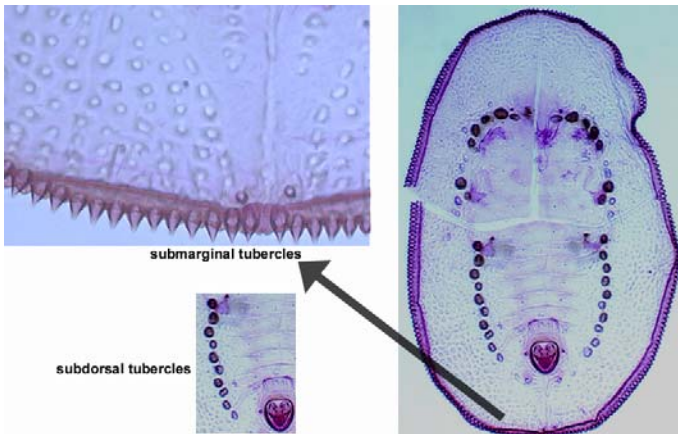


figure 4

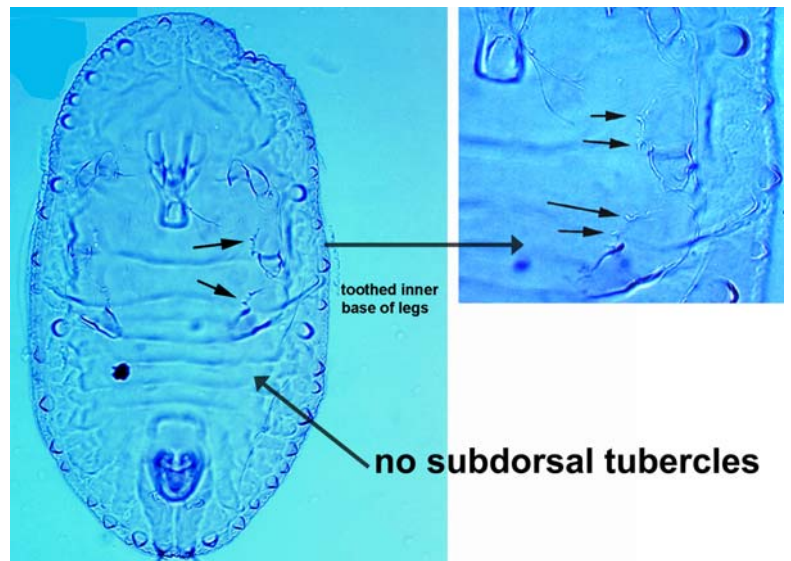


figure 4'

- 4' Submarginal papillae about as long as broad, in irregularly spaced single row or band, less to more than its width from margin; disc pores distad or interspersed among submarginal papillae; subdorsal tubercles absent; inner base of legs toothed.....6
- 5(4) Tip of lingula exposed; submarginal papillae elongate oval, sides almost parallel except near outer end; dorsal disc pores numerous, 9-14 pores on each side of abdominal segments III-VII.....*oblongifoliae* Russell

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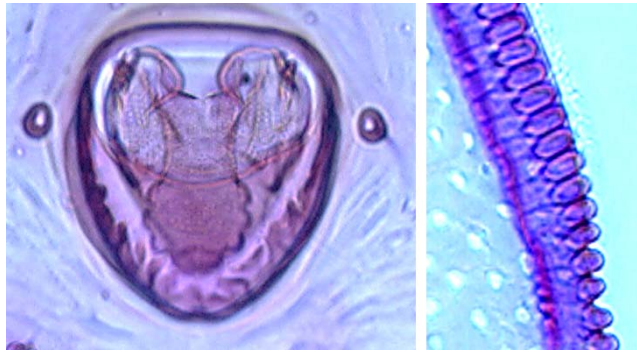


figure 5

- 5' Tip of lingula covered by operculum; submarginal papillae conical; dorsal disc pores fewer, 5-6 pores on each side of segments III-VII.....mirissimus Sampson & Drews

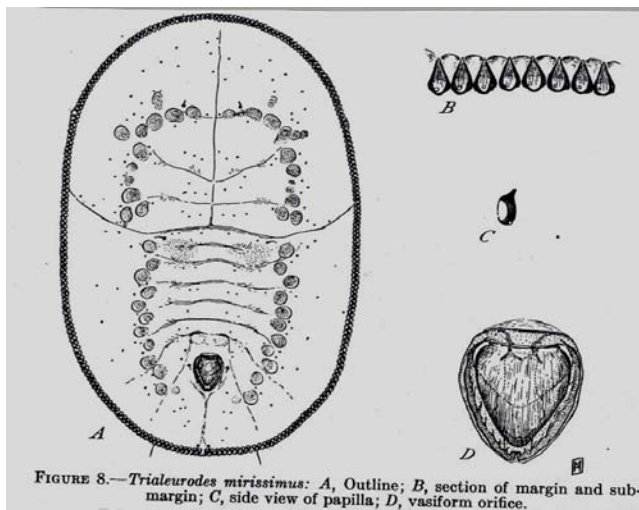
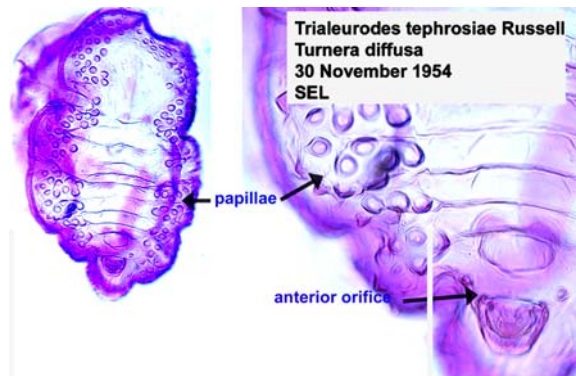


FIGURE 8.—*Trialeurodes mirissimus*: A, Outline; B, section of margin and submargin; C, side view of papilla; D, vasiform orifice.

Drawing from Russell, 1948

- 6(4) Anterior rim of vasiform orifice not defined; without median tuberculated area on segments I-II; submarginal papillae in submarginal-subdorsal band on each side;.....tephrosiae Russell



- 6' Anterior rim of vasiform orifice distinct; median tuberculated area on segment I, often on II; submarginal papillae in irregular spaced single row.....7

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- 7(6) Cephalic, first abdominal and eighth abdominal setae long, 75-100 um; thoracic tracheal pore area with 3-4 crenulations differentiated from marginal crenulations; majority of submarginal papillae and some dorsal papillae present.....similis Russell

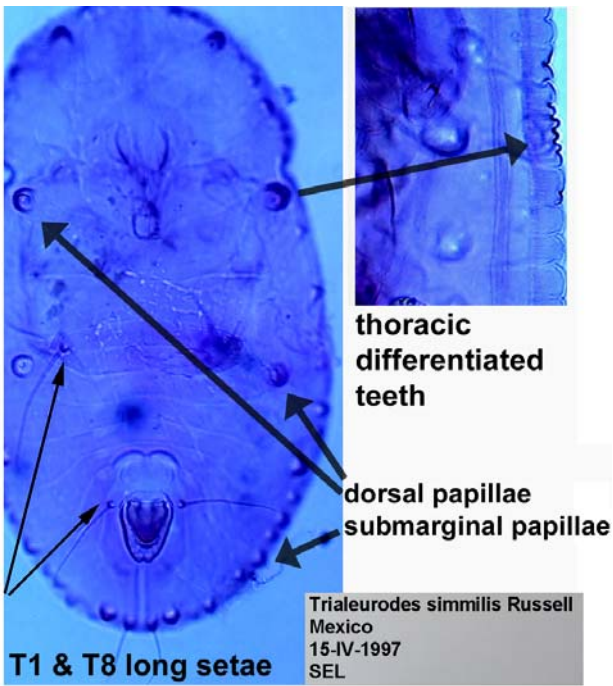


figure 7

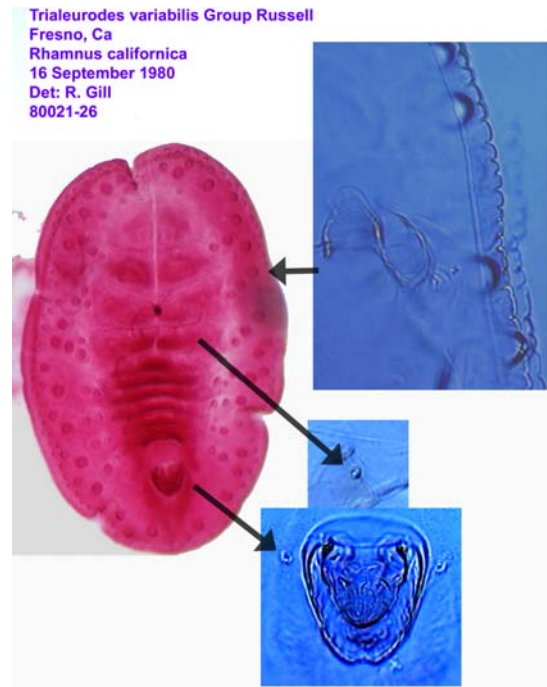
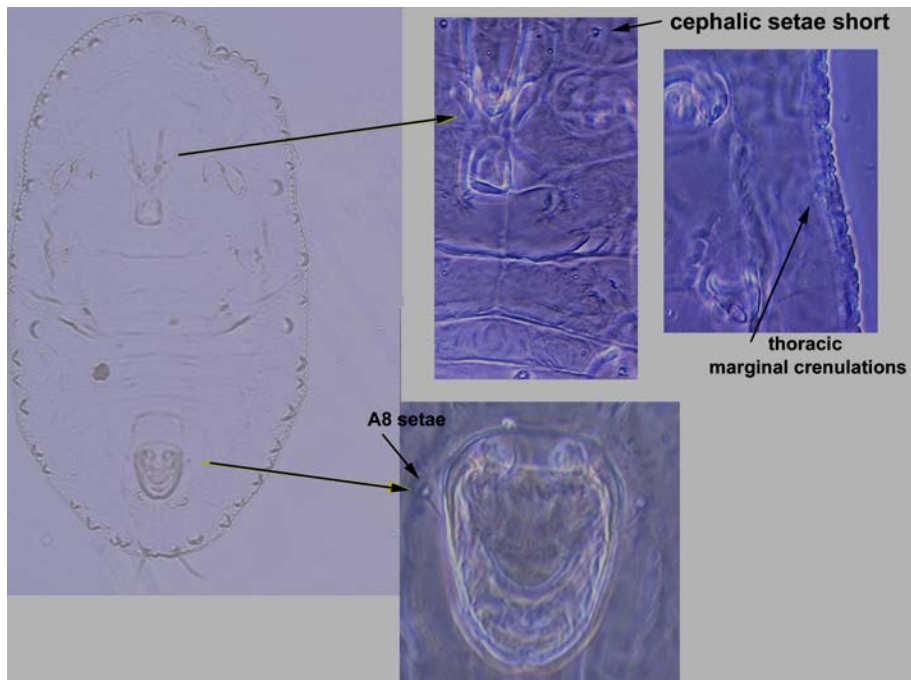


figure 7'

- 7' Cephalic, first abdominal and eighth abdominal setae short, 9-16 um; thoracic pore area without differentiated crenulations; some or none of submarginal papillae and rarely dorsal papillae developedvariabilis (Quaintance)



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8(3) Dorsal derm completely brown or black, thick and heavily sclerotized.....9

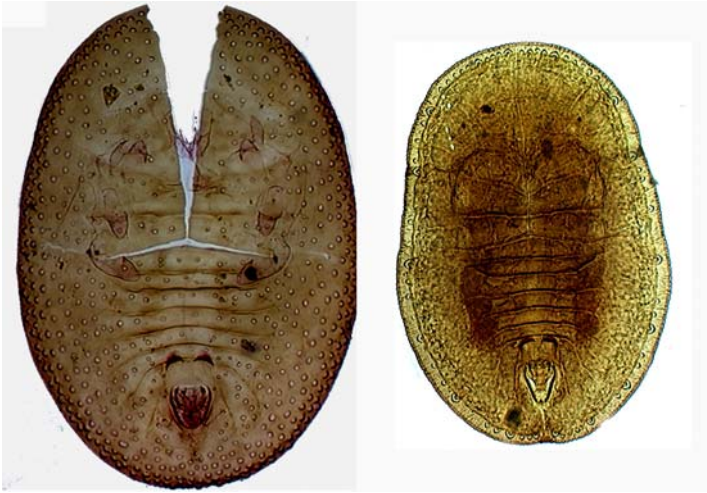


figure 8

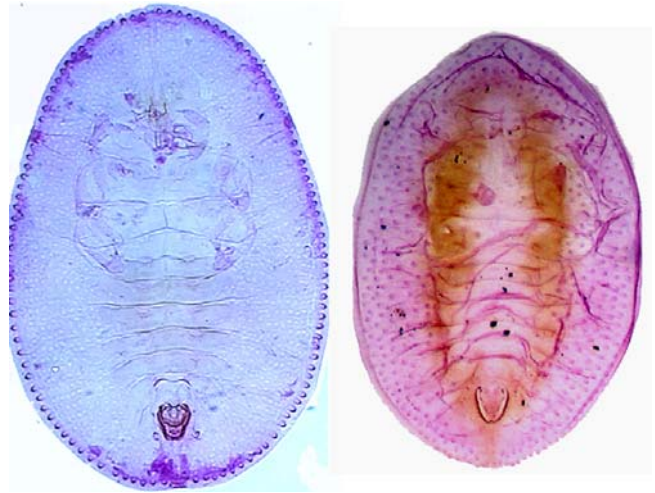
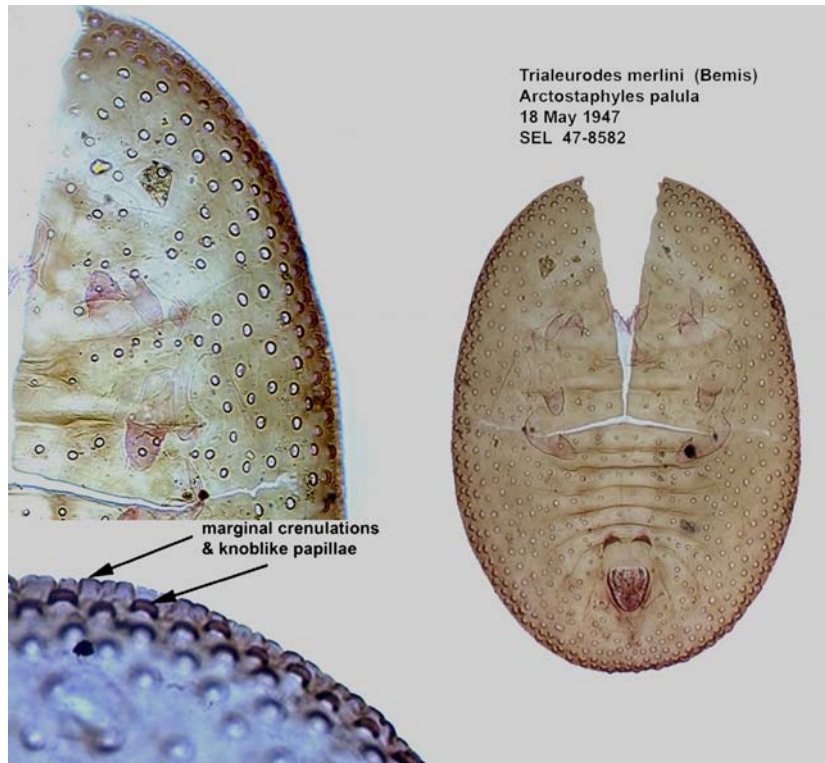


figure 8'

8' Dorsal derm usually pale yellow or colorless, or with subdorsal longitudinal dark band on each side, thin and membranous or slightly sclerotized.....13

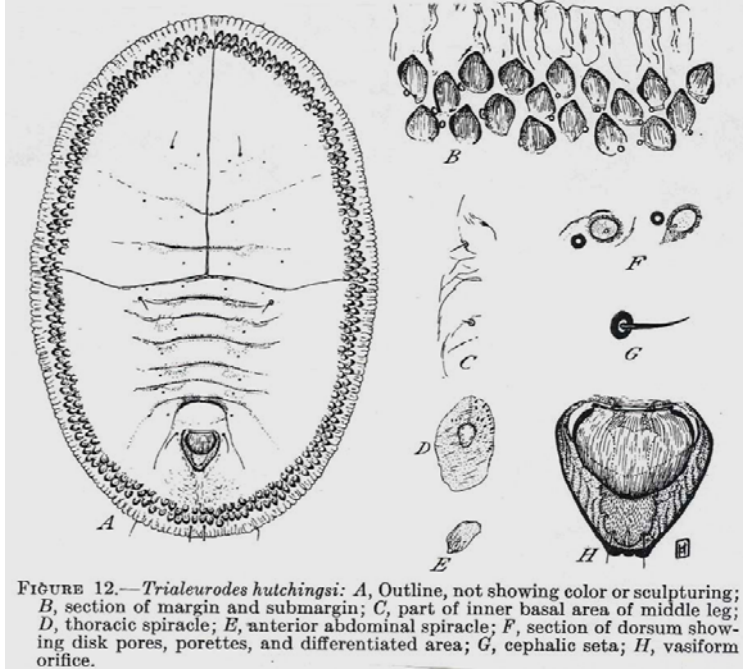
9(8) Papillae somewhat crescent-shaped or knoblike, not in differentiated submarginal row, scattered on dorsum but in somewhat of segmental arrangement with smaller papillae mesally.....merlini (Bemis)



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9' Papillae shaped differently, in distinct submarginal row.....10

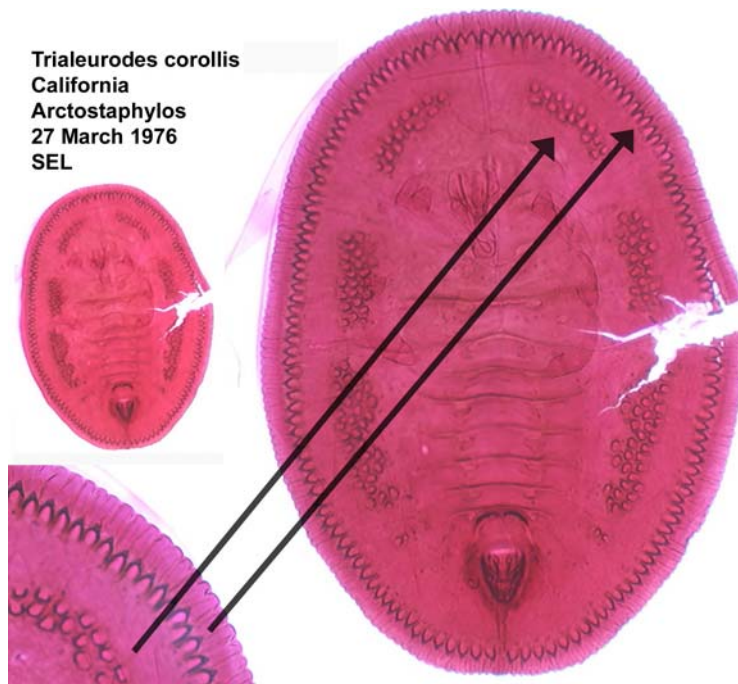
10(9) Submarginal papillae in 2-3 irregular rows.....hutchingsi (Bemis)



drawing fom Russell, 1948

10' Submarginal papillae in 1 irregular row.....11

11(10) Subdorsal papillae in 3 clusters on each side; submarginal papillae elongate, their tips drawnout, acute, and about twice the length of a papilla from margin.....corollis (Penny)



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- 11' Subdorsal papillae absent or not in clusters; submarginal papillae without drawn out tips, largest papillae about their length from margin or closer.....12
- 12(11) Majority of submarginal disc pores slightly mesad of base of papillae; papillae conical, rather similar in size, less than their length from margin; black.....madroni (Bemis)

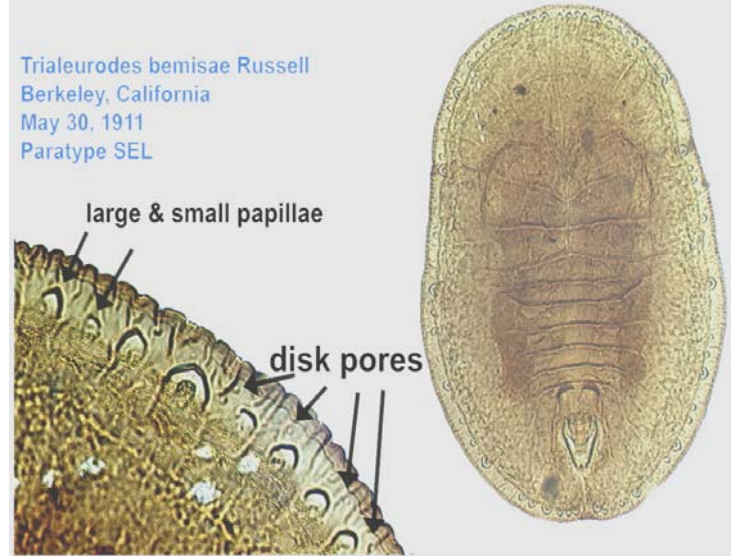
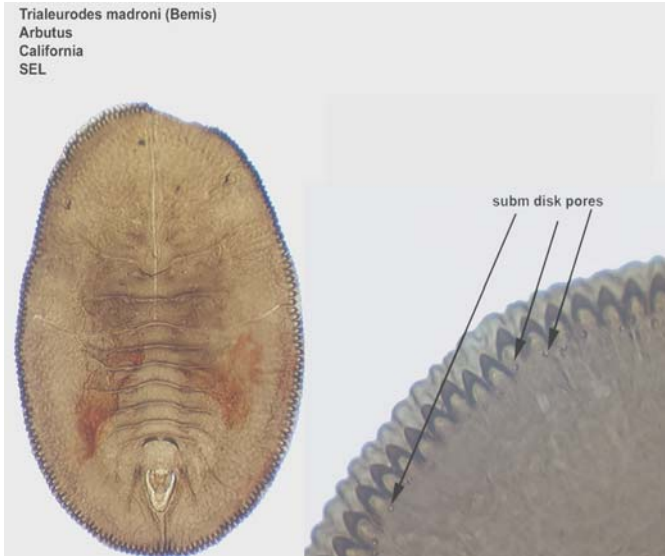
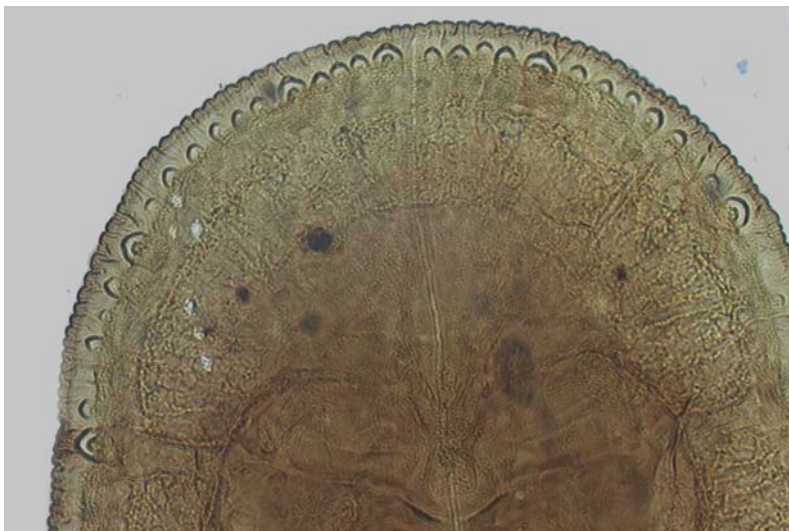


figure 12

figure 12'

- 12' Majority of submarginal disc pores aligned along tips of papillae; papillae broadly conical, larger papillae interspersed with smaller papillae in fairly uniform intervals, at least their length from margin; brown.....bemisae Russell



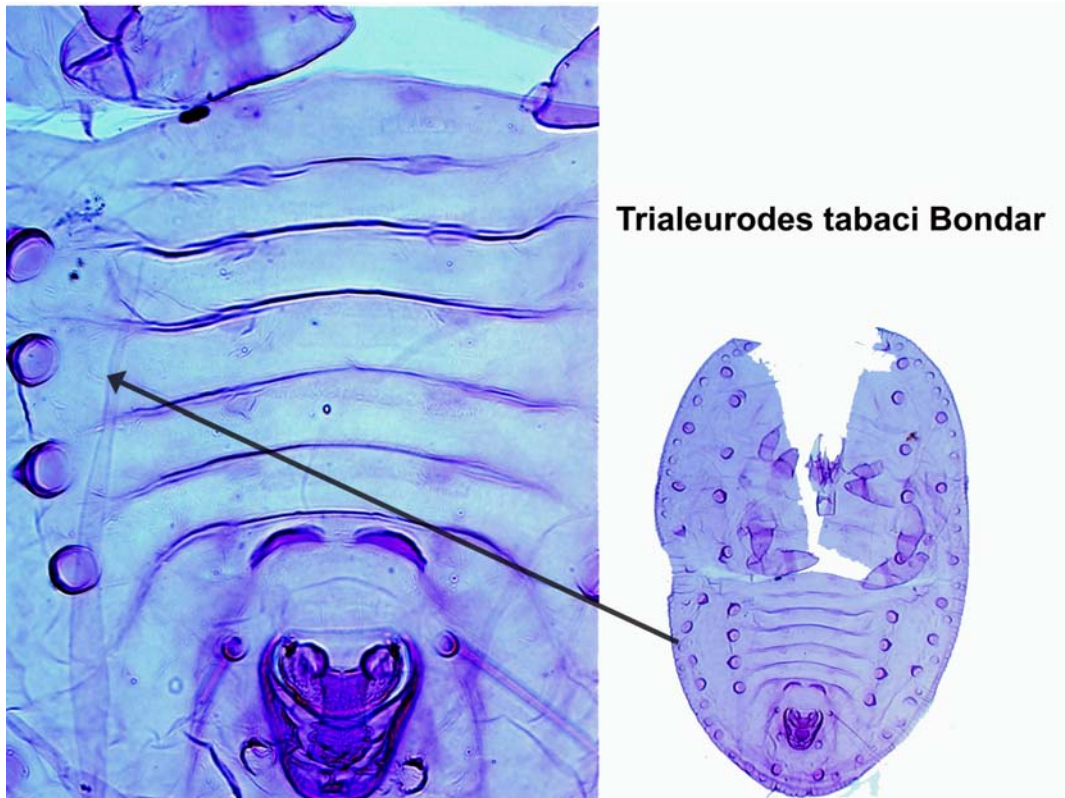
- 13(8) First abdominal setae absent.....14

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13' First abdominal setae present.....17



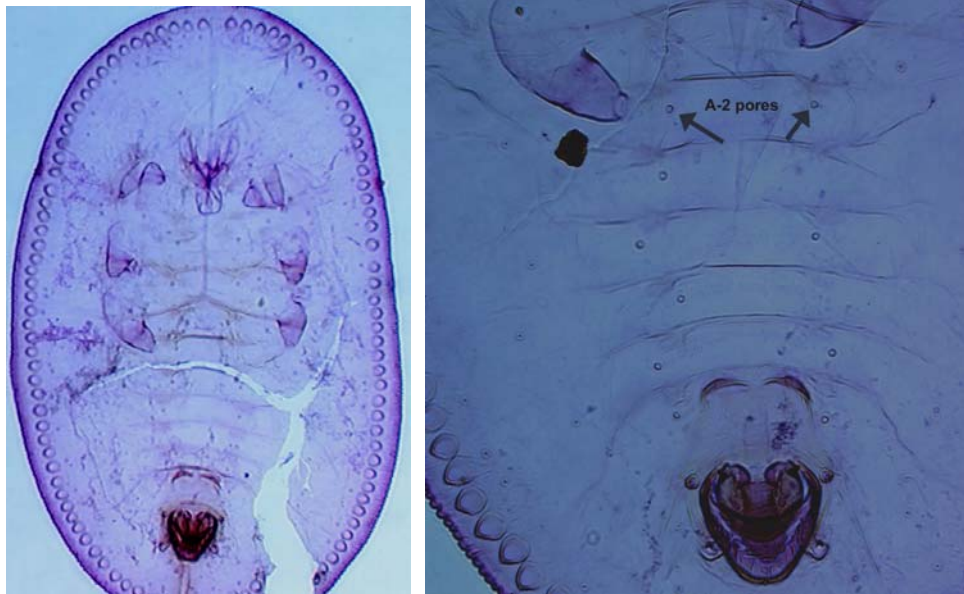
14(3) Subdorsal papillae present; about 12 or as few as 9 marginal crenulations in 100 um; submedian disc pores absent from abdominal segment II; submarginal papillae in single or irregular double rows, rather closely set or more than their width apart majority of submarginal disc pores between papillae and margin, or mesad of papillae.....15



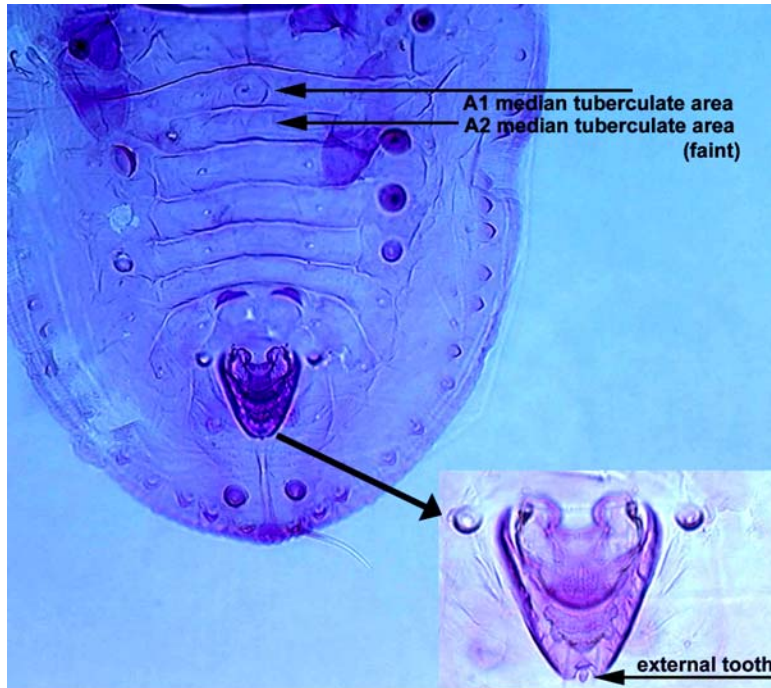
14' Subdorsal papillae absent; about 18 marginal crenulations in 100um; 1 pair of disc pores on abdominal segment II; submarginal papillae in single row, separated by about 1/2 their width about 1/2 of submarginal disc

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pores slightly mesad of papillae, the remainder between papillae and margintentaculatus (Bemis)



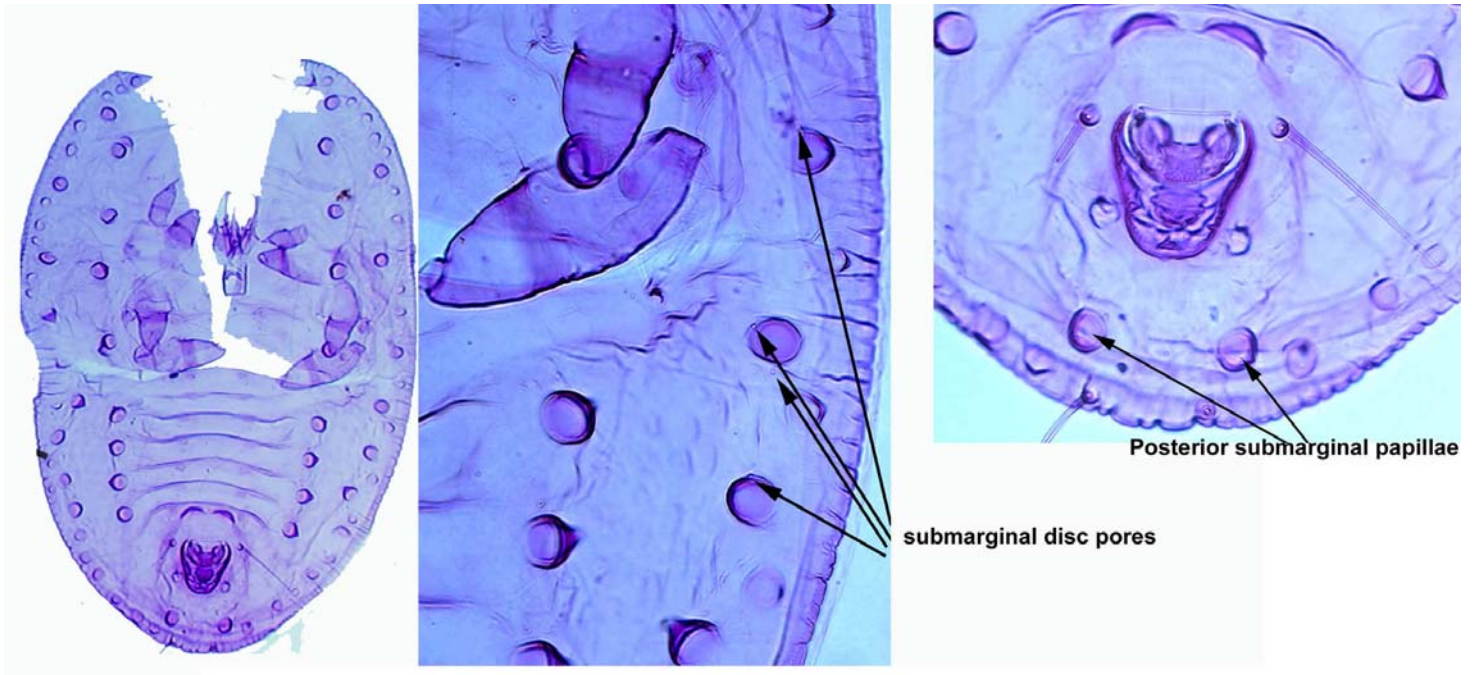
15(14) Median tuberculate area on abdominal segments I-II; posterior pair of submarginal papillae anterior to caudal setae, not aligned with other papillae; papillae in single row, usually separated by distance equal to their width or farther apart; vasiform orifice with small, median, external tooth at posterior endnotata Russell



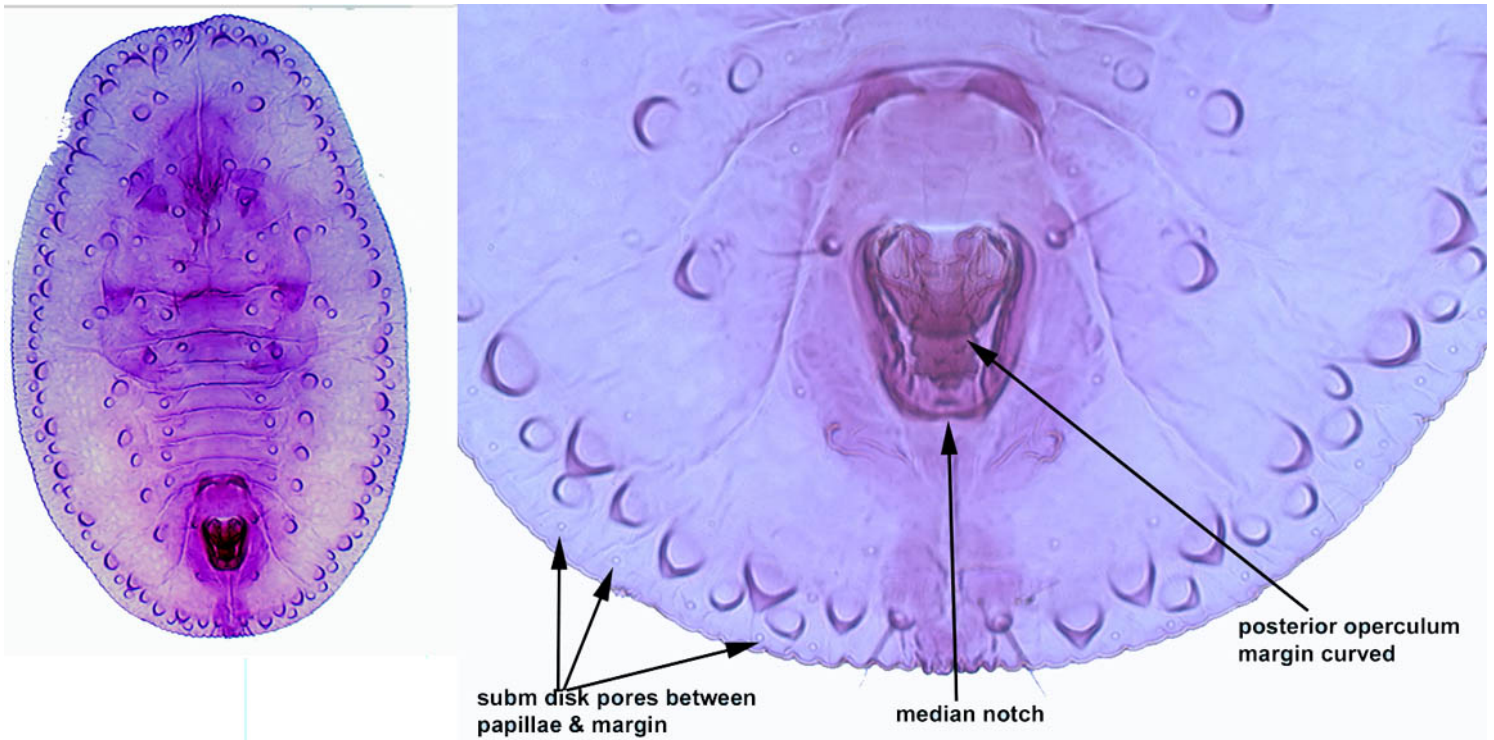
15' Median tuberculate area absent from segments I-II; (posterior pair of submarginal papillae in line with other papillae); other characters variable.....16

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16(15) Posterior pair of submarginal papillae anterior to caudal setae; submarginal disc pores mesad of papillae or among papillae; operculum with posterior margin subtruncate; vasiform orifice lacking median notch on posterior end.....tabaci (Bondar)

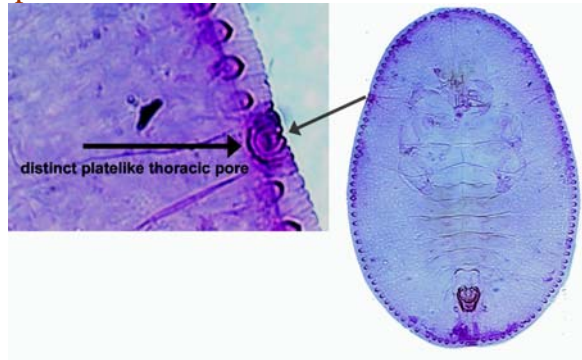


16' Posterior pair of submarginal papillae not anterior to caudal setae; majority of submarginal disc pores between papillae and body margin operculum with posterior margin curved; vasiform orifice with median, notch on posterior end.....drewsi Sampson



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17(13) Cephalic setae absent; tracheal pore area with distinct, platelike pore; submarginal disc pores in row mesad of papillae by about length of papilla.....asplenii (Maskell)



17' Cephalic setae present; other characters different.....18

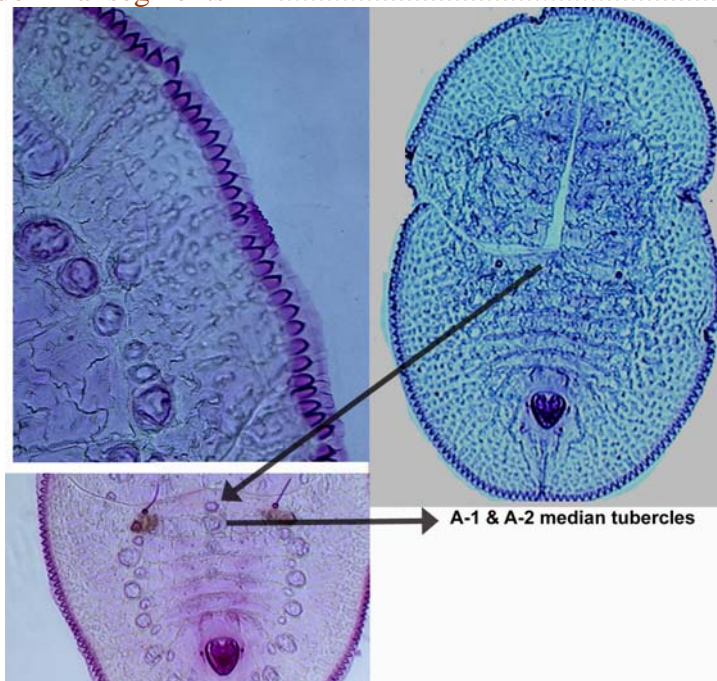
18(17) Submarginal papillae elongate oval or conical, longer than wide, subequal in size, in close-set single row, tips pointed laterad; submarginal disc pores on mesal part of papillae19

18' Submarginal papillae broadly conical, as broad as long or broader than long, subequal or different in sizes, separated by various distances, in single or multiple irregular rows, tips pointed laterad, diagonally or vertically; submarginal disc pores between papillae and margin, among papillae or mesad of papillae26

19(18) Abdomen with medial and/or subdorsal tubercles20

19' Abdomen without tubercles.....22

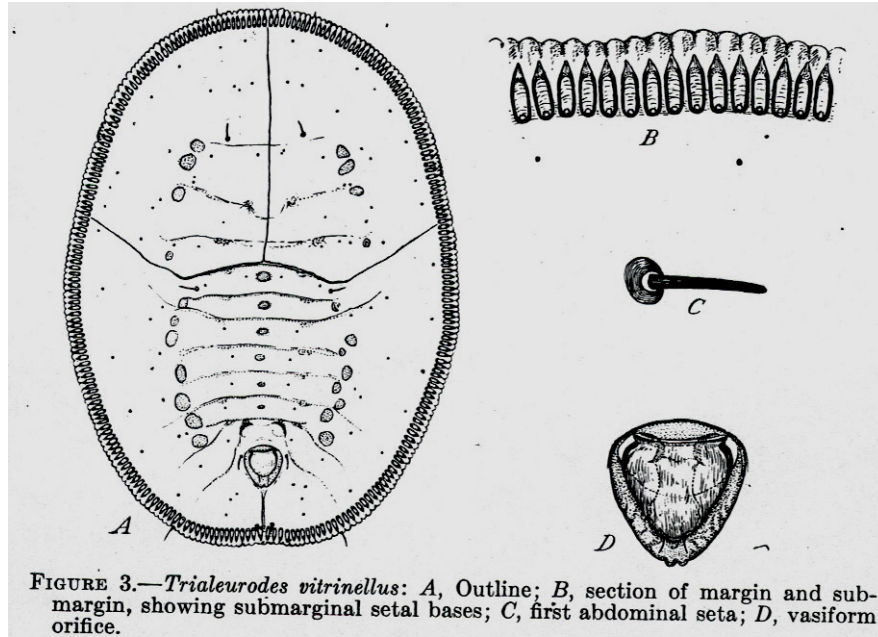
20(19) Marginal crenulations variable in width, smaller ones interspersed with larger ones, about 16 per 100 um; median tubercles on abdominal segments I-II.....floridensis (Quaintance)



20' Marginal crenulations about same width, 10-12 per 100 um; median tubercles present or absent from abdomen21

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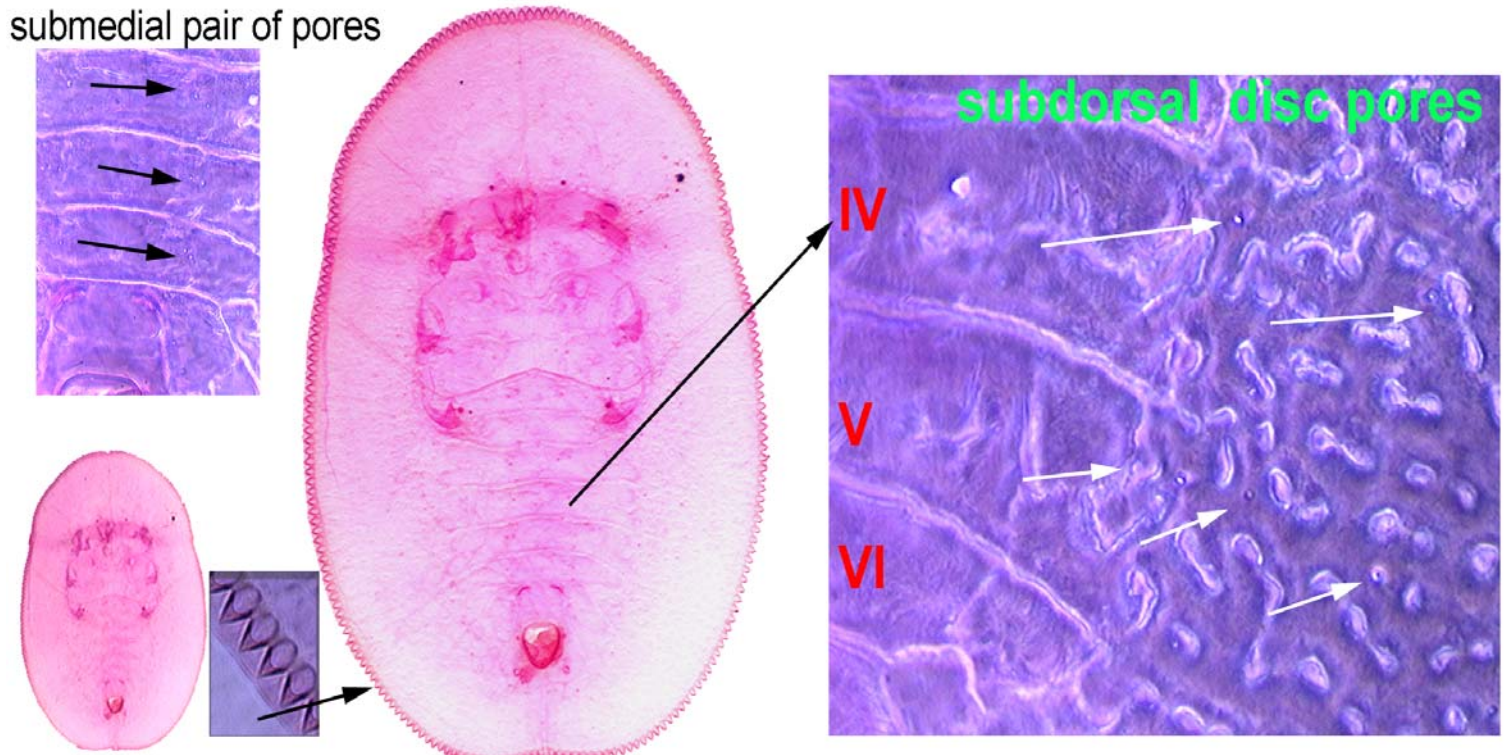
21(20) Median tubercles present on abdominal segments I-V or VI; 2-3 pairs of disc pores on IV-VI; submarginal papillae with rather parallel sides before tapering; lingula hidden by operculumvitrinellus Cockerell



drawing by Russell 1943

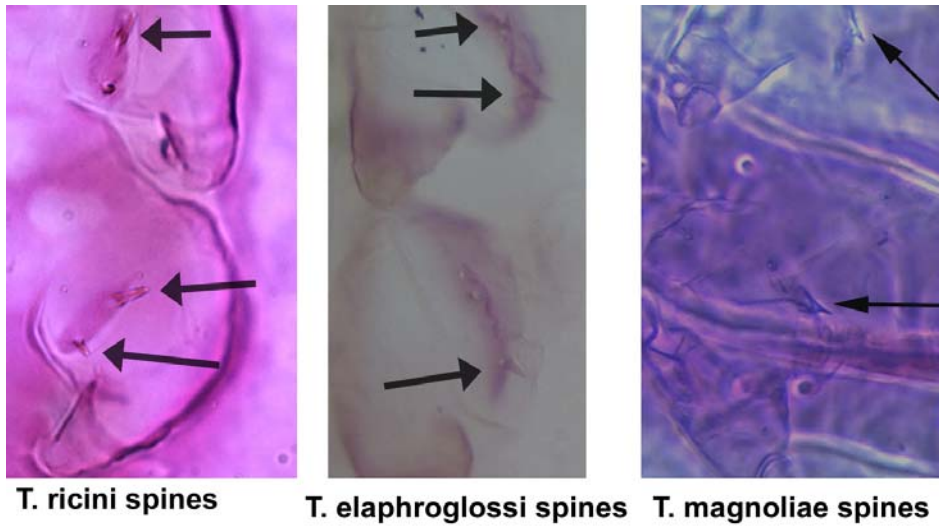
21' Median tubercles absent from abdomen; 5 pairs of disc pores on abdominal segments IV-VI; submarginal papillae conical; apex of lingula exposedcocolobae Russell

submedial pair of pores



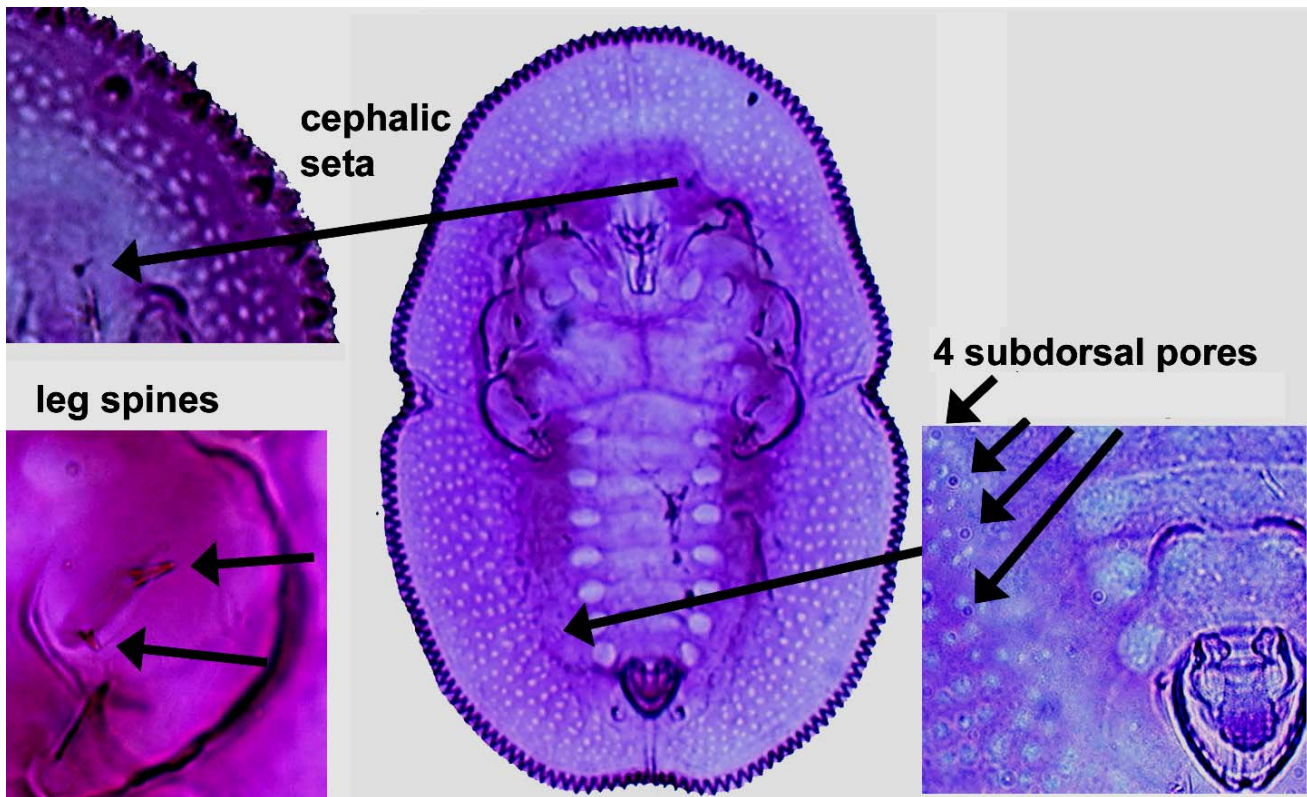
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22(19) Legs with 1 or 2 spines.....23



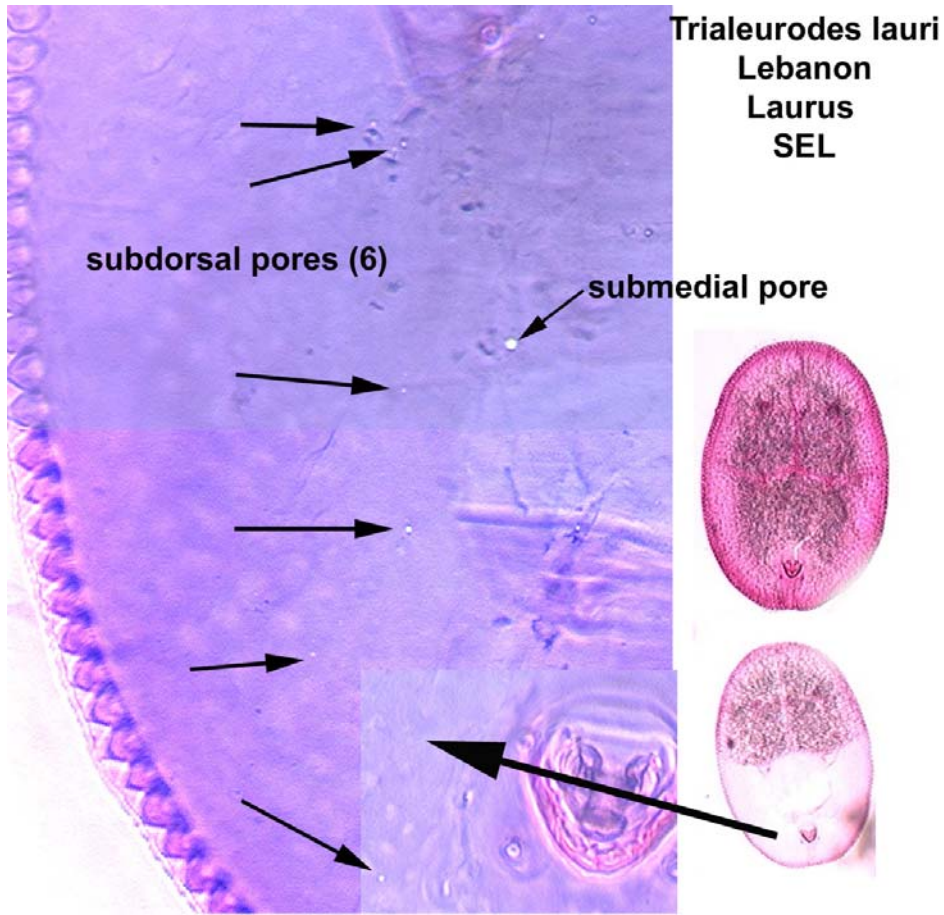
22' Legs lacking spines, only setae present.....24

23(22) Cephalic setae present; normally with 4 subdorsal disc pores on each side of abdomenT. ricini (Misra)



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23' Cephalic setae absent; normally with 6 subdorsal disc pores on each side of abdomen.....lauri (Signoret)



24(22) Submedian disc pores absent from abdominal segment VIII anterior to vasiform orifice; segments III-VII each with 0-5 pairs of dorsal disc pores; vasiform orifice without notch on posterior endintermedia Russell

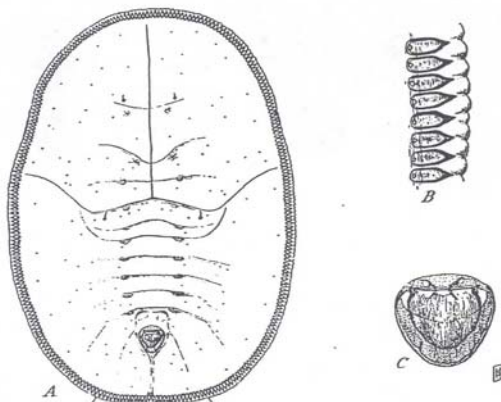
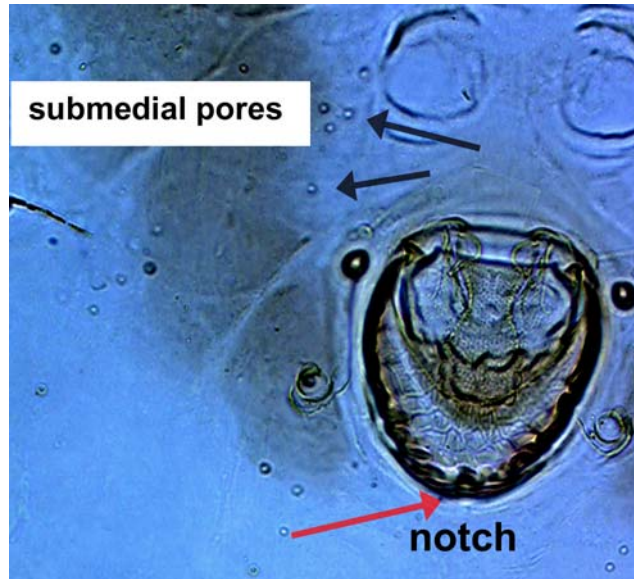


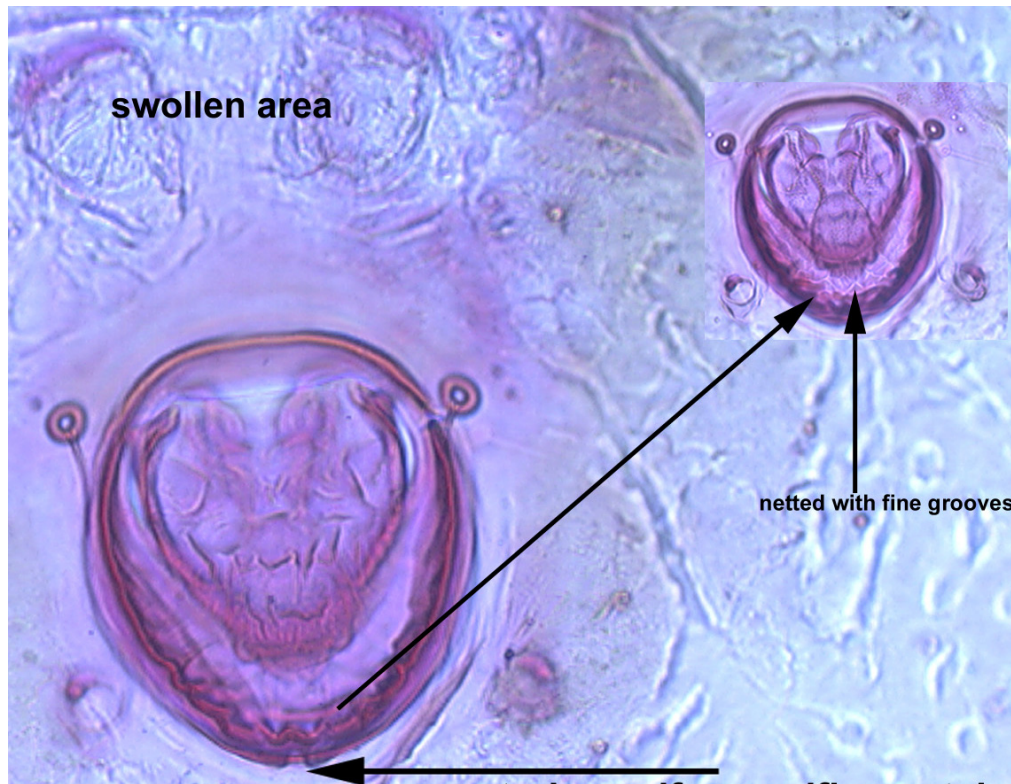
FIGURE 2.—*Trialeurodes intermedia*: A, Outline; B, section of margin and submargin; C, vasiform orifice.

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- 24' Submedian disc pores present on abdominal segment VIII anterior to vasiform orifice; segments III-VII each with more than 5 pairs of disc pores; vasiform orifice with notch on posterior end25

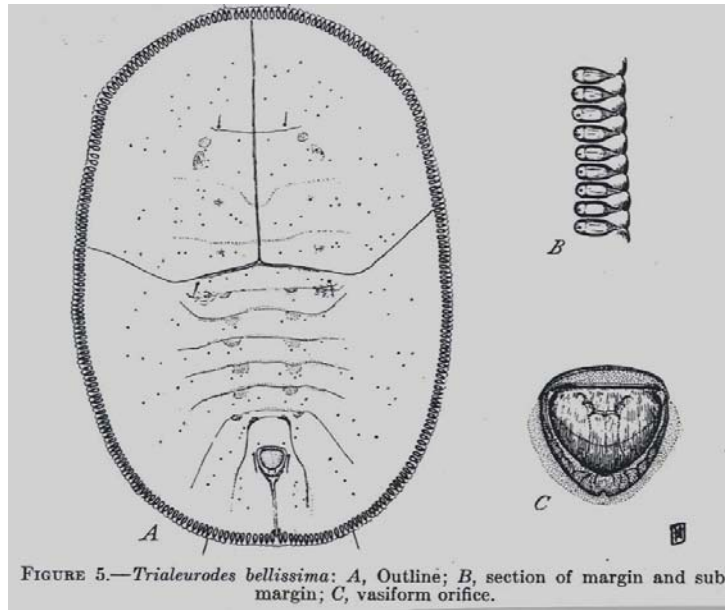


- 25(24) Numerous dorsal disc pores, more than 11 pairs on each abdominal segment; segment VIII with conspicuous swollen area posterior to pockets; vasiform orifice with bottom netted with fine grooves; usually with longitudinal, dark subdorsal band on each sidemultiporti Russell

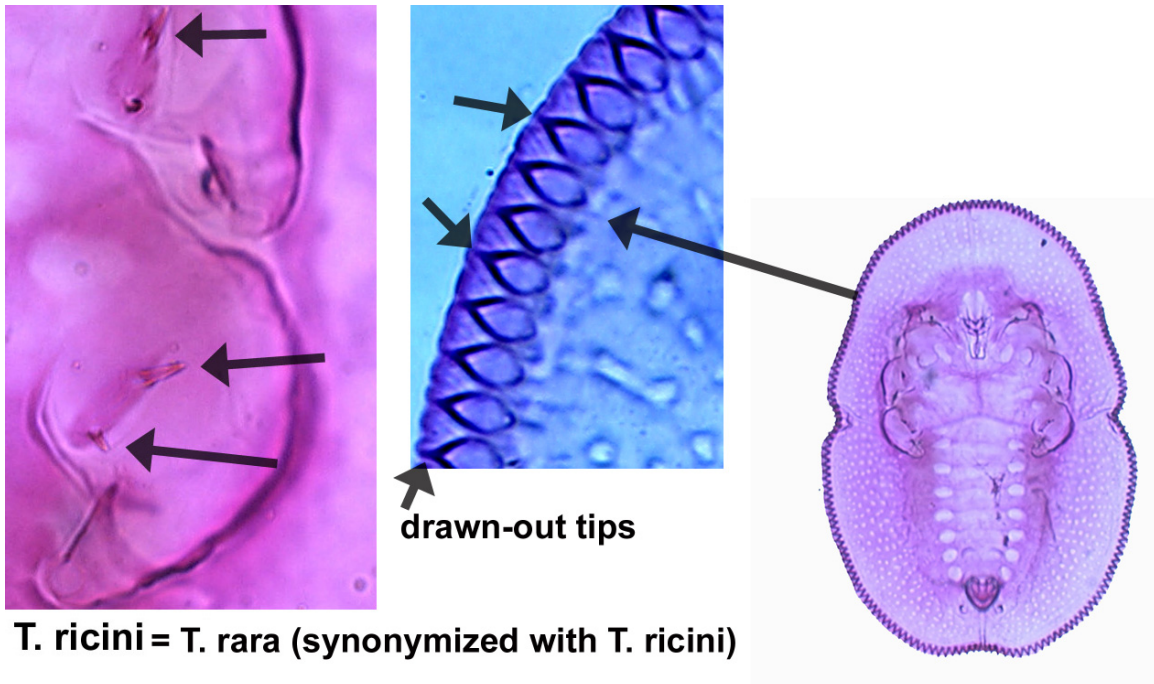


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- 25' Disc pores less than 11 pairs on each side abdominal segment; segment VIII without swollen area posterior to pockets; vasiform orifice with bottom smooth; dark longitudinal bands absent
bellissima (Sampson & Drews)



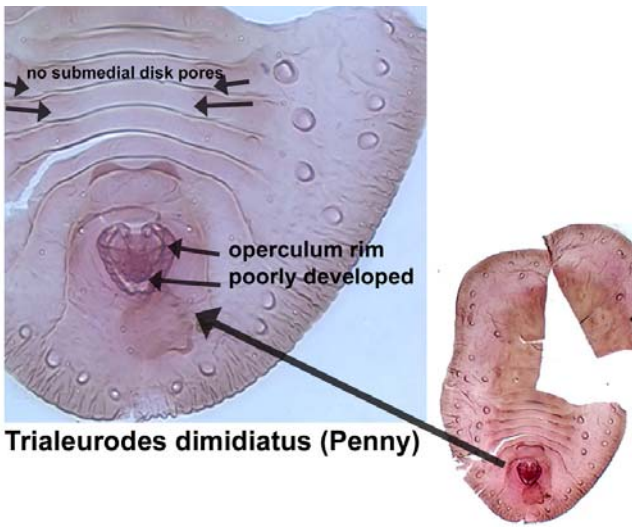
- 26(18) Legs with 1 or 2 spines; submarginal papillae with somewhat drawn out tips, funnel shape; submedial papillae absentrara Singh (= *T. ricini*)



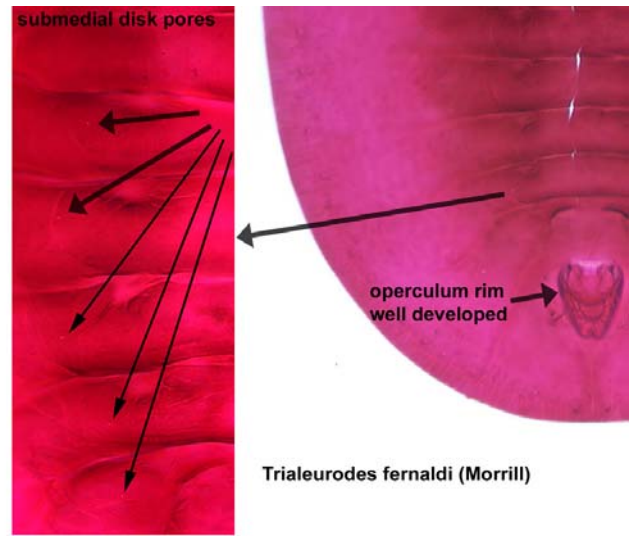
- 26' Legs lacking spines, only with setae; papillae not funnel shape; submedial papillae present or absent.....27

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27(26) Operculum completely covering lingula, its length at least $\frac{3}{4}$ the length of vasiform orifice; rim poorly differentiated from adjacent derm; abdominal segments III-VI without submedian disc pores on 1 or 2 segmentsdimidiatus (Penny)



Trialeurodes dimidiatus (Penny)



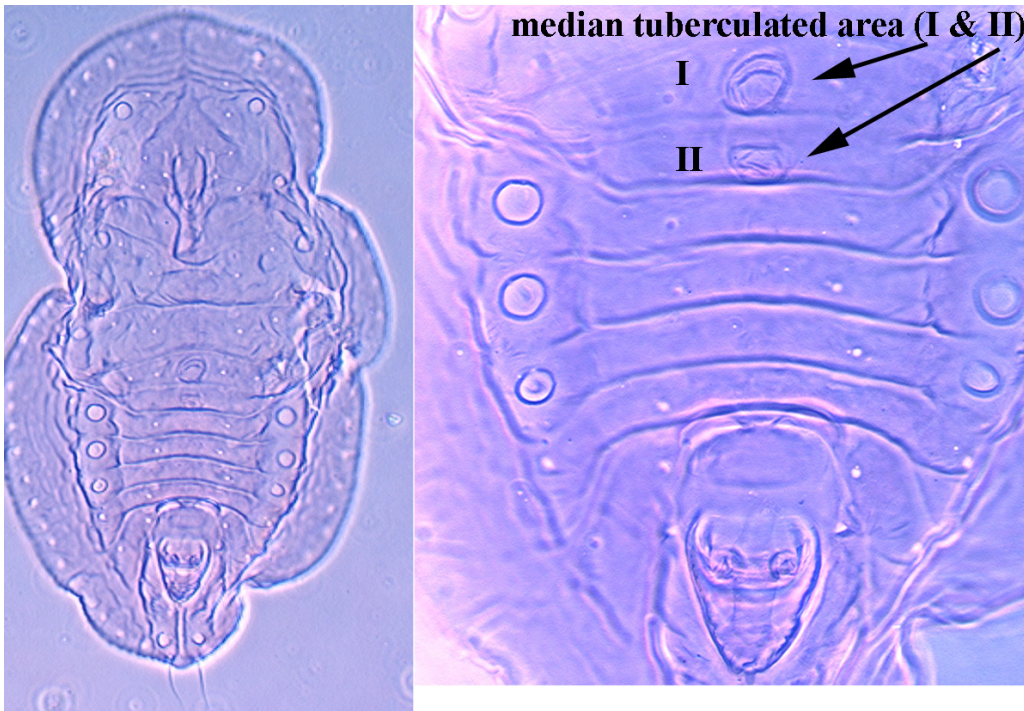
Trialeurodes fernaldi (Morrill)

figure 27

figure 27'

27' Operculum not reaching beyond third lobes of lingula, its length about $\frac{2}{3}$ the length of vasiform orifice; rims distinct from adjacent derm; abdominal segments III-VI with disc pores28

28(27) Dorsum with a conspicuous, lightly sclerotized subdorsal ridge containing subdorsal disc pores and papillae; median tuberculated area on segments I-IIvaria Quaintance & Baker

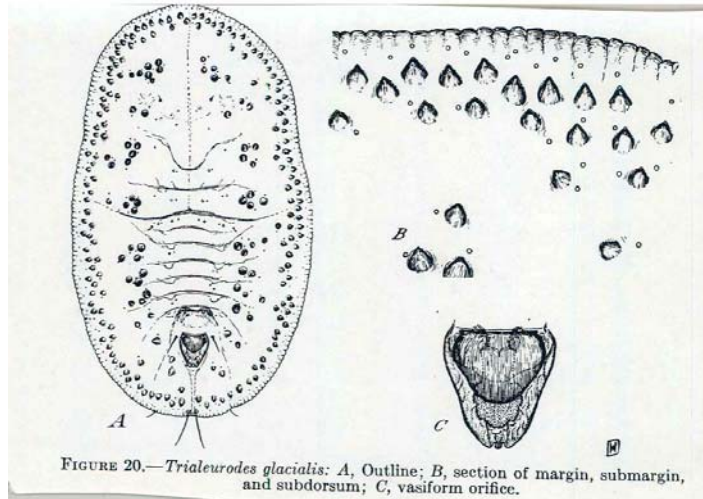


28' Dorsum without subdorsal ridge; median tuberculated area absent from abdomen.....29

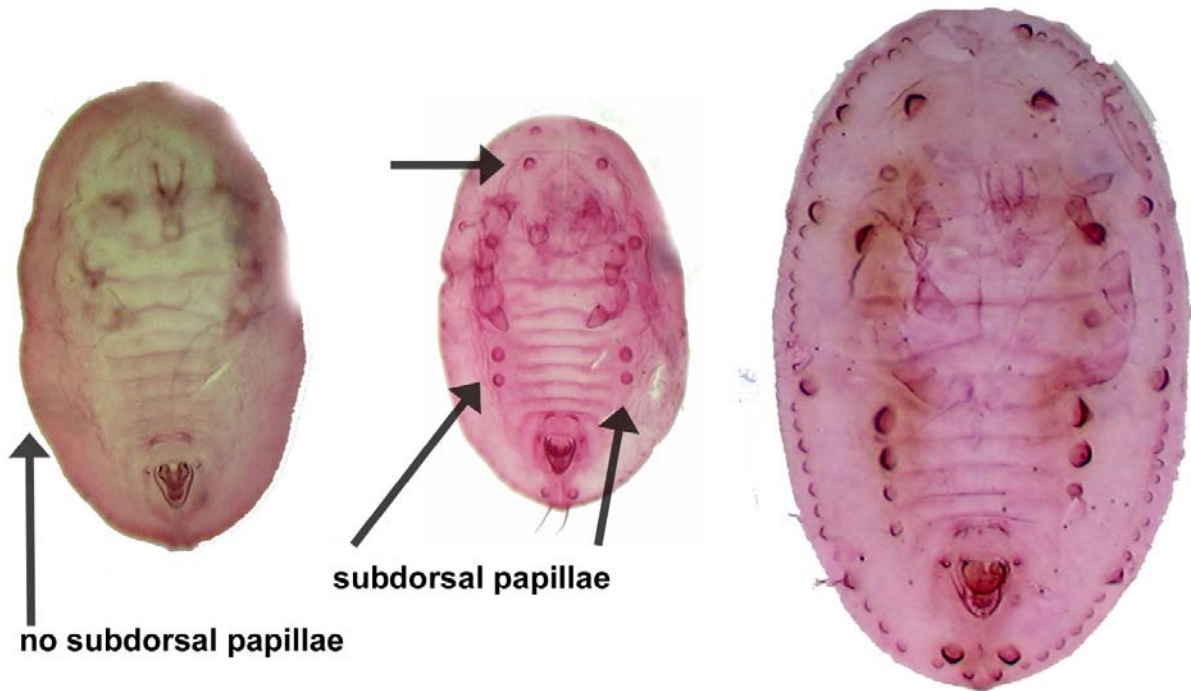
29(28) Submarginal papillae about twice their width from margin, about equal in size, in irregular single to triple

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rows; subdorsal clusters or band of papillae on each side, often with submedial row of smaller papillae
 glacialis (Bemis)



29' Submarginal papillae about their width or less from margin, about equal in size or few large interspersed ones, in irregular single row; large papillae and often small ones in single row on subdorsum, or papillae absent from dorsal discvaporariorum (Westwood)



30(2) Median section of VII abdominal suture posterior to VI suture so that 8 segments are visible in median area of abdomen; anterior marginal setae present; each leg with at least one spine.....31

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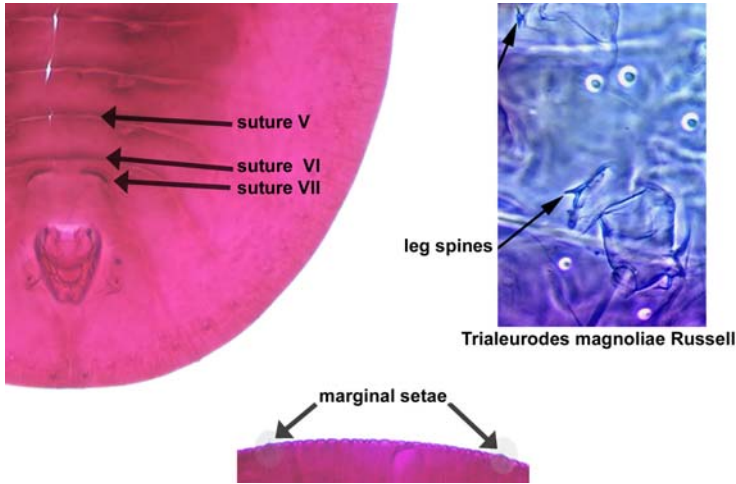


figure 30

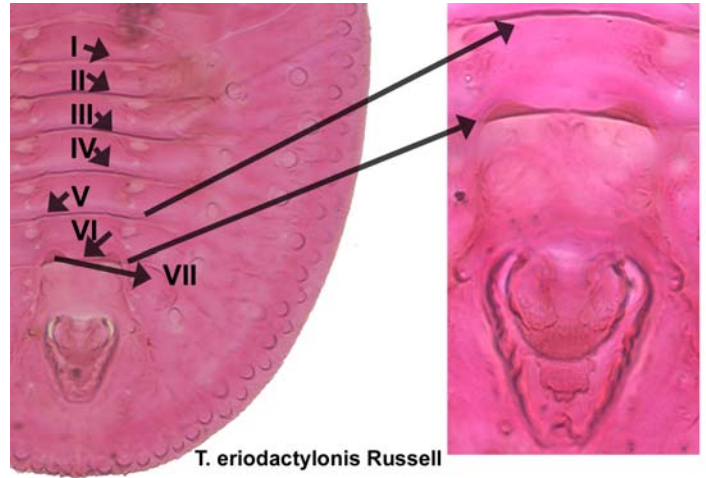
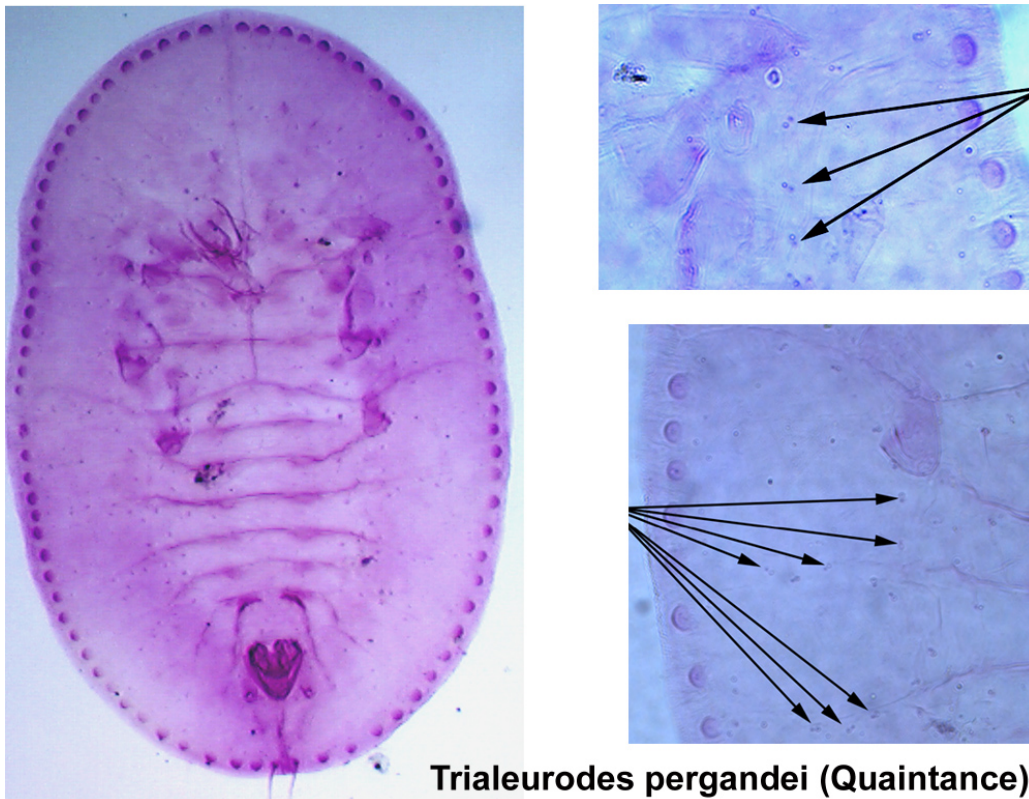


figure 30'

30' Median section of VII abdominal suture as far cephalad as VI suture or beyond so that 7 segments are visible in median area of abdomen; anterior marginal setae absent; legs without spine.....38

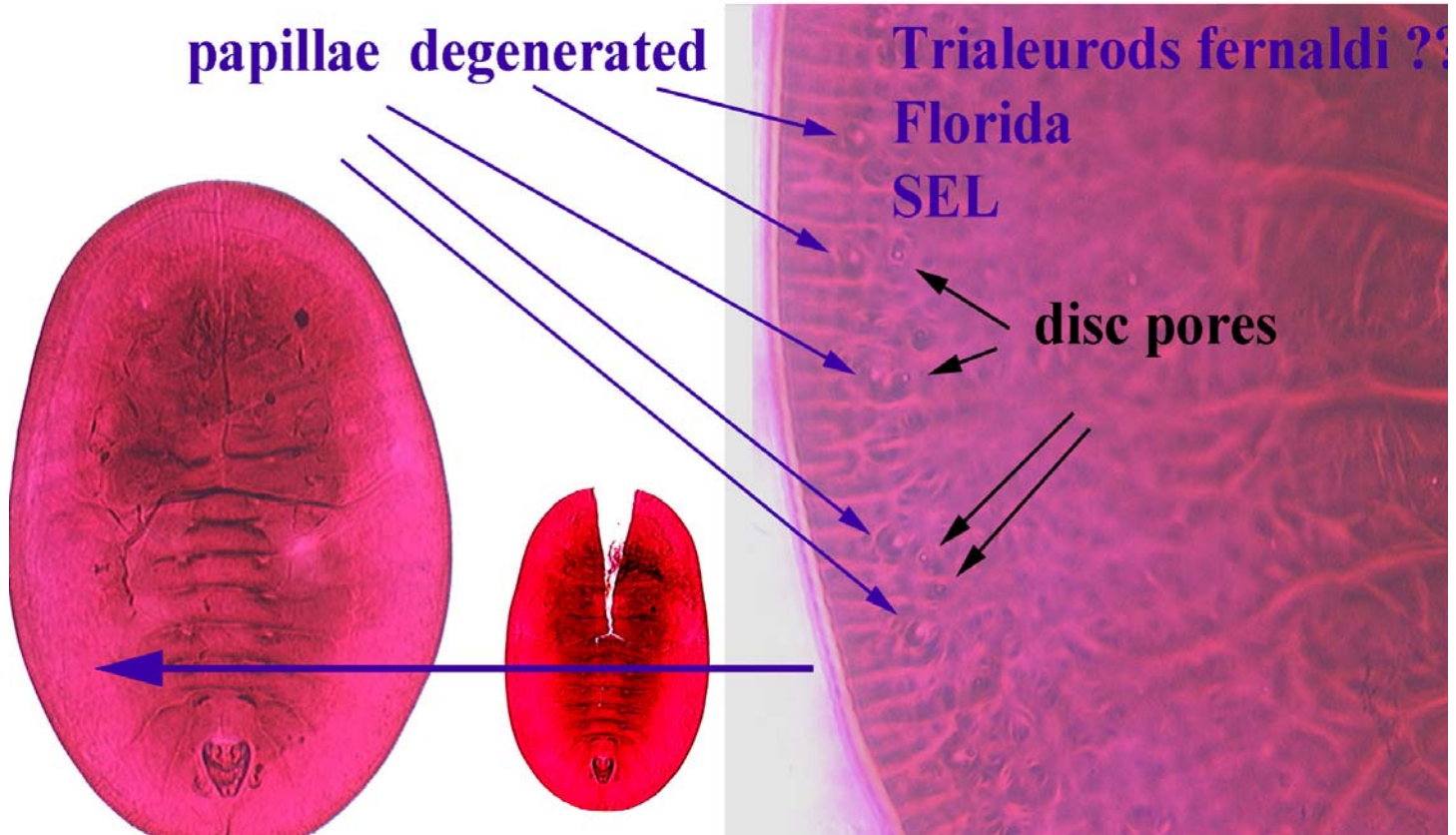
31(30) Dorsal disc pores numerous, aligned in 3 scalloplike lines on each side of cephalo-thorax and 3 semilunar lines on each side of abdomen; submedian disc pores absent from abdominal segments V-VIII; marginal crenulations about 30 per 100 mu; submarginal papillae slightly wider than long, in single row about 1/2 their width apartpergandei (Quaintance)



Trialeurodes pergandei (Quaintance)

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- 31' Dorsal disc pores not aligned in scalloplike or semilunar lines; submedian disc pores present on abdominal segments V-VII; marginal crenulations 28 or less; submarginal papillae present or absent, arrangement variable.....32
- 32(31) Submarginal disc pores mesad of papillae by two to four times the diameter of a papillae, papillae degenerate, indistinct, in single row indicated by lined, circular area, often situated on a minute prominence; papillae absent from dorsal disc.....fernaldi (Morrill)



- 32' Submarginal disc pores mesad of submarginal papillae by slightly more than the diameter of a papillae or closer; submarginal papillae well developed, degenerate or reduced and craterlike; papillae present or absent from dorsal disc.....33
- 33(32) Operculum completely covering lingula or exposing only tip of lingula; elongated setae of lingula not reaching posterior rim of orifice.....34
- 33' Operculum reaching only to the third or second lateral lobes of lingula; elongate setae on lingula extending beyond edge of posterior rim.....35

- 34(33) Submarginal papillae in single row, papillae contiguous or nearly so; each leg with two spines, 2-4 um long;

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dorsal submedial-medial area dark brown, surrounded by broad, yellow marginal band..... heucherae Russell

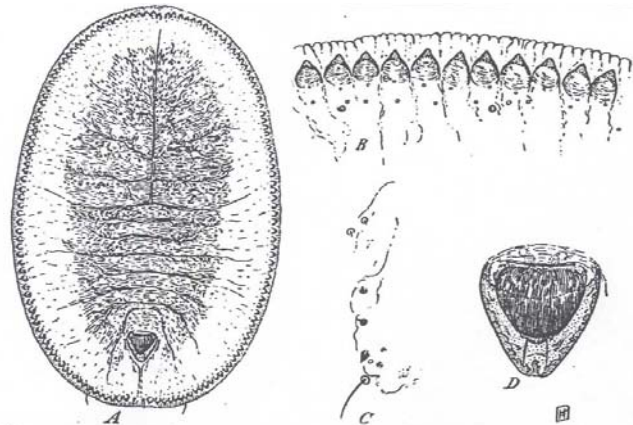
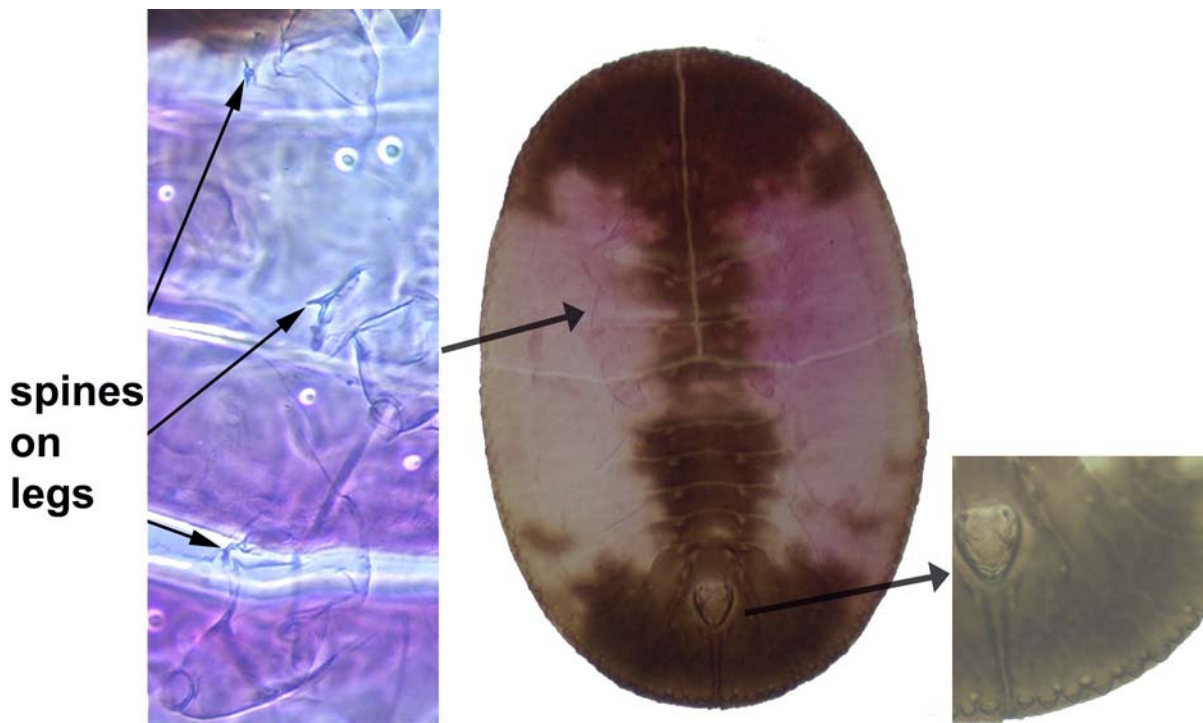


FIGURE 29.—*Trialeurodes heucherae*: A, Outline; B, section of margin and submargin; C, part of inner basal area of middle leg; D, vasiform orifice.

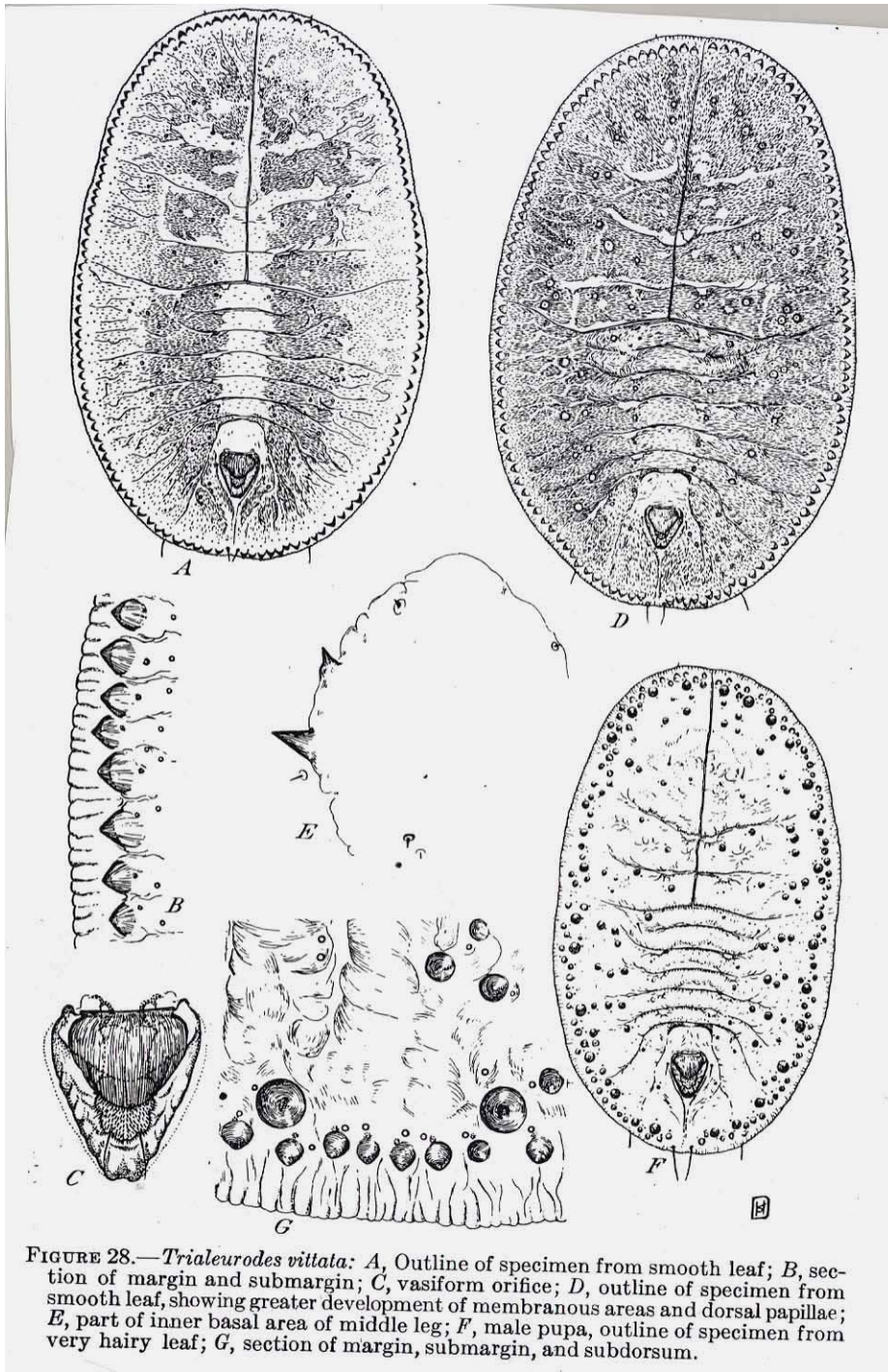
- 34' Submarginal papillae in double rows, papillae on inner row alternating with papillae on outer row, each leg with a spine 8-12 um long, another about 4 um long, and middle leg with another small spine; dorsum dark brown with pale yellow area of varying sizes on each side, or pale yellow and dark brown on head and posterior abdominal area by vasiform orifice..... magnoliae Russell



35(33) Numerous submarginal and subdorsal disc pores each associated with a papillae lateral-most submarginal

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papillae not differentiated from other submarginal-subdorsal papillae arranged segmentally, papillae mesad of margin by more than their lengths; submedial papillae present at least on thorax.....vittata (Quaintance)



35' Disc pores in submarginal row mesad of submarginal papillae; submarginal papillae in single regular or irregular row, distinctly differentiated from other dorsal papillae mesad of margin by about their length or less; submedial papillae present or absent36

36(35) Abdominal segments III-VII each with 1-3 subdorsal disc pores on each side; submarginal papillae longer than

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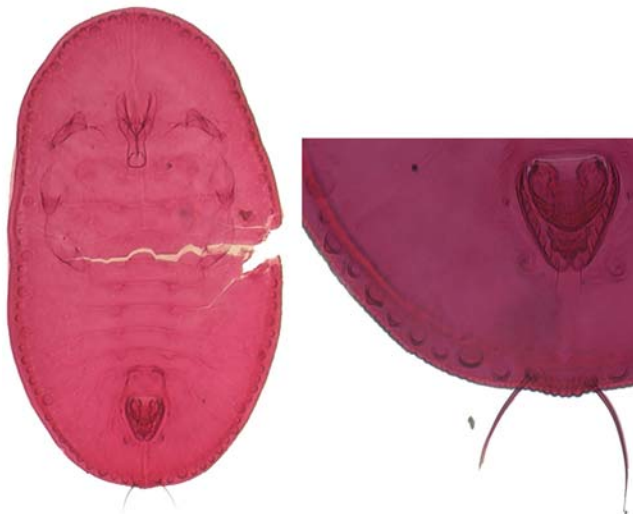
wide, rather sharply pointed; papillae on inner subdorsum of abdomen and cephalothorax, a submedial papilla on each side of most abdominal segments, thoracic segments and head; pale brown to dark brown, often with narrow, pale submarginal band along row of submarginal papillae, or with paler median band and submargin.....vittata (Quaintance)

36' Not as above.....37

37(36) Pupal case sclerorized, sculptured, brown or black, usually paler along submarginal row of papillae; papillae broader than long, apices curved, usually appearing semilunar, in irregular row; dorsal papillae absent.....ruborum (Cockerell)



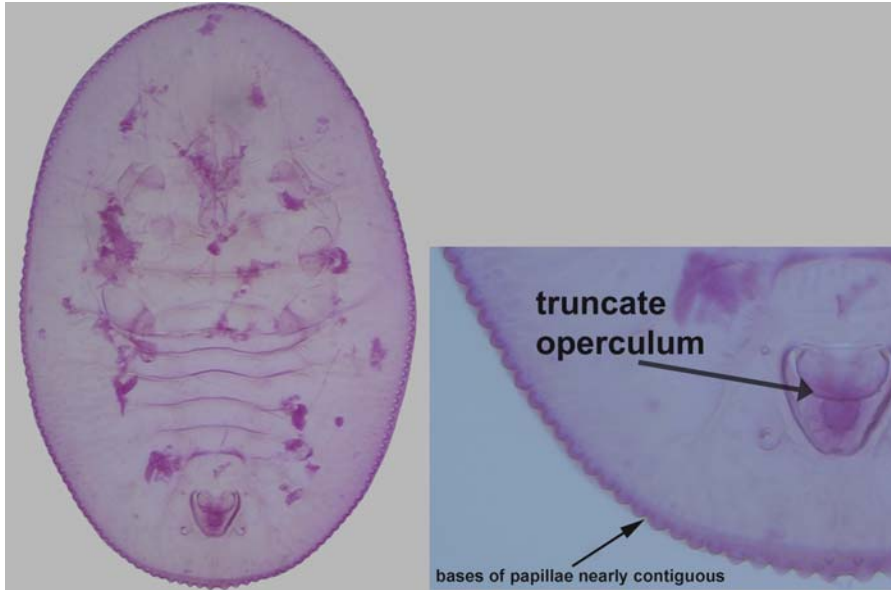
37' Pupal cases colorless or pale yellow, rarely pale brown in center; submarginal papillae about as wide as long or wider than long, conical, or reduced and indicated only by Etched, craterlike area, in rather regular row; larger papillae slightly mesad of row, few present or absent from subdorsum.....packardi (Morrill)



38(30) Operculum relatively truncate posteriorly, about 1.5 times broader than long; papillae absent from dorsal disc;

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submarginal papillae in closely set single row, about their length or less from margin, bases of papillae nearly contiguous.....euphorbiae Russell



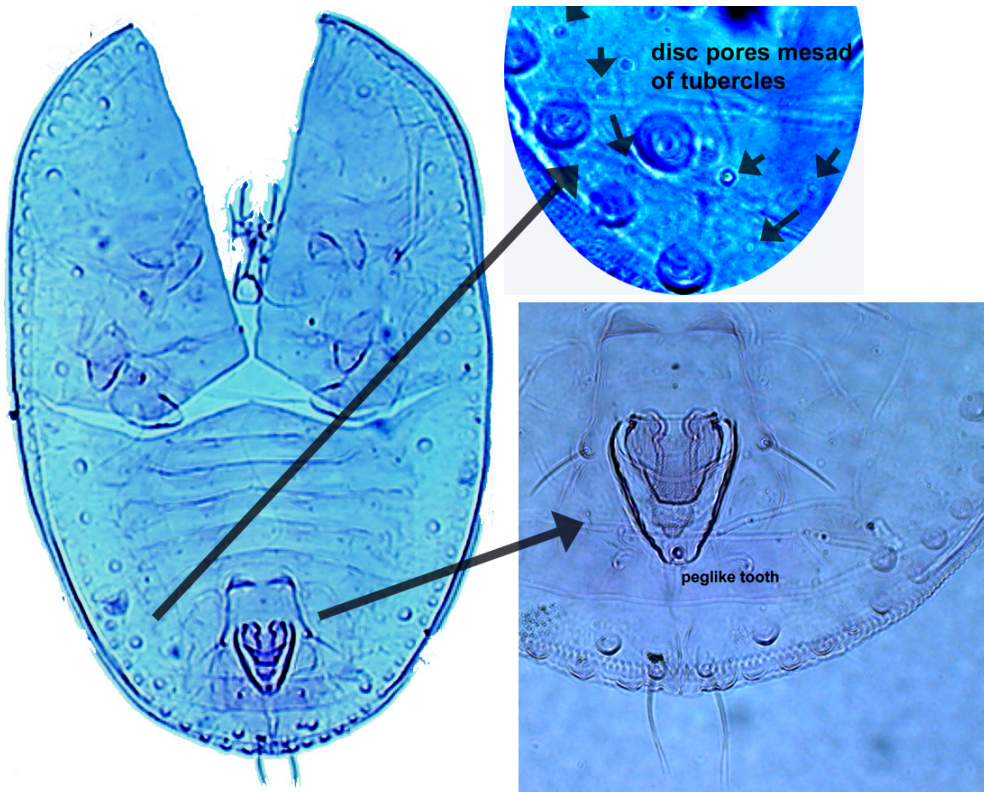
- 38' Operculum narrowed or broadly curved posteriorly, slightly broader than long or to longer than broad; papillae present on subdorsum; submarginal papillae in irregular spaced row or in submarginal-subdorsal band, separated by at least ½ their width and mesad of margin by about twice their width.....39
- 39(38) Pupal cases elliptical, broadly curved posteriorly; operculum subcordate, about as broad or slightly broader than long, broadly or narrowly curved posteriorly; eighth abdominal setae 12-80 um long; colorless or pale yellow, occasionally pale brown centrally or with longitudinal pale brown bands.....40
- 39' Pupal case oval, narrowed posteriorly; operculum elongate cordate, longer than broad strongly narrowed posteriorly; eighth abdominal setae 85-125 um long, on tuberculated bases; colorless or pale yellow.....eriodictyonis Russell



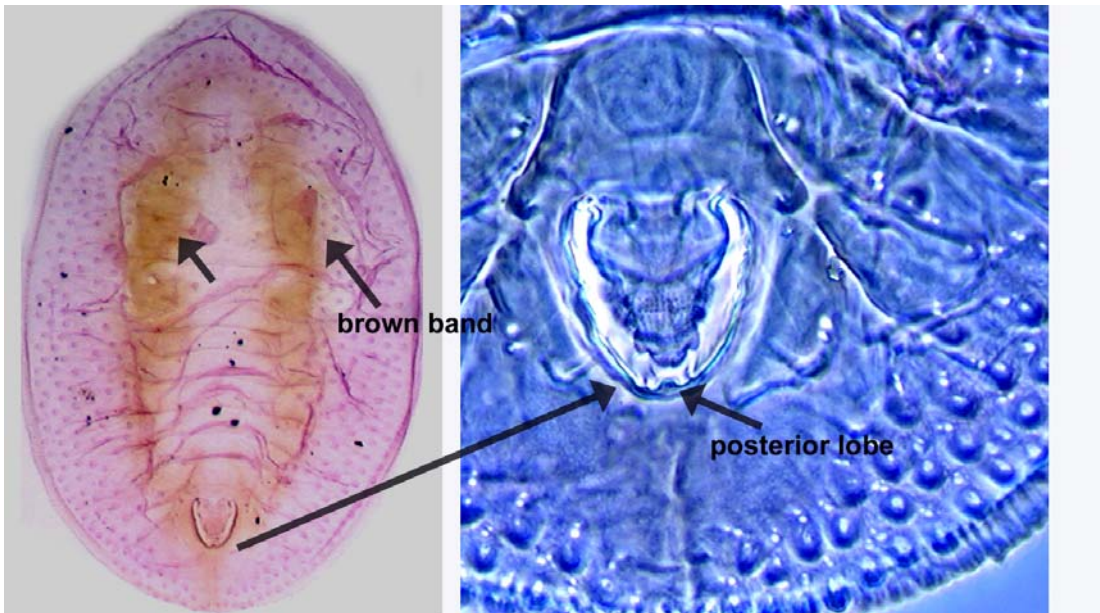
40(39) Vasiform orifice with distinct, medial, peglike internal tooth and small, medial external lobe at posterior end;

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submarginal papillae in irregular or closely set row or papillae present submarginally-subdorsally but not in segmental arrangement; submarginal disc pores mesad of row of papillae; colorless, yellow or median area brown or with brown streakabutiloneus (Haldeman)



40' Vasiform orifice lacking distinct medial, peglike internal tooth and small, medial external lobe at posterior end; numerous submarginal-subdorsal papillae arranged segmentally; numerous disc pores at bases of papillae; colorless with brown, submedial-subdorsal longitudinal band on each side.....colcordae Russell



Key from Steve Nakahara

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Images from J. Dooley
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