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Morphology of the First Instar of *Quadraspidiotus zonatus* (Frauenfeld) (Homoptera, Coccinea, Diaspididae)

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Abstract. First instar male and female of *Quadraspidiotus zonatus* (Frauenfeld) are described and illustrated; dorsal tarsal campaniform sensillum is present in male, absent in female. Some biological date are given.

Key words: *Quadraspidiotus zonatus*, first instar, morphology.

INTRODUCTION

Quadraspidiotus zonatus (Frauenfeld) is a common Palearctic species (Kosztarab, Kozar 1988). It occurs mainly on oaks *Quercus* sp., but also *Fagus*, *Juglans*, *Fraxinus*. In Poland it has been recorded only from oaks (Kawecki 1985).

Q. zonatus is biparental and develops through 3 instars in female and 5 ones in male. In climatic conditions of Poland, it is univoltine and overwinters as fertilized female on the bark of trunk and branches. The females begin to oviposit in June and the first instar larvae hatch shortly thereafter. The male crawlers move on leaves and settle on their underside, whereas the female larvae develop on bark. They undergo the first moult in July (Podsiadło 1995).

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MATERIAL AND METHOD

First instar larvae – from newly hatched individuals to full-grown ones, as well as their exuvia – were collected in 1991, 1992 and 1994 on *Quercus robur* L. in Warsaw. Slide mounts were made of 94 male specimens and 18 exuvia, and 87 female specimens and 20 exuvia. Newly hatched larvae were described, while settlers and exuvia were examined mainly for sex and body shape.

The number of setae and other structures is given for one body half. Ranges are followed by averages in parentheses. Drawings were made by using a microscope drawing tube.

MORPHOLOGY

Male (Fig. 1)

Live individuals yellow, oval. Body size of slide mounted specimens given in Table 1. Derm membranous except for appendages and pygidial areas. It becomes slightly sclerotized before molt.

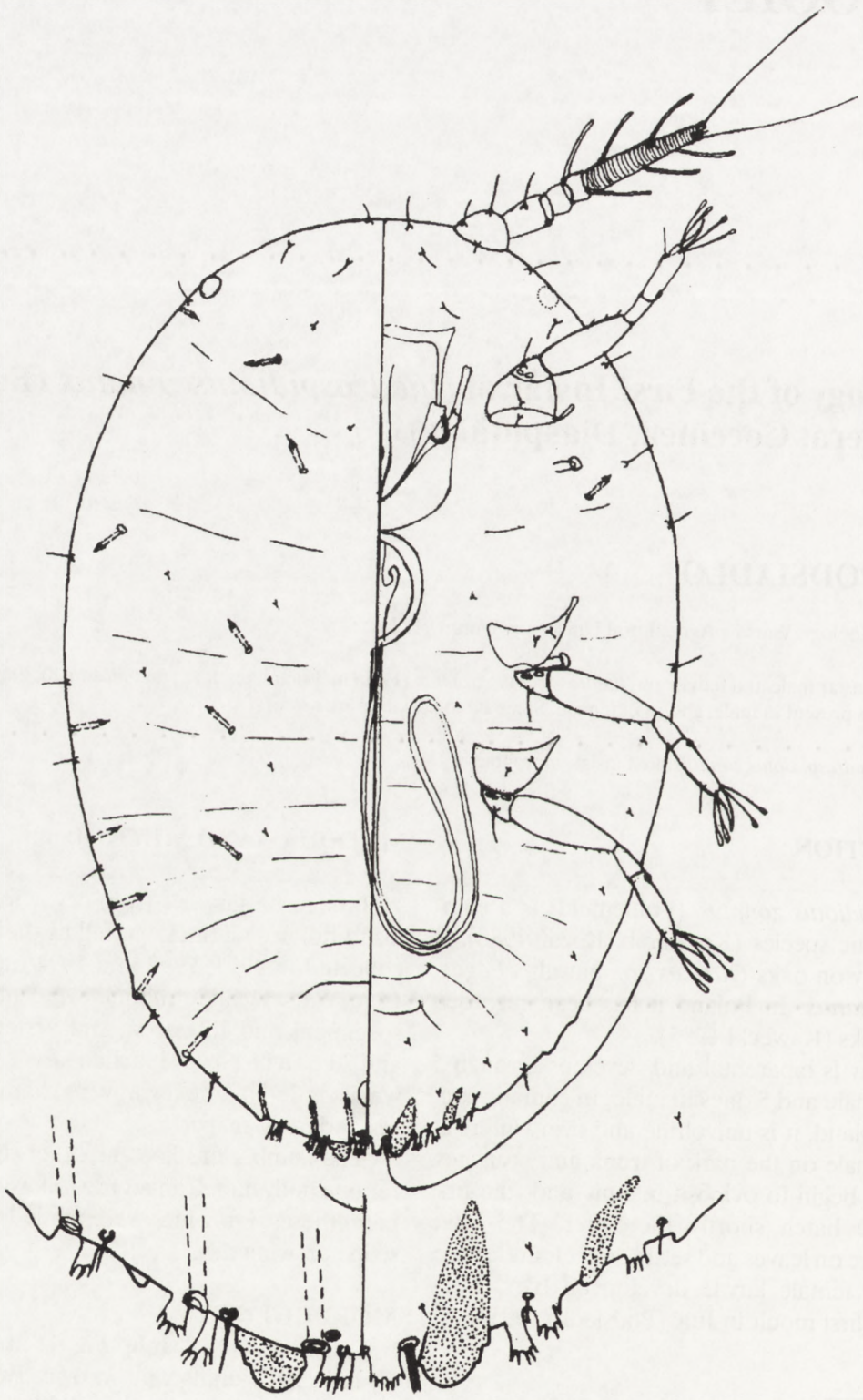

Fig. 1. First-stage male of *Quadraspidiotus zonatus* (Frauenfeld).

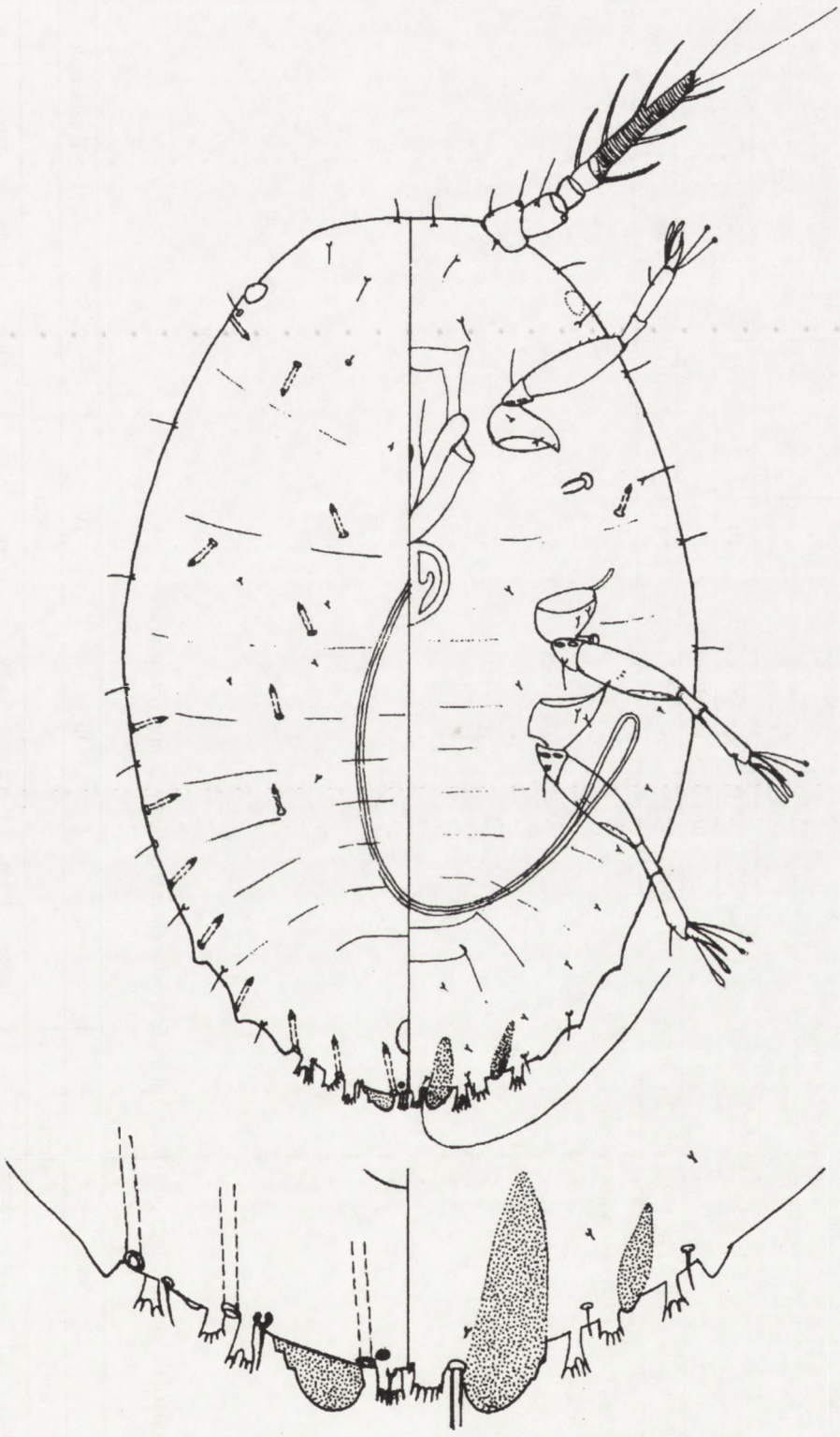

Fig. 2. First-stage female of *Quadraspidiotus zonatus* (Frauenfeld).

Table 1.
Body sizes (in μm) and ratios of the first instar of *Quadraspidiotus zonatus* (Frauenfeld)

Newly hatched specimens						Full-grown specimens						Exuvia					
n	length		width		width/ length ratio	n	length		width		width/ length ratio	n	length		width		width/ length ratio
	range	av.	range	av.			range	av.	range	av.			range	av.	range	av.	
first instar males																	
11	220–260	236.3	140–177	155.2	0.65	40	365–425	388.6	260–330	295.4	0.76	14	360–430	397.7	280–323	301.4	0.75
first instar females																	
13	222–260	244.3	145–172	159.2	0.65	20	325–395	362.7	245–325	287.8	0.79	17	340–410	377.1	287–345	306.5	0.81

av. – average, n – number of specimens

Table 2.
Dimensions of the antennal segments (in μm) in the first instar *Quadraspidiotus zonatus* (Frauenfeld)

Scape				II		III		IV		V		Total length	
length		width		length									
range	av.	range	av.	range	av.	range	av.	range	av.	range	av.	range	av.
first instar males n = 12													
8.7–10.0	9.6	11.2–13.8	12.8	6.2–8.8	7.7	3.7–5.0	4.9	3.7–5.0	4.4	32.5–38.5	35.4	57.5–67.5	62.0
first instar females n = 12													
8.7–11.3	10.1	11.2–13.8	12.9	6.2–10.0	8.3	3.7–6.3	4.9	3.7–5.0	4.4	35.0–41.3	38.2	61.2–68.8	65.9

Table 3.
Length of legs (in μm) in the first instar of *Quadraspidiotus zonatus* (Frauenfeld)

Leg	Coxa		Trochanter		Femur		Tibia		Tarsus		Claw		Entire leg	
	range	av.	range	av.	range	av.	range	av.	range	av.	range	av.	range	av.
First instar males n = 12														
I	10.0–12.5	10.8	7.5–12.5	9.6	22.5–31.3	26.3	6.2–8.8	7.1	13.7–17.5	15.6	10.0–12.5	11.3	76.2–85.0	80.7
II	10.0–12.5	10.8	7.5–11.3	9.8	25.0–28.8	26.4	7.5–8.8	7.7	13.7–18.8	16.1	11.2–13.8	12.3	78.7–88.8	83.1
III	10.0–12.5	11.1	7.5–11.3	9.6	25.0–27.5	26.8	7.5–10.0	8.0	15.0–20.0	17.2	12.5–15.0	13.5	80.0–91.3	86.1
First instar females n = 12														
I	10.0–11.3	10.7	8.7–11.3	9.8	27.5–30.0	28.3	6.2–8.8	7.5	15.0–17.5	16.0	11.2–13.8	12.1	80.0–87.5	84.4
II	10.0–11.3	10.8	8.7–11.3	10.2	27.5–30.0	28.5	7.5–8.8	7.8	16.2–18.8	17.2	11.2–13.8	12.7	83.7–90.0	87.2
III	11.2–12.5	11.9	7.5–11.3	9.7	27.5–31.3	29.5	7.5–8.8	8.3	17.5–21.3	19.0	12.5–15.0	13.6	88.7–96.3	92.0

Pygidial margin. Lobe 2 well developed, unilobed, sclerotized, with 2–3 notches on outer margin. Lobe 3 indicated by a minute hyaline process and basal sclerosis. Within pygidium two sclerotized areas. They begin at the base of lobe 2 and 3, and diverge anteriorly and obliquely. Plates: 1 furcate on segment 6, 2 furcate on segment 7, and 1 furcate on segment 8. The last one with some 6 apical teeth.

Dorsal surface. Head, pro- meso-, metathorax and abdominal segments 1–5 fairly well marked by intersegmental dermal furrows, while the following ones fused.

Marginal setae: 3 on head, 1 on each thoracic segment, and 1 on each of abdominal segments 1–8. Marginal minute seta of abdominal segment 9 is placed anteriorly to seta of segment 8. Mesolateral setae: 1 short on each meso- and metathorax. Submedian setae: 3 on head, 1 on each meso- and metathorax and 1 on each of abdominal segments 1–2. Setae of submedian series short except, for the first anterior elongate seta.

Marginal microducts: 1 on head near eye and 1 on each of abdominal segments 1–8. Submarginal microducts: 1 on mesothorax. Mesolateral microducts: 1 on head. Submedian microducts: 1 on each thoracic segment and on abdominal segment 2.

Anal opening broadly oval, av. 9.9 × 7.1 μm, located dorsomedially at a distance of about 1–3 times its length from the posterior margin.

Ventral surface. Segmentation less distinct than on dorsal surface, intersegmental dermal furrows rather obscure.

Antennae 5-segmented, the fifth segment being the longest. Dimensions in Table 2. Segment I with 1 short basal, 1 medial subbasal and 1 long apical slender seta. Segment II with 1 long slender seta and an apical sensorium. Segment III without setae. Segment IV with 1 stout basal and 1 stout apical seta. Segment V annulated, with 4 stout setae and 2 (1 on each of the two apical projections) very long setae. Invaginate minute setae located between apical projections and near the middle of segment V.

Clypeolabral shield 50.0–63.7 (56.0) μm long, 31.2–40.0 (36.3) μm wide. Labium one segmented, 22.5–26.2 (23.7) μm long, 25.0–30.0 (27.6) μm wide. No setae visible.

Legs well developed, the posterior is the longest (Table 3). Coxa with 1 seta on dorsal and 1 on ventral side. Trochanter with 2 sensilla on each side and 1 elongate seta. Femur without setae but with a row of toothlike structures on posterior margin. Tibiotarsal septum present. Tibia:tarsus ratio ca. 1:2. Tarsus with a campaniform sensillum near its base, 1 subapical seta and 2 knobbed apical digitules longer than claw. Claw with 2 knobbed ungual digitules exceeding its length.

Meso- and metathoracic spiracles present. Mesothoracic spiracles displaced anteriorly on prothorax.

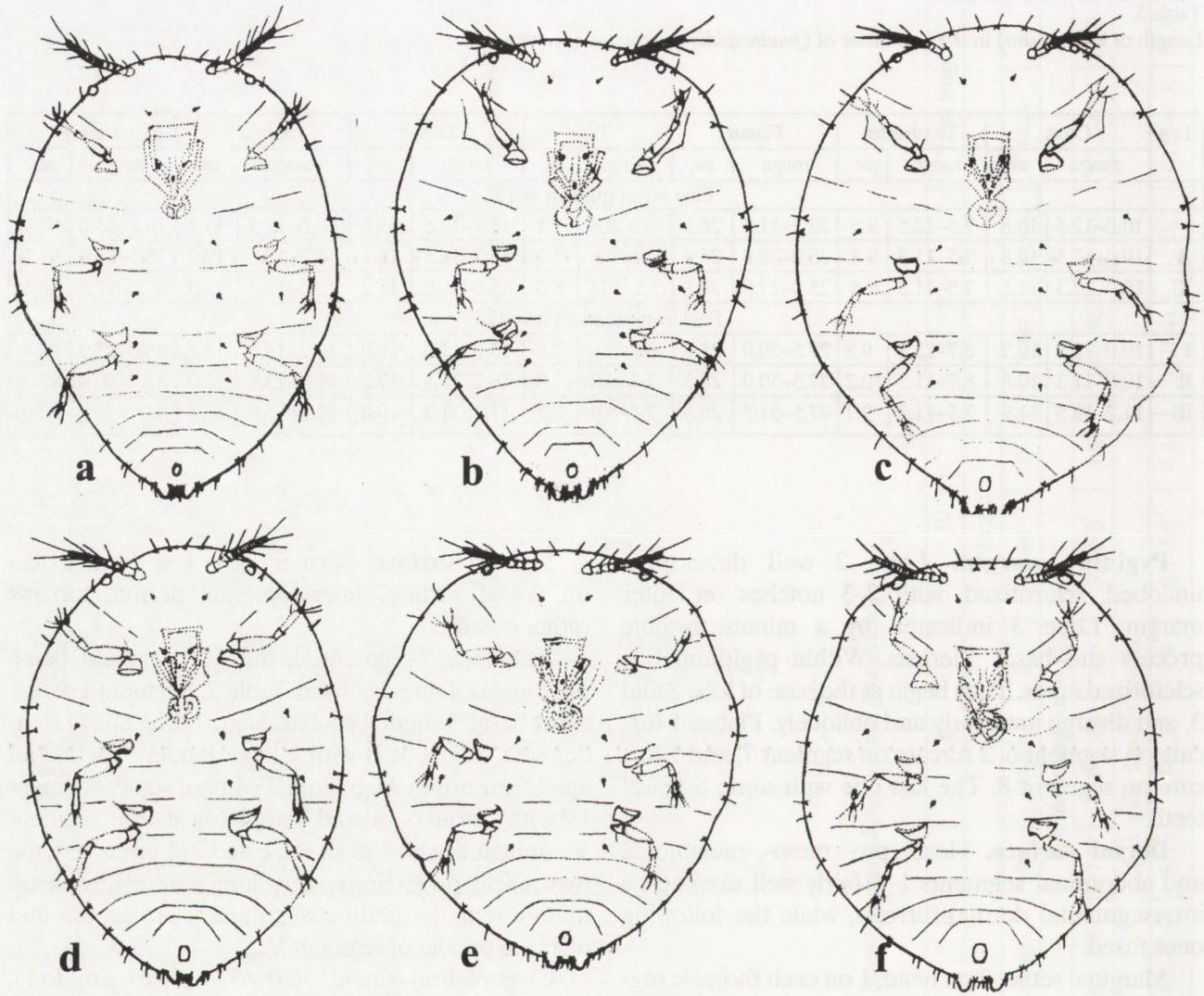

Fig. 3. Variability of the body shape in full-grown larvae of the first instar of *Quadraspidiotus zonatus* (Frauenfeld): a, b, c – males, d, e, f – females.

Marginal setae: 2 on head, 1 on each thoracic segment and 1 on each of abdominal segments 5–9. On each thoracic segment, ventral and dorsal marginal setae form a fairly well isolated pair. Marginal seta of 8th abdominal segment, the so-called "apical seta", up to 95 μm long. Submarginal setae: 1 on head near eye, 1 on prothorax and 1 short on each of abdominal segments 1–8. No submarginal seta visible on metathorax. Submedian setae: 2 on head above clypeolabral shield, 1 short on each meso- and metathorax, and 1 short on abdominal segment 7, lacking on preceding abdominal segments.

Microducts: 1 submarginal duct on prothorax posterolaterad to anterior spiracle. No ventral submarginal duct on metathorax.

Female (Fig. 2)

Similar to male, but differs distinctly in the absence of a campaniform sensillum near the base of tarsus and in the absence of a pair of dorsal submedi-

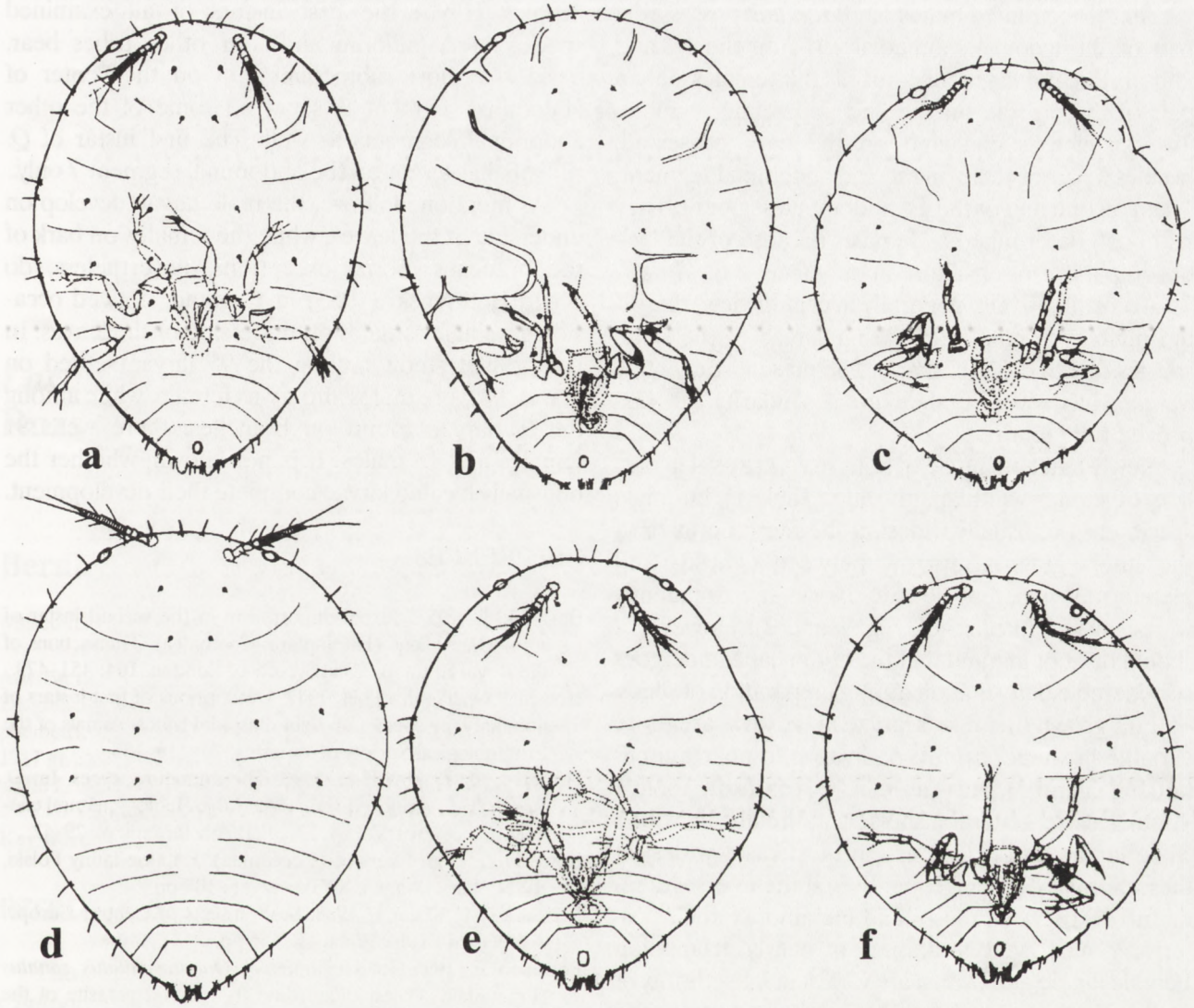

Fig. 4. Variability of the shape of exuvia of the first instar larvae of *Quadraspidiotus zonatus* (Frauenfeld): a, b, c – male exuvia, d, e, f – female exuvia.

al setae on the first abdominal segment. Rarely there is 1 short dorsal submedial seta on one side of this segment. Measurements of body, antennae and legs are given in Tables 1, 2 and 3.

NOTES

Howell and Tippins (1977) noted a tarsal campaniform sensillum in all male larvae of eight diaspidid tribes, but only in some of them in the female larvae. *Q. zonatus* belongs to the group, without the sensillum in females. Stoetzel and Davidson (1974a, 1974b) have drawn the attention to the setal pattern, a character by which the sexes can be distinguished in all stages Aspidiotini. According to them, all male stages possess 1 short dorsal submedial seta on each half of the 1st and 2nd abdominal segments. In female instars these setae are lacking. However in a few species, both immature and mature females may possess 1 short dorsal submedial seta on one body half.

All the examined males of *Q. zonatus* possessed a pair of short dorsal submedial setae on the 1st and 2nd abdominal segments, but all the females only a pair of these setae on the 2nd abdominal segment. Two specimens collected on the bark possessed, besides a pair of setae on the 2nd abdominal segment, 1 seta on one half of the 1st abdominal segment. They had been determined as females because of the lack of campaniform sensillum on the tarsus.

According to the generally accepted view, diaspidid male and female first instar larvae of the same species do not differ in shape. The present study of *Q. zonatus* has revealed their great similarity but disproved full identity.

Newly hatched larvae of both sexes are oval in outline, of similar width/length ratio (Table 1), but male specimens are usually widest at the mesothorax or at the intersegmental furrow between meso- and metathorax, whereas female larvae are frequently widest at metathorax (cf. Fig. 1 and 2). However it should be kept in mind that the body shape undergoes considerable deformation during preparation of slides.

Full-grown first instar larvae and exuvia are more variable in shape, from broadly oval to nearly circular (Fig. 3 and 4), but – as can be seen from Table 1 – females are generally shorter and relatively wider. Male larvae and exuvia are in most cases widest at mesothorax or – less frequently – at the intersegmental furrow between meso- and metathorax; their posteriorly narrowed abdomen is nearly triangular. Female larvae and exuvia are widest at mesothorax or at the intersegmental furrow, rarely at metathorax; their abdomen is usually more rounded.

However, many individuals are intermediate in shape, and some show even characteristics of the opposite sex, so determination of the sex based upon the shape is highly uncertain.

The first instars of *Q. zonatus* differ from other members of Aspidiotini. According to Howell and Tippins (1990) the first instars of all examined species of Aspidiotini and four other tribes bear, besides a short submedian seta on the venter of abdominal segment 7, setae on some of the other abdominal segments as well. The first instar of *Q. zonatus* has a seta on the abdominal segment 7 only.

As mentioned above, the male larvae develop on underside of the leaves, while the females on bark of the branches. Some exceptions, nevertheless, do occur. Boratyński (1953) in England, noticed occasionally single females on underside of the leaves. In the present study, among the 95 larvae settled on leaves, 94 were males and 1 was female, while among the 94 larvae found on branches, there were 81 females and 13 males. It is not known, whether the unusually located larvae complete their development.

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