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SOME TAXONOMICAL AND BIOLOGICAL NOTES ON *TOGEPSYLLA MATSUMURANA* KUWAYAMA, JR. (HEMIPTERA : PSYLLIDAE)*

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The genus *Togepsylla* was originally described from Formosa by Satoru KUWAYAMA(1931) basing upon *T. takahashii* which was collected at Urai by R. TAKAHASHI. Subsequently, the Japanese species, *T. matsumurana*, was added by Satoru KUWAYAMA (1949), basing upon the specimens collected in Tokyo. Thus, the genus is represented by only these two species. Those are very peculiar psyllids and characteristic of many long setae on head, thorax and wing veins, of which generic name originally came from.

The position of this genus is still doubtful, but it is placed in the subfamily Pauropsyllinae for the present as mentioned afterward.

As for *Togepsylla takahashii*, TAKAHASHI (1936) recorded two species of host plants and mentioned about the immature stages and biology. However, the life history or the immature stages of *T. matsumurana* have not been known yet. In the present paper, the adult is redescribed and the developmental stages are described in detail except for the third and the fourth instars, with a brief note on its life history. Two species of host plants belonging to the Lauraceae are recorded here for the first time.

According to the private communication from Dr. Satoru KUWAYAMA, neither types of *T. takahashii* and *T. matsumurana* are now left unfortunately. Therefore, I could not examine the type series of *T. matsumurana*. The material treated in this paper will be deposited in the collections of the Osaka Museum of Natural History, the Entomological Laboratory of Kyushu University, the Entomological Laboratory of Ehime University and in my collection.

Before going further, I wish to express my deepest appreciation to Prof. K. YASUMATSU of the Entomological Laboratory, Kyushu University for his constant guidance in the course of this study. My hearty thanks are also due to Dr. M. CHIJI and Mr. I. HIURA of the Museum for their encouragement and kind help.

Togepsylla matsumurana KUWAYAMA, Jr.

Togepsylla matsumurana KUWAYAMA, Jr., 1949, Insecta Matsumurana 17(1) : 48 (type locality : Tokyo, Japan).

Color : General color light brown to brown ; vertex light brown ; eyes brown ; apex of 3rd labium black. Antenna whitish, with 2 basal segments brown, apices of III, IV, VI, VIII and 2 apical segments black (Fig.1—A), with 2 long brownish setae apically. Thorax dark brown

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dorsally, lighter laterally, with many long setae of black or white. Forewing almost transparent, slightly infuscated along M+Cu, Cu, Cu_1, base of Cu_2, with veins mostly light brown ; R_1, apex of M_{1+2}, base and apex of Rs dark brown, veins with many long black setae. Legs yellowish brown ; dorsal surface of femur, apex of tibia and apical segment of tarsi dark brown. Abdomen dark brown dorsally, light brown ventrally, genital segments light brown.

Structure : Head (Fig.1—H) very small, flat, slightly deflexed, narrower than thorax ; vertex somewhat quadrate, slightly shorter than wide, nearly straight at posterior margin, with 4 tubercles as figured, 2 on the median line near center, one each on lateral margin close to eyes ; vertex with 8 long setae in total, 2 long black ones each on lateral tubercles, 2 shorter white ones each on tubercles on median line ; genal cones absent, only anterior margin of vertex more or less produced downward laterally, with pubescence sparsely along anterior margin ; occiput almost flat, slightly depressed medially, more or less produced caudad laterally ; eyes large ; lateral ocelli small, frontal ocellus large and elevated from plane of vertex ; antennal socket located entirely between eyes, prominently elevated ; upper edge of clypeus not strongly produced forward, with a long seta anteriorly ; relative length of 1st labium, 2nd lab. and 3rd lab. as 1 : 1.1 : 0.7 ; the 3rd labium taking the shape of tip of writing brush, pointed and black apically (Fig. 1—Mo). Antenna (Fig.1—A) moderately long, 1.7 times as long as width of head, stout, without conspicuous sensorium ; apex with 2 long setae ; relative length of antennal segments as 1 : 1 : 2.3 : 2.2 : 1.3 : 1.7 : 1.5 : 1.7 : 1.4 : 1.

Thorax small, quite flat, strikingly spiny ; pronotum vertical or slightly deflexed, nearly as wide as head including eyes, with 8 long setae dorsally, one pair of white ones near center, one black one each outside of them, 2 white ones each at lateral margin ; mesothorax with 14 long setae, a pair of white ones on praescutum, a pair of white ones and 4 pairs of black ones on scutum, a pair of black ones on parapteron, mesoscutellum without setae, mesoscutum convex ; metascutum with a pair of white setae and metascutellum with a pair of white setae ; postscutellum without setae, thus number of thoracic setae becoming 26 in total.

Forewing (Fig. 1—Fr) large, about 1.5 times as long as body, very fragile like that of some aphid species, nearly 2.3 times as long as wide, basal half narrow and apical half wide, apex broadly rounded ; veins with many long setae as figured, total number of setae ranges between 45 and 53, usually around 50, C+Sc with 12—16 black setae, first one of which is white, R+M+Cu constantly with 2 white setae, R with 4—5 black setae, Rs with 5—8 black setae, R_1 with 1 black seta only, M+Cu with 1—2 black setae, M with 6—8 black setae, M_{1+2} with 3—5 black setae, M_{3+4} without any setae, Cu with 1 black seta only, Cu_1 with 3—4 black setae, Cu_2 without any setae, A constantly with 4 setae, two basal ones of which are white ; R_1 very short and stout ; Rs strongly arched ; Cu_2 very long, forming elongate cubital cell ; M_{1+2} and M_{3+4} nearly equal, forming triangular medial cell ; relative length of veins R+M+Cu, M+Cu, Cu, Cu_1 as 4 : 3 : 1 : 1 ; claval suture ending almost apex of Cu_1.

Hind wing (Fig. 1—hn) long, nearly 3/4 as long as forewing, transparent, much thinner than forewing, about 3.4 times as long as wide, rounded at apex, posterior margin slightly incised at the end of claval suture, R long, nearly parallel to anterior margin, without subdi-

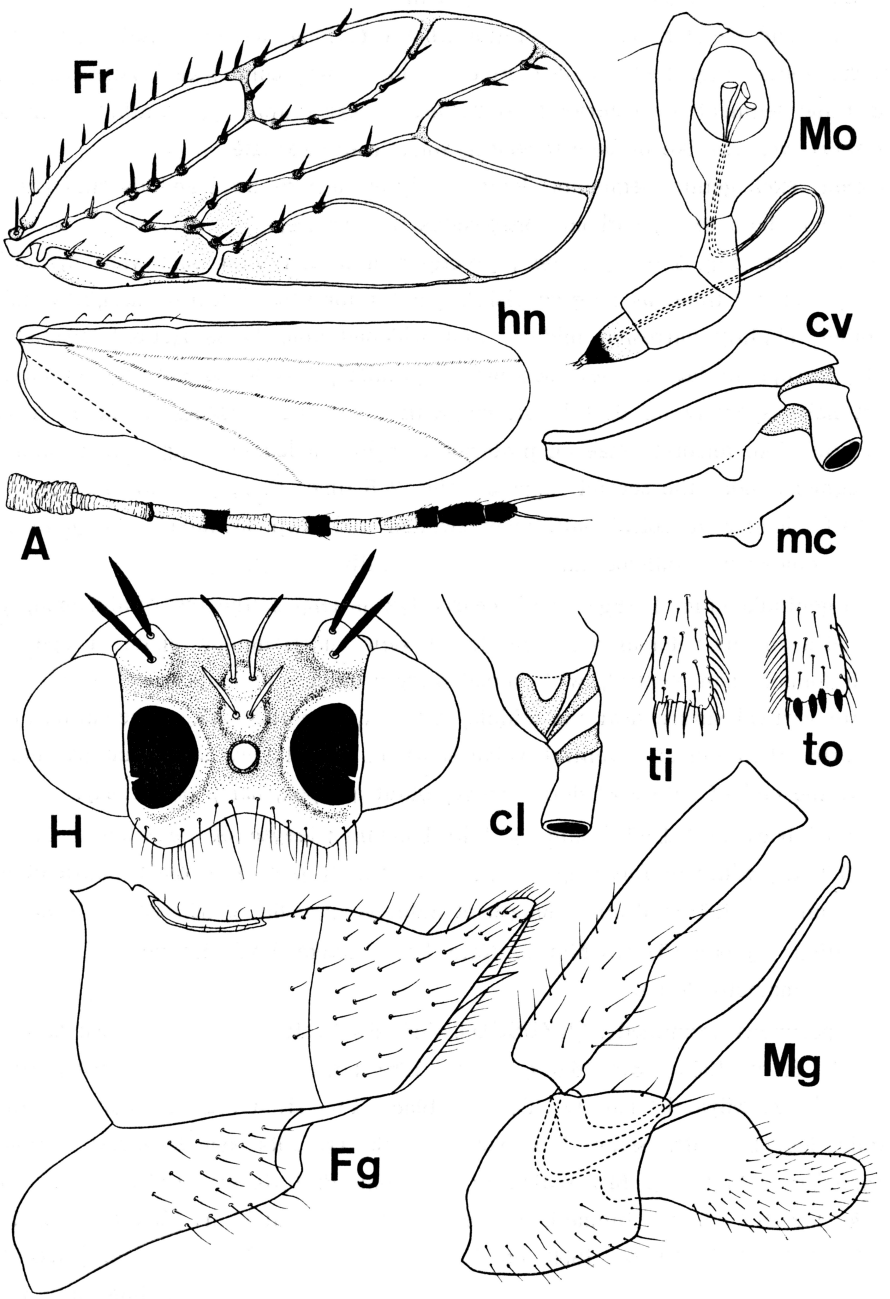

Fig. 1. Adult of *Togepsylla matsumurana* KUWAYAMA, Jr.

Fr, Forewing ; hn, Hind wing ; A, Antenna ; H, Head (antennae excluded), frontal view ; Mo, Mouth parts ; cv, Posterior coxa, ventral view ; mc, Meracanthus, lateral view ; cl, Posterior coxa, lateral view ; ti, Apex of posterior tibia, inner side ; to, Apex of posterior tibia, outer side ; Fg, Female genitalia, lateral view ; Mg, Male genitalia, lateral view.

vision, M and Cu without subdivision, C+Sc with 5 hooked frenulum basally.

Legs long and slender, hairy ; posterior tibia very long, without basal spur, with 4 outer, black, apical spurs (Fig. 1—to) and 5 inner, light brown, comb-like bristles (Fig. 1—ti) at apex ; proximal segment of posterior tarsi without apical spurs ; meracanthus (Fig. 1—cl, mc, cv) very short, verruca-like or hemispherical, sometimes subacute.

Abdomen (excl. genital segments) long, nearly as long as head and thorax combined, quite flat and wide in both sexes, without conspicuous pubescence.

Male genitalia (Fig. 1—Mg) large ; proctiger in lateral view somewhat cylindrical, long and slender, nearly 2 times as long as visible part of forceps, with both margins almost parallel to each other, slightly narrowed midway and widened apically as figured, sparsely hairy at basal half ; forceps in lateral view somewhat spatulate, broadened basally, rounded at apex, with short hairs sparsely on dorsal surface, with inner face bearing a curved hook midway and short brush-like retrorse setae on posterior margin ; aedeagus long, longer than proctiger, the first segment short, the second segment long, 2.5 times as long as the first segment, stout at basal half, slender at apical half, apex swollen and earpick-shaped ; subgenital plate in lateral view somewhat parallelogrammic, hairy ventrally.

Female genitalia (Fig. 1—Fg) small, nearly 1/2 as long as the rest of abdomen, flat as well as abdominal segments ; dorsal valve in dorsal view subtriangular, acute at apex, in lateral view much longer than ventral, with dorsal margin sinuate and upturned apically as figured, with obscure vertical suture near the middle, with hairs on the back of the suture ; inner valve slightly shorter than dorsal ; ventral valve short, in lateral view somewhat parallelogrammic, ending near the end of suture of dorsal valve, blunt at apex, hairy posteriorly.

Length of body ♂ 1.1—1.2 mm, ♀ 1.2—1.3 mm ; length of forewing ♂ 1.6—1.8 mm, ♀ 1.8—1.9 mm ; width of forewing ♂ 0.6—0.8 mm, ♀ 0.8—1.0 mm ; length of hind wing ♂ 1.2—1.5 mm, ♀ 1.4—1.6 mm ; length of antenna ♂ 0.60—0.66 mm, ♀ 0.55—0.63 mm.

Distribution : Japan (Tokyo Metro., Nara Pref., Osaka Pref., Ehime Pref., Fukuoka Pref., Ooita Pref., Kumamoto Pref.).

Adult specimens examined : [KYUSHU]. 7♂♂8♀♀, 10. v. 1958 ; 19♂♂21♀♀, 10—12. v. 1958 ; 1♀, 3. v. 1962 ; 3♂♂6♀♀, 4. v. 1962 ; on *Lindera erythrocarpa*, Mt. Hikosan, Fukuoka Pref., Y. Miyatake leg. 1♂, 26. iv. 1958 ; 1♀, 15. iv. 1960 ; Hirao, Fukuoka City, Y. Miyatake leg. 1♀, Mt. Sefuri, Fukuoka Pref., 13. iv. 1958, on "Hisakaki"-*Eurya japonica*, Y. Miyatake leg. 2♂♂2♀♀, Mt. Wakasugi, Fukuoka Pref., 9. iv. 1960, on *L. erythrocarpa*, Y. Miyatake leg. 8♂♂5♀♀, Inunaki, Fukuoka Pref., 5. v. 1966, Y. Miyatake leg. 7♂♂6♀♀, Mt. Kujuh, Ooita Pref., 10. v. 1959, on *L. erythrocarpa*, Y. Miyatake leg. [SHIKOKU]. 1♂, Sugitate, Matsuyama City, Ehime Pref., 16. iv. 1954, K. Sasaki leg. (Ehime Univ. Coll.). 2♂♂ 3♀♀, Mt. Sara, Ehime Pref., 11. v. 1954, K. Sasaki leg. (Ehime Univ. Coll.). 15♂♂19♀♀, Omogo Valley, Ehime Pref., 18. v. 1953, K. Sasaki leg. (Ehime Univ. Coll). [HONSHU]. 1♂, nr. Kômori-kutsu, Kasugayama, Nara City, 12. v. 1968, on *Neolitsea sericea*, Y. Miyatake leg. 1♀, Mt. Kongo, Osaka Pref., 1. v. 1968, on *Lindera glauca*, Y. Miyatake leg. 4♂♂4♀♀, Mt. Iwawaki, Kawachi-nagano, Osaka Pref., 21. v. 1967, on *L. erythrocarpa*, Y. Miyatake leg.

Host plants : "Kanakugino-ki" - *Lindera erythrocarpa* MAKINO [Lauraceae] ; adults and eggs, confirmed at Mt. Hikosan, Fukuoka Prefecture in May, 1958 and at Mt. Kujuh, Ooita Prefecture in May, 1959 ; eggs and nymphs, confirmed at Mt. Wakasugi, Fukuoka Prefecture in April, 1959 by K. Morimoto and at Kikuchi-suigen, Kumamoto Prefecture in May, 1962 ; nymphs, confirmed at Mt. Kanayama, Fukuoka Prefecture and Mt. Hikosan, Fukuoka Prefecture in June, 1958. "Yama-koubashi" - *Lindera glauca* (SIEB. et ZUCC.) BLUME [Lauraceae] ; nymphs, confirmed at Mt. Wakasugi, Fukuoka Prefecture in May, 1959 ; adult, confirmed at Mt. Kongo, Osaka Prefecture in May, 1968. "Aogashi" or "Hosoba-tabu" - *Machilus japonica* SIEB. et ZUCC. [Lauraceae] ; adults and nymphs, confirmed at Omogo Valley, Ehime Prefecture by K. SASAKI, 1954—p. 32. "Shirodamo" - *Neolitsea sericea* (BLUME) KOIDZ. [Lauraceae] ; adults, KUWAYAMA, 1949—p. 49 ; adult, confirmed at Kasugayama, Nara City in May, 1968.

Both *Lindera erythrocarpa* and *L. glauca* are here recorded for the first time as the host plants of *Togepsylla matsumurana*. The former species is a conspicuously dominant host plant through the range of this psyllid. *Neolitsea sericea* can not be the host plant of nymphs but the food plant of adults. No nymphs have been found from this plant.

This species differs from the Formosan species, *Togepsylla takahashii* in being darker in color and stouter, in having forewing much wider, R_1 thickened and M_{3+4} nearly straight (strongly arched in *takahashii*), anterior margin without setae between apex of Rs and apex of M_{1+2} (usually with one seta in *takahashii*), without maculation along veins Rs, M_{1+2}, M_{3+4}, Cu_2 as seen in *takahashii*, in having setae on body and wing veins much shorter, antenna with V and VII entirely white (all apices from III to VIII black in *takahashii*), male forceps much stouter and broadly rounded at apex (subacute in *takahashii*), dorsal valve of female genitalia distinctly shorter, nearly 1/2 as long as the rest of abdomen (longer than the rest of abdomen in *takahashii*), wider in dorsal view, with apex upturned in lateral view.

Concerning the position of this genus, KUWAYAMA (1931) included it in the subfamily Carsidarinae, because of having slender body, unarched thorax and some head characters. This species, however, seems to have more characters in common with those of members in the subfamily Pauropsyllinae ; head without conspicuous genal cones and not deeply cleft in front between antennae as in Carsidarinae ; meracanthus very small and short ; proximal segment of posterior tarsi without conspicuous, black, apical spurs ; the nymphs have gall forming habit. The features of both male genitalia and female genitalia resemble those of *Leptynoptera sulfurea* CRAWFORD which is the member of Pauropsyllinae and widely distributed through the South Pacific Islands, especially in having a peculiarly elongate male proctiger.

Thus, the genus would appear to be placed in the Pauropsyllinae for the present, although it is still doubtful. More detailed examination of the morphological characters of head and thorax would be necessary to clarify the problem.

Descriptions of the developmental stages

A. **Egg** (Fig. 2—0)

Length 0.19—0.21 mm, width 0.10—0.12 mm.

Oval, rounded basally, with a short apical projection, which is somewhat tumor-shaped and usually put its head on one side, never pointed apically like those in *Trioza* spp. Light greenish yellow and semitransparent, more yellowish basally, becoming white and transparent near hatching. Just before hatching, head and brown eyes of the 1st instar can be seen through the eggshell. Surface of the eggshell without microscopical structure, which can be often found on the eggs of *Trioza* spp.

B. **Nymphs** (Fig. 2)

There are supposed to be five nymphal instars in this psyllid also. However, only the first instar and the second instar were obtained and their diagnoses are given below. The description of the final instar was made only basing upon several weathered exuviae.

a) First instar (Fig. 2—1)

Length 0. 20—0. 25 mm, width 0. 10—0. 15 mm.

Body elongate oval, semitransparent, more yellowish on abdomen. Head and prothorax well separated by membrane ; mesothorax and metathorax also well separated.

Thorax with rather broad membranous area along median line. Head with 1 pair of sectasetae and small short setae at anterior margin, 1 pair of sectasetae near eyes and 1 pair of sectasetae near center. Prothorax, mesothorax and metathorax with 2 pairs of sectasetae each, 1 pair near median line and the other at margin.

Antenna (Fig. 2—1a) slender, about 0. 07 mm, 2-segmented, relative length of each segment as 13 : 15 ; basal segment with 1 sectaseta and 1 large sensorium ; apical segment with 2 setae apically. Eyes reddish brown, with 4 facets.

Wing pads not defined yet. Thorax with 2 pairs of small spiracles ventrally. Legs long, tibio-tarsal articulation lacking, tibiotarsus dorsally with a pair of long setae apically, apices of which are hooked, and ventrally with a sensorium and a pair of claws at apex (Fig. 2—1t).

Abdomen well segmented, without sectasetae on the first segment, with 1 pair of sectasetae on II, with 3 pairs of sectasetae each on III-VII (one pair marginal), with 2 pairs of sectasetae on VIII dorsally and 1 long setae ventrally, with 1 pair of sectasetae on the terminal process ; circum-anal pore ring circular, with 20—24 pores.

b) Second instar (Fig. 2—2)

Length 0. 29—0. 33 mm, width 0. 17—0. 20 mm.

Body elongate oval in general shape, but much more angulate than the first instar. General color bright yellow, thorax semitransparent, legs light yellow and semitransparent. Features similar to those of the first instar, but distinguishable from the latter by the following characters.

Antenna (Fig. 2—2a) about 0. 08 mm, with 3 segments, relative length of each segment as 1 : 7 : 6, with 2 large sensoria, one on II at apex and the other on III near center ; the second segment with 2 sectasetae and rivet-shaped setae sparsely. Eyes reddish brown, with 8—10 facets.

Head with 2 pairs of larger sectasetae at anterior margin. Prothorax, mesothorax and

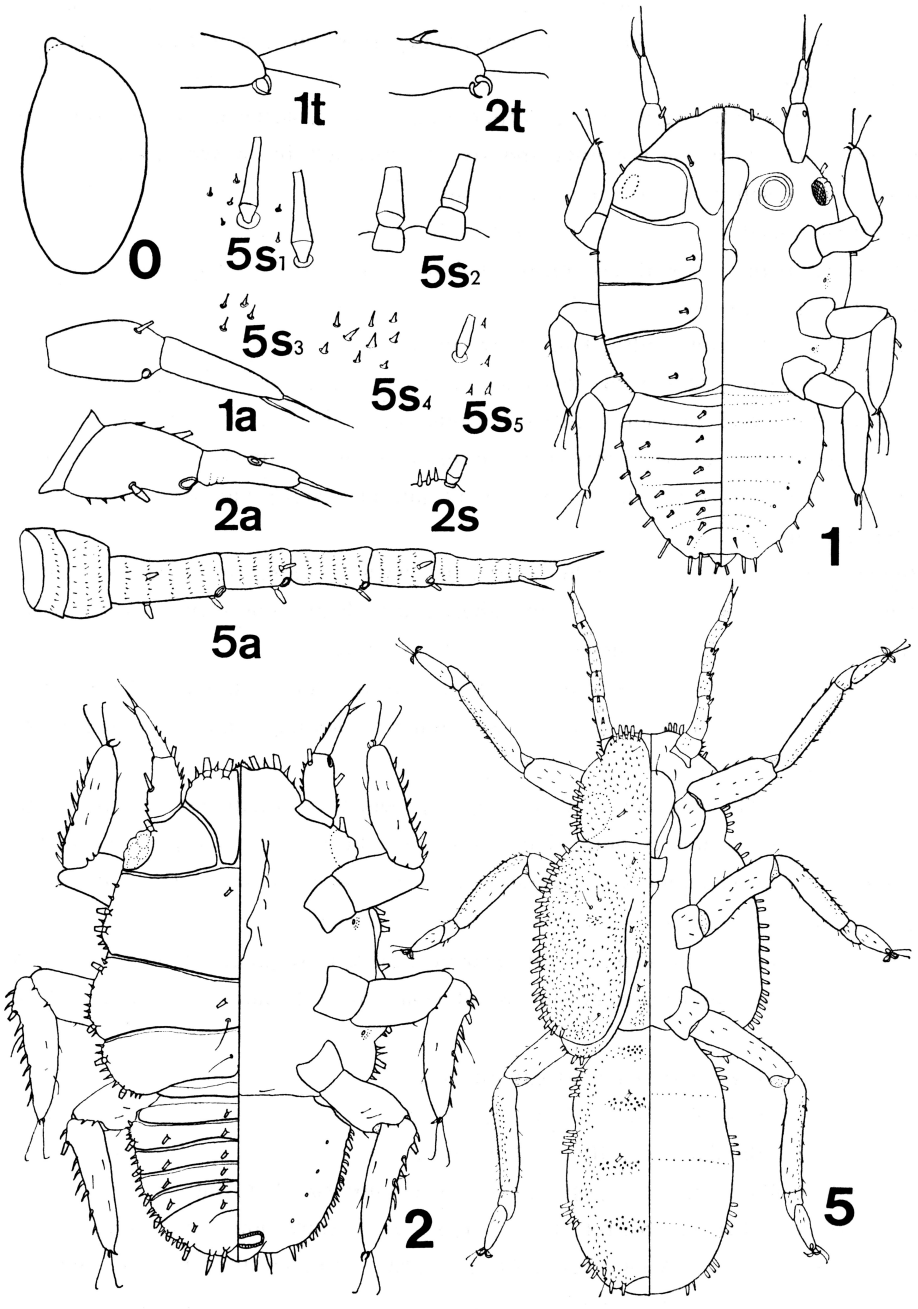

Fig. 2. Egg and nymphs of *Togepsylla matsumurana* KUWAYAMA, Jr.

O, Egg ; 1, First instar (1a, antenna ; 1t, apex of tibiotarsus) ; 2, Second instar (2a, antenna ; 2s, setae on posterior tibia ; 2t, apex of tibiotarsus) ; 5, Fifth instar (5a, antenna ; $5s_1$, sectasetae and setae on apex of abdomen ; $5s_2$, marginal sectasetae of abdomen ; $5s_3$, setae on antenna ; $5s_4$, dorsal setae on abdomen ; $5s_5$, setae on posterior tibia).

metathorax with 2 pairs of marginal sectasetae each and with many strong setae between sectasetae along margin ; mesothorax and metathorax more or less produced laterad, forming signs of wing pads.

Tibio-tarsal articulation still lacking, tibiotarsus with 1 sectaseta and 8 strong sickle-like setae, two of which are above sectaseta and six of which are below sectaseta.

Abdomen well separated by membranous area from I to VI, VII and VIII fused, with the same number of dorsal sectasetae as in the first instar, except for VII with 3 pairs of sectasetae ; outer circum-anal pore ring with 36—42 pores, inner ring with about 30 pores.

C) Fifth instar (Fig. 2—5)

Length 0. 93—1. 27 mm, width 0. 47—0. 55 mm.

Body elongate, wing pads well developed. Dorsal surface of head and thorax with short setae densely. Head and prothorax fused ; prothorax well divided from mesothorax. Head + prothorax with 5 pairs of sectasetae near anterior margin, with 1 pair of sectasetae a little behind, with 7 pairs of sectasetae near eyes at lateral margin and with 1 pair of sectasetae near center dorsally.

Antenna (Fig. 2—5a) long, 0. 35—0. 40 mm, with 7 segments, relative length of each segment as 5 : 5 : 14 : 8 : 9 : 8 : 15, with short setae (Fig. 2—$5s_3$) extensively in annulation as shown in Fig. 2—5a, with 8 sectasetae in total, 3 on III, 2 on IV, 1 on V and 2 on VI, with 4 large sensoria, each of which is located at apices of III—VI, with 2 apical setae.

Anterior wing pads with 22 pairs of sectasetae at lateral margin ; posterior wing pads with 2 pairs of sectasetae.

Legs extraordinarily long and well developed ; tibia with microsetae dorsally (Fig. 2—$5s_5$) ; 2 tarsal segments conspicuously defined by suture, the proximal one short and pointed knife-shaped, and the distal one long and slender, with web-like pulvillus attached to claws.

Abdomen with 2 pairs of sectasetae dorsally accompanied by short setae (Fig. 2—$5s_4$), with 4 pairs of groups of sectasetae along lateral margin, each group of which consists of 4 sectasetae (Fig. 2—$5s_2$) and apart at similar intervals, with 2 pairs of longer sectasetae near end (Fig. 2—$5s_1$).

Specimens of developmental stages examined :

egg, Mt. Wakasugi, Fukuoka Pref., 29. iv. 1959, on *L. erythrocarpa*, K. Morimoto leg.
egg, Mt. Hikosan, Fukuoka Pref., 10. v. 1958, on *L. erythrocarpa*, Y. Miyatake leg.
egg, Mt, Kujuh, Ooita Pref., 10. v. 1959, on *L. erythrocarpa*, Y. Miyatake leg.
egg, Kikuchi-suigen, Kumamoto Pref., 28. v. 1962, on *L. erythrocarpa*, Y. Miyatake leg.
1st instar, Mt. Wakasugi, Fukuoka Pref., 29. iv. 1959, on *L. erythrocarpa*, K. Morimoto leg.
1st instar, Mt. Hikosan, Fukuoka Pref., 10. v. 1958, on *L. erythrocarpa*, Y. Miyatake leg.
1st instar, Mt. Wakasugi, Fukuoka Pref., 28. v. 1958, on *L. erythrocarpa*, K. Morimoto leg.
1st instar, Kikuchi-suigen, Kumamoto Pref., 28. v. 1962, on *L. erythrocarpa*, Y. Miyatake leg.
2nd instar, Mt. Wakasugi, Fukuoka Pref., 28. v. 1958, on *L. erythrocarpa*, K. Morimoto leg.
2nd instar, Mt. Wakasugi, Fukuoka Pref., 31. v. 1959, on *L. erythrocarpa* and *L. glauca*, Y. Miyatake leg.

2nd instar, Mt. Hikosan, Fukuoka Pref., 6. vi. 1959, on *L. erythrocarpa*, Y. Miyatake leg.
2nd instar, Mt. Kanayama, Fukuoka Pref., 15. vi. 1958, on *L. erythrocarpa*, Y. Miyatake leg.
5th instar (exuvia), Mt. Wakasugi, Fukuoka Pref., xi. 1959, on *L. erythrocarpa*, Y. Miyatake leg.

General biology

This species of psyllid seems to have only one generation a year. Hibernating take place in the stage of adult. In fall and in winter, usually they can be found on such evergreen trees as "Sugi"-*Cryptomeria japonica*, "Hinoki"-*Chamaecyparis obtusa*, "Shirodamo"-*Neolitsea sericea*, "Arakashi"-*Quercus glauca* and "Hisakaki"-*Eurya japonica*, according to experience.

Adults begin to appear on the host plants in the beginning or in the middle of April, just when the buds of *Lindera erythrocarpa* and *L. glauca* are ready to germinate. Copulation occurs soon, and the form of copulating is always parallel style.

Females start to lay eggs from middle to later part of April. Usually eggs are laid one by one on underside of young leaves scatteringly, and scarsely two eggs are laid together. Eggs are not always laid along the leaf veins. It seems that female does not lay eggs on the leaf which is too young and still closed.

After a few days of ovipositing, the part of leaf where the egg was laid becomes an eruption dorsally, before hatching of the 1st instar. This very small pit gall is more or less yellowish in color and grows up to 0.5—0.8 mm in outside diameter and 0.33—0.45 mm in inside diameter (Fig. 3—1). The number of galls (the number of eggs) on one leaf is usually less than 10, but sometimes 30 to over 50, and maximum record shows 225 on one leaf (Fig. 3—2, 3).

The period of incubation is approximately 10—12 days, and the first instar may begin to hatch from the middle of May. The first instar settles down at the same pit gall, where the egg was laid on at the first time without transfer. By the end of May, the first instar finishes molting to become the second instar.

The period of the succeeding stages is not definite yet. It appears that the adults emerge early in July and they pass summer and winter until spring of the next year. There is, however, possibility that this species has two generations a year.

According to the information given by TAKAHASHI (1936), the nymphs of the relating species in Formosa,

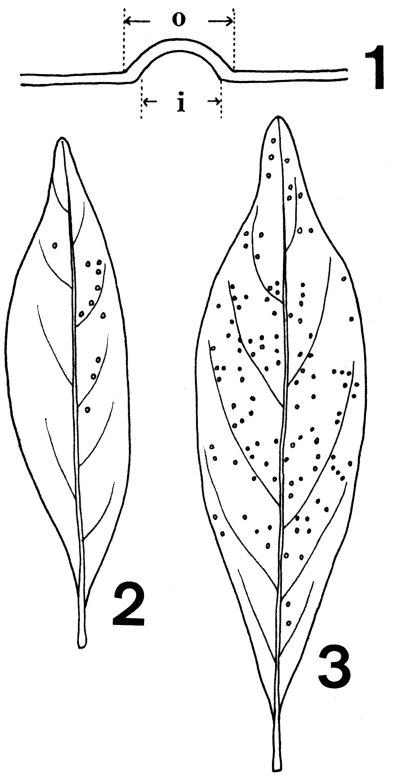

Fig. 3. Galls of *Togepsylla matsumurana* KUWAYAMA, Jr. on *Lindera erythrocarpa*.
1, Cross section of gall (o, outside diameter ; i, inside diameter) ; 2, Leaf with average number of galls ; 3, Leaf with many galls.

Togepsylla takahashii, live in the roll gall of the leaf edge on *Lindera communis* and *L. oldhami*. It is interesting to learn that Japanese species and Formosan species of *Togepsylla* form different type of leaf gall respectively on the related host species, the pit gall by the former species and the roll gall by the latter species.

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