Two New Species of *Kermes* (Homoptera: Coccinea: Kermesidae), with a Key to the Young Adult Females of Known Species of Kermes from China

Yongjie Liu and Yuliang Shi

Section of Entomology, Department of Plant Protection
Shandong Agricultural University
Taian, Shandong, 271018 China

Abstract: Two new species of Kermesidae, *Kermes orientalis* Liu and Shi and *K. flavus* Liu, are designated. Morphological characters of post-reproductive and teneral young adult females, as well as the first instars (crawlers) are described and illustrated. A key to the young adult females of the genus from China is given. Type materials are deposited in the Insect Collection, Section of Entomology, Department of Entomology, Shandong Agricultural University, Shandong; Insect Collection, Institute of Zoology, Chinese Academy of Sciences, Beijing, China; and British Museum (Natural History), London, England.

Key words: Insecta, Coccinea, Coccoidea, scale insects, Kermesidae, new species, *Kermes orientalis*, *K. flavus*, oak, Fagaceae.

Introduction

Kermesidae is one of the least studied families of scale insects in China. Systematic studies on kermesids in China can be traced back to the 1920s, when Japanese entomologist Takahashi (1929, 1936) described 2 species from Taiwan (Formosa). Later, Kuwana (1931) found another species, *Kermes tomarii*, from Liaoning, northeastern China. Russian coccidologist Borchsenius (1960) found four additional species from Sichuan and Yunnan of southern China. By collecting all records from literature, Young (1982) listed 12 species of *Kermes* from China. In her recent study, Hu (1986) described 3 species based on specimens collected from Shandong, eastern China and she considered *K. tomarii* to be a synonym of *K. miyasakii*.

We began a comprehensive survey on this genus starting in 1988, and have designated 3 species (Liu and Shi 1994) and these 2 new species based on the morphological characters of young adult females and first instar nymphs.

Terminology used for the descriptions is that used by Bear and Kosztarab (1980, 1981 and 1985) and Bullington and Kosztarab (1985). Measurements are in microns, except for those specified as millimeters, and are given as mean and range in parentheses.

Abbreviations of institutions where the type materials are deposited are as follows: BMNH-British Museum (Natural History), London, England; IZCAS-Institute of Zoology, Chinese Academy of Sciences, Beijing, China; SAU-Shandong Agricultural University, Taian, China;

Kermes orientalis Liu and Shi

new species (Fig. 1 & 2)

Type material

Holotype, female, Qufu Co., Shandong, CHINA, from *Quercus acutissima*, from Qufu Co., Shandong, CHINA, IV-25-1993, Coll. Y. Liu, deposited at SAU. **Paratypes**, 40 postreproductive adult females, 20 at SAU, 10 at BMNH, 10 at IZCAS; 60 young adult females, 30 at SAU, 10 at BMNH, 20 at IZCAS; and 200 first instars, 180 at SAU, 10 at BMNH, 10 at IZCAS; same host and location as above, V-12-1991, Coll. Y. Liu.

Postreproductive female. Body spherical, 10.2 mm (9.8-18.9) long, and 9.8 mm (9.5-10.6) wide, 9.5 mm (9.0-9.8) high; greenish gray, with a thin layer of white waxy powder on derm; purple circular

marks with yellow margin located on dorsal surface and sides; whitish waxy secretory materials and 2 curly waxy threads at anal area.

Young adult female (Fig. 1). Body circular, yellowish, 5750 (5105-6603) long and 5030 (4210-5825) wide.

Tergum

Multilocular disc pores (Fig. 1 b & c). Scattered on dorsal, lateral surfaces, more on anterior area of anus, 3-, 4-, 5-, 6-, 7- and 9-locular pores, but mostly 5-, 6- and 7-locular and rarely 3- 4- or 9-loculars.

Microducts (Fig. 1 d). Distributed on dorsal and marginal area, and mixed with multilocular disc pores, 5.2-6.0 long.

Anal lobes (Fig. 1 j). Each lobe with 7-8 slender setae, 53.0 (33.8-81.3) long.

Anal ring. Sclerotized, arc-shaped, 134 (118-157) long and 98 (92-105) wide, without setae.

Sternum

Antennae (Fig. 1 f). Six segmented, some segments partially combined, 122.5 (115.0-134.7) long, 1 seta on segment I, 2 setae on II, and 3 on III, 5 sensorial setae on segments IV- VI, and 4-5 stout setae on terminal segment.

Labrum. Three segmented, 273.6 (224.5-302.4) long and 167.2 (148.9-186.5) at base.

Spiracles. Anterior spiracle, 248.8 (215.2-283.5) long, atria 238.3 (215.1-250.0) wide; posterior spiracle 230.6 (219.7-254.3) long, atria 286.7 (264.3-303.5) wide.

Legs. Slender, distinctly segmented. Length: front leg, 248.8 (215.2-283.5), mid-leg, 257.5 (223.0-279.5); hind leg, 276.3 (241.5-307.5).

Tubular ducts (Fig. 1 g). 36.5 (34.1-38.6) long and 5.7 (5.2-6.0) in diameter, with a wider base of 9.4 (9.0-10.0) in diameter; those ducts forming a horseshoe-shaped band.

Multilocular pores (Fig. 1 h). Most 10-locular, 7 clusters on each of abdominal segments I-IV, 6 on V and VI.

First Instar (Fig. 2)

Body. Elongate oval, light red, 577.7 (552.4-598.6) long, and 256.5 (243.0-267.8) wide.

Dorsum

Marginal setae (Fig. 2 b). Slender, 2 pairs on prothorax and 1st abdominal segment, 1 pair on each of other segments, lacking on cephalic region.

Dorsal setae. Tubular, 2 longitudinal rows; 3 pairs on median area, 11 pairs on submedian area, 18 pairs on submarginal area. Length, 11.7 (10.0-12.4), wide, 4.2 (4.0-4.8). One pair of spiracular setae located laterad of anterior spiracle (Fig. 2 f), with a diameter of 6.3 (6.0-6.9).

Multilocular disc pores (Fig. 2 f): Two smaller 5-locular pores on laterad of anterior spiracle.

Simple pores. Four longitudinal rows, 1.6 (1.5-1.8) in diameter.

Anal lobes. Indistinct; 2 tubular setae mesad of anal base, apical setae 276.3 (262.5-297.5) long.

Venter

Antennae. Six segmented, total length, 127.3 (121.2-130.0); measurement of each segment as follows: I, 29.6 (26.4-32.5); II, 18.8 (17.5-20.0); III, 21.5 (18.9-23.2); IV, 16.5 (16.2-17.5); V, 19.7 (17.5-22.1), and VI, 30.0 (27.5-31.5). Setae: 3, 2, 1, 1, 5, and 9 on each segment, respectively. Two trilocular pores located mesad of antennae.

Clypeolabral shield. Length, 107.8 (102.5-112.5), and width, 75.1 (68.8-81.3).

Labrum. Three segmented, 81.6 (75.0-86.3) long, and 56.0 (53.8-57.5) wide at base.

Legs. Several slender setae on each segment, 4 sensoria on trochanter (Fig. 2 i). Measurements of legs as follows:

	Lengths Prothoracic	Lengths Mesothoracic	Lengths Metathoracic
Coxa	27.2(25.3-32.0)	25.6(23.0-30.2)	26.8(24.0-31.3)
Trochanter	25.1(22.4-28.9)	24.3(22.8-27.1)	25.5(23.8-28.7)
Femur	57.3(54.7-59.2)	60.1(56.7-61.4)	58.5(56.2-60.3)
Tibia	34.4(32.1-38.7)	33.2(31.1-37.6)	35.0(31.3-40.0)
Tarsus	53.2(51.4-56.8)	54.6(52.6-57.8)	56.2(55.0-58.7)
Claw	25.0(22.6-27.5)	25.1(21.4-27.0)	25.8(22.5-27.5)
Entire Leg	219(195-238)	220(206-245)	227(198-247)

Binocular pores (Fig. 2 e). Six pairs, 1 pair on each of meso- and metathoracic segments, and abdominal segments I-IV or I-VI.

Multilocular disc pores (Fig. 2 j). Two longitudinal rows, 4 pairs on cephalothoracic area, 5 pairs on abdomen, 5-locular.

Body setae (Fig. 2 k & l). Seven pairs on cephalic area, 6 pairs on abdomen. Medial setae slender; submedial and submarginal setae stout.

Anal lobes and anal ring. Anal lobes indistinct, with 1 submarginal setae, 17.5 (16.4-19.8) long. Anal ring horseshoe- shaped, lacking wrinkles.

Remarks. The specimens were collected from *Quercus acutissima* in Confucius Forest, Qufu Co., Shandong, China. Mostof the trees there were over one hundred years old. Heavy infestations and severe damage were observed on some of these old trees (dead branches and twigs), as well as on some young trees. The adult female of this species is similar to *K. taishanensis*, *K. shastensis*, and *K. flavus* (n. sp.) in having multilocular pores on dorsal surface, but differs from these species in having 34-36 pairs of marginal setae, having 3-, 4-, 5-, 6, 7- and 9-locular pores, and mostly 5-, 6- and 7-locular; 7 clusters of multilocular pores on abdominal segments I-IV. First instar of this species is similar to that of *K. nigronotatus*.

Kermes flavus Liu

new species (Figs. 3 & 4)

Type material

Holotype, female, from Castanea mollissima, from Simao Co., Yunnan, China, IV-20-1988, Coll. M. Xue & J. Sun, deposited at SAU. Paratypes, 6 postreproductive adult females, 2 at SAU, 2 at BMNH, 2 at IZCAS; same data as the holotype.

Postreproductive female. Body spherical, 8.6 mm (8.4-8.8) in diameter, bright yellow, smooth; whitish waxy secretory materials and 2 curl waxy threads at anal area.

Young adult female (Fig. 3). Body circular, light yellow, 4865 (4152-5725) in diameter.

Tergum

Tubular ducts (Fig. 3 g). 35.9 (34.1-37.3) long and 6.8 (6.2-7.4) in diameter.

Multilocular disc pores (Fig. 3 c & e). Scattered on dorsal, lateral surfaces, more on anterior area of anus; 4-, 5-, 6- and 7-locular pores (mostly 5-locular).

Setae and marginal setae. Slender, 16-20 pairs, 15.2 (12.5-17.5) long, some with 4- to 7-locular disc pores (mostly 5-locular); few marginal setae, few setae on anterior area of anus.

Anal lobes (Fig. 3 b). Unsclerotized, 6 pairs of slender setae besides each lobe, 37.5 (32.0-45.2) long.

Anal ring. Sclerotized, arc-shaped, 126 (104-142) long and 95 (87-106) wide, without setae.

Sternum

Antennae (Fig. 3 f). Six segmented, 3rd segment longest; segments IV-VI each with 5 sensorial setae; segments I-III each with 3, 2, and 1 seta, respectively; V with 1-3; and VI with 5-6 setae.

Labrum. Three segmented, 291.4 (273.4-315.0) long and 195.7 (184.1-206.7) at base.

Spiracles. Anterior spiracle, 193.2 (180.0-205.4) long, atrium, 175.4 (158.6-205.4) wide; posterior spiracle, 246.5 (227.8-259.6) long, atrium, 226.7 (195.3-243.5) wide.

Legs. Slender, distinctly segmented. Length: front leg, 248.7 (228.4-257.2), mid-leg, 262.5 (250.0-274.5); hind leg, 279.3 (275.0-287.5).

Multilocular pores (Fig. 3 h). Mostly 10- or 12-locular, 6-7 longitudinal rows, each with 6-7, lacking on median of abdomen.

First Instar (Fig. 4)

Body. Elongate oval, light red, 469.0 (450.0-485.0) long, and 234.5 (220.5-260.0) wide.

Dorsum

Marginal setae (Fig. 4 b & f). Slender, 22 pairs, 6 pairs on cephalic area, 5 pairs on prothorax, 2 pairs on each of meso- and metathorax, 1 pair on each abdominal segment.

Submedial setae (Fig. 4 c & g). Slender, 11 pairs.

Simple pores. Four longitudinal rows, 1.6 (1.5-1.8) in diameter.

Anal lobes. Indistinct, apical setae 245.3 (223.5-252.5) long.

Venter

Antennae. Six segmented, total length, 99.5 (96.2-105.1); measurement of each segment as follows: I, 15.0 (12.5-16.3); II, 19.7 (17.6-21.4); III, 15.9 (15.0-16.2); IV, 13.0 (12.5-13.7); V, 16.5 (15.0-17.3), and VI, 21.5 (20.2-22.7). Setae : 3, 2, 1, 1, 5, and 9 on

each segment, respectively. Two trilocular pores located mesad of antennae.

Clypeolabral shield. Length, 89.7 (87.5-92.0), and width, 68.3 (63.4-72.5).

Labrum. Three segmented, 67.8 (62.5-73.2) long, and 45.2 (42.7-48.5) wide at base.

Legs. Several slender setae on each segment, 4 sensoria on trochanter (Fig. 4). Measurements of legs as follows:

	Lengths Prothoracic	Lengths Mesothoracic	Lengths Metathoracic
Coxa	19.8(18.4-21.2)	20.1(18.0-21.8)	20.4(18.3-22.7)
Trochanter	22.3(19.6-24.2)	22.9(20.4-26.3)	22.5(19.4-25.0)
Femur	50.2(47.6-52.3)	49.8(47.8-52.0)	50.6(48.3-52.0)
Tibia	35.0(32.7-36.9)	35.2(33.3-37.2)	36.4(35.0-37.5)
Tarsus	49.6(47.2-52.3)	50.1(47.0-51.6)	50.5(47.2-51.9)
Claw	19.2(17.4-22.1)	20.8(17.8-21.7)	20.4(18.7-22.5)
Entire Leg	193(178-231)	198(176-233)	210(184-240)

Binocular pores (Fig. 4 i). Eight pairs, 1 pair on each of meso- and metathoracic segments, and abdominal segments I-VI, located at bases of marginal setae.

Multilocular disc pores (Fig. 4 j). Two longitudinal rows, 4 pairs on cephalothoracic area, 5 pairs on abdomen; 11-15 5-
locular pores laterad of anterior spiracle; pores 5.3 (4.8-5.7) in diameter.

Body setae (Fig. 4 k & l). Seven pairs on cephalothoracic area, 6 pairs on abdomen. Medial setae slender; submedial and submarginal setae stout.

Anal lobes and anal ring. Anal lobes indistinct, with 1 submedial seta, 9.2 (8.7-10.4). Anal ring horseshoe-shaped, lacking wrinkles, 14.1 (12.8-15.6) long and 16.5 (15.7-17.5) wide; 1 pair conical setae (Fig. 4 n) anterior of anal ring; 2 cone-shaped setae mesad of anal base (Fig. 4 m).

Remark. Two species of Kermesidae have been found on *Castanea mollissima* -- *Kermes niwai*, and this new species. *Kermes niwai* has been found in Jiangsu, Zhejiang, Jiangxi, and Sichuan, while *K. flavus* is from Yunnan, China.

The adult female of *K. flavus* is similar to *K. taishanensis*, *K. shastensis*, and *K. orientalis* in having multilocular pores on dorsal surface, but *K. flavus* differs from the three in having 16-20 pairs of marginal setae, some of which are associated with 1-6 multilocular disc pores; 7-9 pairs setae located anterior of anus; anal lobes with 2 longitudinal rows of setae; and 4 or 6 clusters of multilocular disc pores in longitudinal rows on abdominal segments I-IV.

The first instar of this species differs from other species in the genus in having 12-16 multilocular disc pores laterad of the anterior spiracles; and only 1 marginal seta on each abdominal segment.

Key to Young Adult Females of 10 Species of *Kermes* from China

1. Anal lobes sclerotized; each lobe with 10-12 slender setae; 30-33 pairs of marginal setae .... *K. punctatus* (Borchsenius)
   Anal lobes unsclerotized 2

2. Dense multilocular disc pores present on dorsum, and the pores often mixed with microtubular glands 3
   No multilocular disc pores present on dorsum; if present, these pores only around anal ring..... 5

3. Marginal setae more than 3 rows; 3-5 multilocular disc porelocated at bases of 2nd and 3rd pairs; anal ring horseshoe- shaped. .... *K. taishanensis* Hu
   Marginal setae 3 rows, no multilocular pores at bases 4

4. Marginal setae, 34-36 pairs, cone-shaped, some with 1-3-, 4- or 5-locular pores at bases; median area of venter with a longitudinal row of clusters of multilocular pores .... *K. orientalis* Liu and Shi
   Marginal setae, 16-20 pairs, hair-like, some with 1-6 5-locular pores at bases; median area of venter without clusters of multilocular pores..... ..... *K. flavus* Liu

5. Multilocular disc pores in a band around anal ring; irregular shallow scars present on each segment of dorsum ..... *K. miyasakii* Kuwana
   Multilocular disc pores not around anal ring 6

6. Tubular glands distributed on anterior part of body and dorsal surface of cephalothoracic region; 14 pairs of marginal seta-pore clusters; 3 clusters of multilocular pores on each abdominal segment ..... *K. nakagawae* Kuwana
   Tubular glands distributed on submarginal region of venter; 4-9 cluster of multilocular pores on each abdominal segment 7

7. Marginal setae 50 pairs; 1 pair of tubular setae located at margin of anterior of body, associated

with a cluster of multilocular pores .... *K. qingdaonensis* Hu

Less than 33 pairs of marginal setae; no tubular setae 8

8. Multilocular pores located at bases of marginal setae, 4-16 ..... *K. tropicalis* Takahashi

Multilocular pores absent at bases of marginal setae 9

9. Multilocular pores distributed in a small area anterad of anus, rarely found laterad of tubular duct bands ..... *K. vividis* (Borchsenius)

Multilocular pores forming a semi-circular band anterad of anus, and extended to middle area of body, but absent on cephalothoracic region. ... . *K. nigronotatus* Hu

Acknowledgments

We thank Prof. F. T. Tang (Shanxi Agri. Univ., Taigu, Shanxi) and Prof. C. K. Yang (Beijing Agri. Univ.), Dr. S. W. Bullington (Penn State University, University Park, PA, USA) for review of this manuscripts. Our special thanks extend to Dr. A. B. Hamon (Division of Plant Industry, Gainesville, FL) for his critical and valuable review of this final manuscript, and Prof. C. C. Tao (Taiwan Forest Res. Inst., Taibei, Taiwan) for sending references, and to Dr. Tong-Xian Liu, University of Florida (Immokalee, FL, USA), for providing references and for preparing this English version. We also thank Yusheng Liu, Ming Xue, Jilin Sun, and Tielu Mo for technical assistance during this study.

References

Bear, R. G., and M. Kosztarab. 1980. A new species of gall-like coccid from southeastern United States. J. Ga. Entomol. Soc. 15(1): 20-25.

Bear, R. G., and M. Kosztarab. 1981. Two new species of gall-like scale insects on oaks from the Nearctic Region (Homoptera: Coccoidea). Fla. Entomol. 64(2): 226-234.

Bear, R. G., and M. Kosztarab. 1985. A morphological and systematic study of the first and second instars of the Kermesidae in the Nearctic Region (Homoptera: Coccoidea). Va. Agri. Exp. Stn. Bull. 85-11: 119-261.

Borchsenius, N. S. 1960. Fauna of USSR, Coccoidea, family Kermococcidae, Asterolecanlidae, Lecanodiaspididae, Aclerdidae. [In Russian]. Akad. Nauk. USSR, Zool. Inst. (n.s. 77) 8, 282 pp.

Bullington, S. W., and M. Kosztarab. 1985. A revision of the family Kermesidae (Homoptera) in the Nearctic Region based on adult and third instar females. Va. Agri. Exp. Stn. Bull. 85-11: 1-118.

Hu, Xingping. 1986. Studies on Kermesidae from Shandong, China, with descriptions of three new species. Entomotaxonomia 8(4): 291-298.

Kuwana, I. 1931. The genus Kermes of Japan. Jap. Min. Agri. For. Sci. Bull. 2: 15-29.

Liu, Y., and Y. Shi. 1994. Three new species of Kermes (Homoptera: Coccinea: Kermesidae) from China. J. Shandong Agri. Univ.In press.

Yang, P. L. 1982. Scale insects in China. Shanghai Sci. Tech. Press, Shanghai, China.

Takahashi, R. 1929. Observations of the Coccidae of Formosa, Part I. Formosa Govt. Res. Inst. Dept. Agri. Rept. 40: 80 pp.

Takahashi, R.. 1936. Some Coccidae from Formosa and Japan. Kontyu 9(1): 1-2.

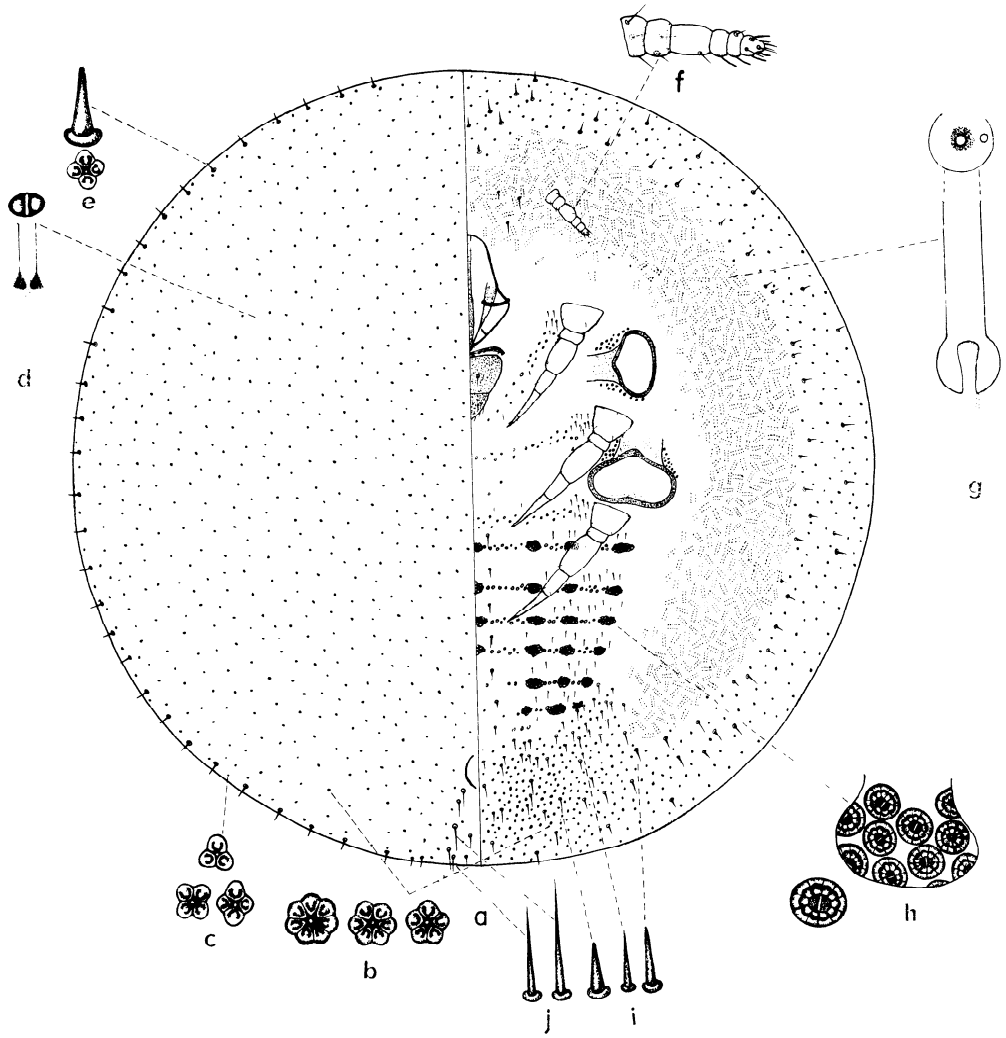

Fig. 1: *Kermes orientalis* Liu and Shi, new species, young adult female.

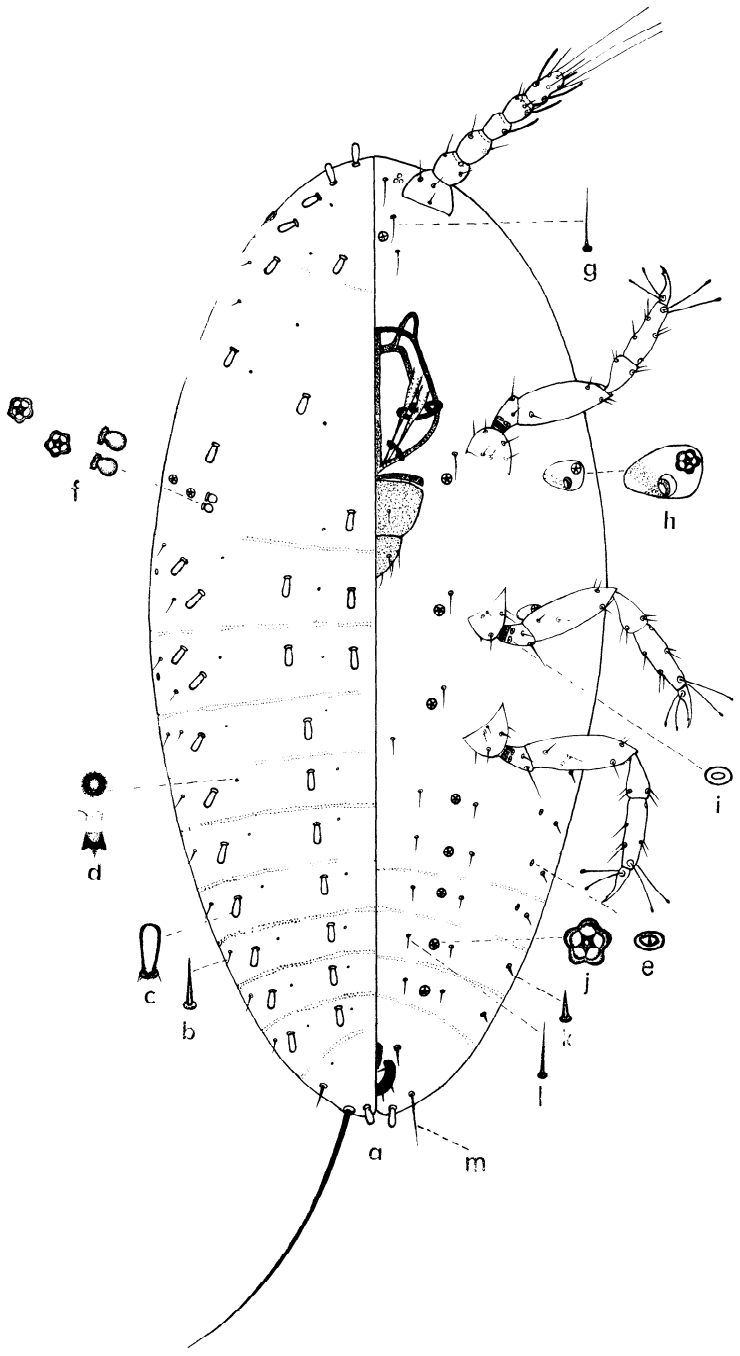

Fig. 2: First instar of *Kermes orientalis* Liu and Shi.

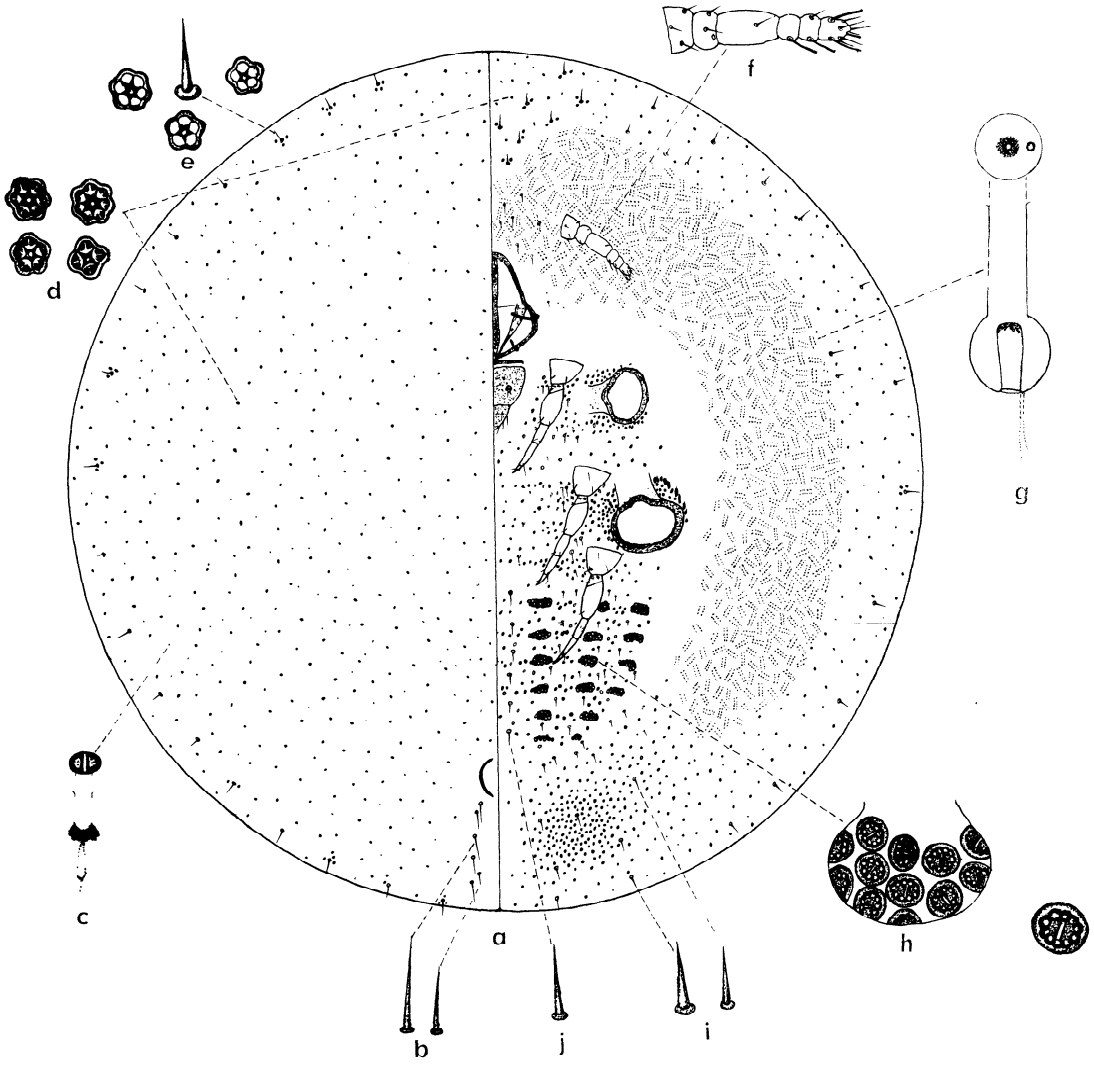

Fig. 3. *Kermes flavus* Liu, new species, young adult female

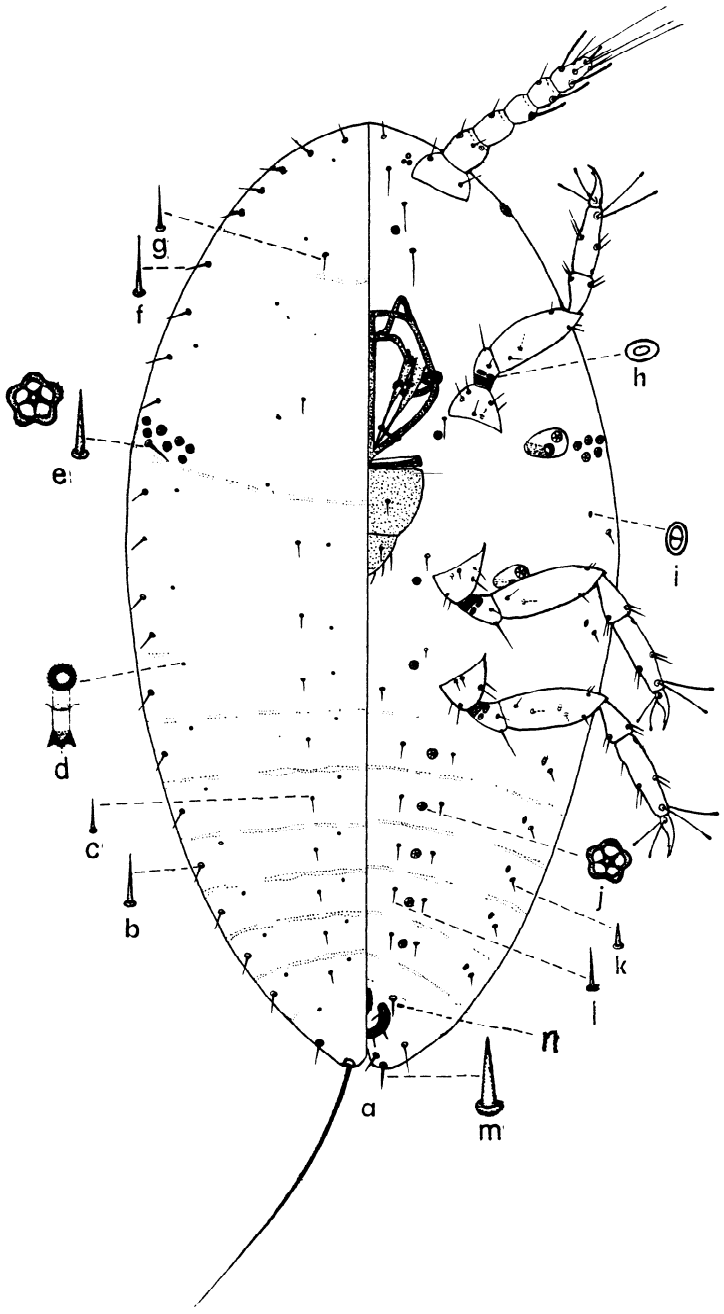

Fig. 4: First instar of *Kermes flavus* Liu.