

AN ABSTRACT OF THE THESIS OF

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Title The Biology of the Bramble Leafhopper, *Ribautiana tenerrima*
(Herrich-Schäffer) -----

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The purpose of this study is to determine the biology of the
bramble leafhopper *Ribautiana tenerrima* (H.-S.).

A review of literature pertaining to the distribution of this
insect revealed that it is of Holarctic distribution. It is a native
of Europe and has only recently been authentically recorded in North
America.

The bramble leafhopper has become a serious pest on loganberries
on Southern Vancouver Island. Both adults and nymphs suck the sap
from the leaves. This removal of the sap causes the leaves to take on
a mottled effect and seriously inhibits the development of the leaves
and fruit.

The relative merits of various methods of sampling nymph and
adult populations of this species are discussed.

A discussion is made of the host plants on which the adult,
nymph and egg populations are found. These hosts are a group of
closely related plants belonging to the genus *Rubus* and commonly
referred to as the "brambles".

A discussion of the taxonomic position of this species is
presented along with illustrations of the main taxonomic characters
such as the wing venation, pygofer, and genitalia.

A description of the various stages and measurements of
nymphal instars and adults is presented based on the measurement
and comparison of ten eggs, twenty nymphs of each instar, and twenty
adults of each sex. Special attention is paid to separating nymphs
of *Ribautiana tenerrima* and *Edwardsiana rosae* which are very similar
in appearance and life history.

Techniques used in rearing and handling the various stages during life history and behavior studies are discussed.

Field observations on the overwintering forms, time of emergence and abundance of the various stages of this species are presented.

Daily observations on the longevity of adults, and the time and manner in which they feed and mate is presented. The oviposition habits and the methods used in determining the preoviposition period and fecundity of the female are discussed.

The hatching of eggs, the moulting procedure of the nymphs and the duration of nymphal instars is discussed.

A discussion of the appearance of the genitalic structures differentiating male and female nymphs in the fourth and fifth instars is presented. A discussion of the sex ratio based on nymphal collections made in the field is also presented.

The parasites and predators attacking adults and eggs of this leafhopper are discussed.

THE BIOLOGY OF THE BRAMBLE LEAFHOPPER,
RIBAUTIANA TENERRIMA (HERRICH-SCHÄFFER).

by

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THE BIOLOGY OF THE BRAMBLE LEAFHOPPER,
RIBAUTIANA TENERRIMA (HERRICH-SCHÄFFER).

INTRODUCTION

The bramble leafhopper, Ribautiana tenerrima (H.-S.) is a native of Europe. The first authentic record of this species in North America was made in July 1947, when it was discovered in the vicinity of Victoria, British Columbia. It has since been found as far north as Cowichan Bay on Vancouver Island and in the lower Fraser Valley of British Columbia (1, p.68). Since its discovery here it has become a serious pest of commercial loganberry plantings and has been found to cause injury to raspberries, blackberries, and boysenberries. Both nymphs and adults suck the sap from the leaves which severely inhibits the development of the leaves and fruit.

Information on the life history and behavior of this insect in North America is very limited. For this reason, and the fact that a detailed study of this subject is required in conjunction with the development of an adequate control program for this economic pest, a study of the biology of the bramble leafhopper on Southern Vancouver Island was undertaken.

DISTRIBUTION

According to McAtee (8, pp.6-7) this species was first described from Germany in 1834 under the name Typhlocyba tenerrima H.-S. and was subsequently recorded from many localities in Europe from Sweden to Italy and westward. In 1850 it was described from England by

James Hardy (7, pp.417-418) under the name Typhlocyba rubi. In 1896 it was reported again from the British Islands by James Edwards (5, p.214) who described it as "common on brambles". Melichar (9, p.349), in 1896 also reported this species from northern Austria and central Europe on oak and bushes.

In North America, Gillette (6, pp.770-771) reported this species from Colorado in 1896. Van Duzee (16, p.710), in 1917 reported the species from Quebec, Ontario, Maine, New Hampshire, New York, Michigan and Colorado, but McAtee (8, p.7) in his revision of the group, stated that he was unable to verify any of these records. The first reliable report of the occurrence of this species in North America was made by Andison (1, p.68) from specimens collected on loganberry in the Victoria area of southern Vancouver Island, British Columbia. Specimens collected in this area in 1947 were subsequently forwarded to Mrs. Dorothy J. Knull of Columbus, Ohio, United States of America, who identified them as Typhlocyba tenerrima (H.-S.). At this time, Mrs. Knull stated that these specimens were the first she had studied that were in agreement with descriptions of R. tenerrima. The remarks of McAtee and Mrs. Knull would seem to cast some doubt on the validity of previous American records for this species. Since 1947 the species has been found in the lower Fraser Valley of British Columbia and forty miles north of Victoria at Cowichan Bay on Vancouver Island, B.C.

ECONOMIC IMPORTANCE AND DESCRIPTION OF DAMAGE

The extent of injury caused by the bramble leafhopper is difficult to estimate. Both adults and nymphs suck the sap from the leaves producing a mottled effect on the upper surface of the leaves (Fig. 33). A severe infestation, during a dry season may result in leaves that are curled and burned. The canes lack vigor and the development and size of the fruit is affected.

METHODS OF SAMPLING

Adult leafhoppers were collected either by using sticky-board traps, an aspirator or with a heavy canvas beating net. Adult population counts were attempted by using sticky-board traps. The traps were 8 by 12 inch boards painted chrome yellow or leaf green and smeared with tanglefoot. They were suspended approximately 4 feet from the ground between the two-wire-trellis supporting the loganberry vines. The insects were removed daily with the point of a knife. Tanglefoot was generally renewed twice weekly. To remove the sticker and prepare the adults for examination they were washed consecutively in xylene, acetone and 70 percent alcohol. A container charged with ammonium carbonate was suspended beneath one of the traps to determine the effect of ammonium carbonate as an attractant to the adults.

Also, population abundance was estimated by taking leaf samples at intervals along the wires and counting the number of nymphs per leaf. The leaf samples were generally restricted to

"stippled" or "mottled" leaves, since these symptoms usually indicated a high population of nymphs on the underside of the leaf.

HOSTS

In this discussion the term "host plants" refers to those plants in which eggs are deposited and on which the nymphal development takes place. Whereas, the term "food plants" refers to those plants that are utilized as a source of food by the adults but are not normally used for oviposition. The host plants of R. tenerrima appeared to be a group of closely related vine plants belonging to the genus Rubus and commonly referred to as the "Brambles". All stages of the leafhopper have been observed on Himalaya blackberry, (Rubus procerus P.J. Muell.) loganberry, boysenberry, and raspberry, (R. idaeus L.). Thimbleberry (R. parviflorus Nutt.) plants supported small adult and nymphal populations but to date no eggs have been found in the cane tissue. Adults were occasionally found on adjacent strawberry (Fragaria sp.) plants which appeared to be food plants rather than host plants.

During leafhopper rearing experiments it was observed that the leafhopper was able to commence its cycle on one host and complete it on another. Nymphs taken while feeding on loganberry, blackberry and boysenberry transformed to adults and laid eggs in the canes and leaves of raspberry. Similarly, adults taken while feeding on loganberry leaves laid eggs in blackberry leaves.

TAXONOMIC POSITION

The approved common name of this insect is "The Bramble Leafhopper" (11, p.133). This species has been placed in the Order - Homoptera; Family - Cicadellidae; Subfamily - Typhlocybinae; Tribe - Typhlocybini; Genus - Ribautiana; Species - tenerrima.

The following indented text and figures 2-5 and 10-12 pertaining to the taxonomic position of the bramble leafhopper R. tenerrima (H.-S.) have been extracted from the works of Young (18, pp. 17,39) and Christian (4, pp.1114, 1120-1122).

The Subfamily Typhlocybinae:

In this group of insects there has been a reduction in area and venation in the apical portion of the costal area of the hind wing, although this reduction is variable within the Typhlocybinae. From a practical standpoint, all leafhoppers which lack discal branching of the longitudinal veins of the fore wings, basad of the bases of the apical cells, may be placed in this subfamily. Young (18,p.6) has employed the name Typhlocybinae because the name conforms to the practice of retaining suprageneric names with priority. He reports that the first use of the group name was by Kirschbaum (1868) who used "Typhlocybidae" as a subfamily name.

KEY TO TRIBES OF TYPHLOCYBINAЕ (18, p.17)

1. Fore wing with an appendix ----- ALEBRINI
Fore wing without an appendix ----- 2

2. Hind wing with submarginal vein present (except in
TYPHLOCYBELLA) AND extending laterad then basad
along costa beyond apex of vein "R+M" -- DIKRANEURINI
Hind wing with submarginal vein present or absent
at wing apex, when present not extending beyond
apex of posterior branch of R (or "R+M" where
fusion occurs) ----- 3

3. Vein IV absent, style with distinct preapical
lobe and apical extension ----- ERYTHRONEURINI
Vein IV present, style without distinct preapical
lobe and apical extension TYPHLOCYBINI
(SEE DISCUSSION TO FOLLOW)

The Tribe Typhlocybinae (18, p.89)

The leafhoppers of this group have hind wings in which the veins 1V and 2V are separated apically (Fig. 2). The posterior branch of R is distinct and separate in some groups, combined with vein M_{1+2} in others. The submarginal vein is present or absent at the wing apex, and when present, it never extends beyond the apex of the outermost longitudinal vein whether the latter be the posterior branch of R or the fusion of vein "R+M".

The apical venation of the fore wings appears to offer but slight basis for establishing relationships between genera.

The pygofer is quite varied, frequently possessing macrosetae on the disc, and frequently with pygofer hooks, and these are often ventral in origin. The occurrence of macrosetae in uniserrate groups on the male plates are rare.

The style typically lacks a preapical lobe or apical extension (Fig. 5). Usually it is slender, tubular, and tapering and usually possesses ungrouped setae along its length. Occasionally, a deltoid preapical protuberance occurs on the mesal margin of the style.

The aedeagus is quite varied in form. Frequently it is composed of a long preatrium and a short shaft (Fig. 4). Various processes occur on it and these are occasionally complex.

Several distinct complexes occur within the tribe, of which the Typhlocyba Complex is of primary concern in this work. The bramble leafhopper was formerly included in the genus Typhlocyba. A discussion of the complex follows.

The Typhlocyba Complex (4, p.1114)

Most of the species included in the genus Typhlocyba prior to the segregation of the genera included in this revision were placed in this genus on the basis of wing venation as found in the type species, Typhlocyba quercus (Fabricius), the hind wing having two open apical cells, the fore wing with the inner and outer apical cells short and not attaining the wing apex, and the third apical cell of the fore wing triangular and usually stalked. The North American species with rare exceptions agree with the type species in wing venation (Figs. 2 and 3).

In recent interpretation of the genus Typhlocybae the structure of the male genitalia has been regarded as more significant than wing venation as a generic character, resulting in the segregation of groups of species from Typhlocyba as genera (Zachvatkin, 1939, 1947; Young, 1952).

The North American genera, including Ribautiana, are segregated from the Typhlocyba Complex as follows:

KEY TO THE GENERA OF THE TYPHLOCYBA COMPLEX (4, p.1114)

1. Crown with median length equal to median length of pronotum or nearly so; ocelli present; pygofer without group of macrosetae near basal angle of male plate.

HENRIBAUTIANA

Crown with median length much less than
median length of pronotum; ocelli rarely
present; pygofer usually with macrosetae
near outer basal angle of male plate ----- 2

2. Aedeagal shaft reduced to a flattened
membranous structure occurring between
a pair of arms formed by longer forcipate
atrial processes; plate without macroseta
at outer basal angle.

OSSIANNILSSONOLA

Aedeagal shaft strongly sclerotized or
absent, not so enclosed; plate with
macroseta at outer basal angle ----- 3

3. Aedeagal shaft absent, atrial processes
fused at base, branched near apex.

MCATEEANA

Aedeagal shaft present, heavily sclerotized,
atrial processes when present not branch-
ing ----- 4

4. Mesal margin style with distinct preapical
angular protuberance.

RIBAUTIANA

(SEE DISCUSSION FOLLOWING KEY)

Mesal margin of style without distinct pre-
apical angular protuberance ----- 5

5. Aedeagal shaft with three pairs of apical
processes and three broad, thin plates
arising from anterior margin.

EMPOA

Aedeagal shaft with less than three pairs
of apical processes or none, rarely with
one thin plate arising from anterior
margin ----- 6

6. Aedeagal shaft with two pairs of apical
processes, frequently one or both pairs
branched; without atrial processes,
aedeagal apodeme a slender arm nearly
two thirds the length of shaft.

EDWARDSIANA

Aedeagal shaft with one pair or without
apical processes; usually with atrial
processes present; aedeagal apodeme
usually laterally broadened, less than
two thirds the length of shaft.

TYPHLOCYBA

The Genus *Ribautiana* Zakhvatkin (4, p.1119-1120)

Type of the genus, *Cicada ulmi* Linnaeus, by original designation.

Figures referred to in the following text are those of *R. tenerrima* which compares favourably with *R. ulmi*.

Fore wings - Inner and outer apical cells short, not attaining wing apex; second apical cell much broader at apex than at base; third apical cell petiolate, wing apex smoothly rounded; with dark markings at apices of the veins which form distal margins of inner and outer apical cells, dark areas in apices of inner three basal cells (Fig. 7).

Hind wings - Vein 1V branching from vein 2V near its mid-length; submarginal vein absent at wing apex; both apical cells open apically; posterior branch of R fused with apical portion of vein M₁₊₂; usually whitish hyaline, fuscous on apical half in *R. ulmi* (Fig. 8).

Genital capsule - Male plate, in ventral aspect (Fig. 14), abruptly narrowed near middle its length to narrow upturned divergent apex, with single macroseta near outer basal angle and two smaller setae near lateral margin near middle of plate; in lateral aspect (Fig. 16), with a number of scattered microsetae, some of which tend to form a submarginal row along lateral margin; pygofer, in lateral aspect (Fig. 10), with group of macrosetae just dorsad of outer basal angle of plate, with numerous microsetae in region caudad and dorsad of these and a small row on inrolled margin directed mesad; posterior margin scarcely inrolled, not differentially sclerotized, not well differentiated, merging with ventral margin, pygofer hooks wanting; anal hooks wanting.

Internal male genitalia - Style (Fig. 17) elongate, slender, gradually tapering and curved laterad or dorsad towards apex, inner margin with preapical triangular protuberance and several alveoli, outer margin with a few long setae; connective (Fig. 17) Y-shaped or triangular; aedeagal articulation terminal or subterminal; aedeagus (Figs. 11, 12 and 17) without preatrial arm; aedeagal apodeme well developed, simple; atrial processes or basal shaft processes present, and usually one or more pairs of processes more distad on the shaft.

Head in dorsal aspect Fig. 6), narrower than pronotum, scarcely produced, median length not greatly exceeding the length next the eye, female longer than male, anterior margin of crown smoothly rounded; in lateral aspect contour of face convex and divergent from the line of dorsum, ocelli absent; pronotum short, with lateral margins greatly divergent posteriorly, and with posterior margin shallowly emarginate; width of pleural portion greatly exceeding width of ocellocular area.

The genus has a Holarctic distribution.

KEY TO THE SPECIES OF RIBAUTIANA
(4, p.1120-1121)

1. Length 3.5-4.0 mm.; fore wings greenish-yellow; abdomen black on venter; aedeagus without processes on shaft.

Length 3.25 mm. or less; fore wings white to orange-yellow; abdomen yellow on venter; aedeagus with processes on shaft ----- ulmi 2

2. Scutellum dark brown or black ----- 3
Scutellum light colored ----- 4

3. Aedeagus with two pairs of apical processes, shaft three times as long as atrial processes.

Aedeagus with three pairs of apical processes, median pair branched, shaft twice as long as atrial processes. luculla

sciotoensis

4. Aedeagus with a pair of processes arising near middle of shaft ----- 5
Aedeagus without processes arising near middle of shaft ----- 6

5. Shaft of aedeagus slender, apex gradually curving ventrocaudad, with two or three pairs of short apical processes.

unca

Shaft of aedeagus stout, apex not curving ventrad, with a pair of apical processes directed cephalad, and a single unpaired process directed dorsad from posterior margin.

tenerrima

(SEE DISCUSSION FOLLOWING KEY)

6. Inferior pair of apical processes of aedeagus with numerous spinelike projections ----- 7
 Inferior pair of apical processes of aedeagus smooth ----- 8

7. Length of shaft of aedeagus beyond apical processes equal or nearly equal to length of inferior processes.

multispinosa

Length of shaft beyond apical processes of aedeagus less than half the length of inferior processes.

piscator

8. Apical half of aedeagal shaft nearly straight, inferior pair of processes only slightly curved.

parapiscator

Apical half of aedeagal shaft curved into nearly a complete circle, inferior pair of apical processes following curve of shaft.

foliosa

The Species Ribautiana tenerrima (Herrich-Schaffer) (4, p.1122)

This species differs from other species of the genus Ribautiana in having aedeagal shaft straight, not curving posteriorly at apex, and in having a pair of short slender basally fused processes arising on posterior margin near middle, another pair on anterior margin, and an unpaired process on posterior margin at apex. (Figs. 11,12 and 17).

DESCRIPTION OF STAGES

EGG

Eggs laid in the plant tissue by gravid R. tenerrima females caged over small logan plants were used in this description of the egg. Measurement of 10 eggs indicated that the length of the egg ranged from .72 mm. to .79 mm., with an average of .76mm.; the width from .22 to .25, with an average of .22 mm. The egg was almost transparent and hyaline when first deposited, but during the embryonic development it became more opaque. It was elongate, slightly curved, and narrower at the end near the egg puncture than at the other. In some cases they were cigar shaped, and in others bean shaped. The various shapes were probably due to the resistance offered by the plant tissue when the eggs were laid. In order to observe the development of the embryo, eggs were dissected from the plant tissue and placed on moist blotting paper in a small petri dish and kept at room temperature. The embryo was first observed as a small, white mass in the center of the egg. It was surrounded by translucent yolk globules which filled the remainder of the egg except for a clear area at the narrow, or anterior end of the egg. When fully developed the red eyes of the embryo were evident. At this stage the dorsal and ventral surface of the embryo could be determined in relation to curvature of the egg. The embryo was oriented within the vitelline membrane with its ventral surface opposite the inner convex surface of the egg (Fig. 21).

NYMPHS

Nymphs of the bramble leafhopper were pale white and were very small. The nymphs passed through 5 instars, increasing in size with each successive moult. Each instar was similar in appearance except for the development of wing pads in the fourth and fifth instars. The eye colour varied from dark red in the first instar to colourless or indistinct purple in the following instars. Drawings of the five instars are shown in Figs. 22 to 26. Measurements of each instar are recorded in Table IV.

First Instar.- The average diameter of head capsule of newly emerged nymphs was .25 mm. while the average length was .94 mm. Recently emerged nymphs were hyaline and almost translucent, with dark red eyes approaching a purple colour. The nymphs soon changed to pale white, and after feeding for a while they often became tinged with green. At this early stage the characteristic round shape of the head and hairiness of the head, thorax and abdomen were evident. The antennae were longer than the abdomen. Nymphs at this stage were generally quite inactive once they had fed and often remained on the underside of the same leaf throughout the several instars (Fig. 22).

Second Instar.- Nymphs of this instar were very similar in appearance to the preceding stage. The average diameter of head capsule was .32 mm., while the average length was 1.15 mm. Nymphs at this stage had the pale white colour characteristic of

the instars to follow. The eyes were either colourless or the centers of some of the eye facets were an indistinct purple colour. The length of the antennae was reduced to about the length of the abdomen (Fig. 23).

Third Instar.- In this stage small, flat wing pads began to develop on the mesa- and metathorax and the eye colour generally disappeared. The average diameter of head capsules in this instar was .40mm., while the average length was 1.54 mm. (Fig. 24).

Fourth Instar.- The wing pads in this instar were more developed extending to about the middle of the third abdominal segment. The pads were now more plump and appeared slightly raised above the level of the abdomen. The abdomen was cigar shaped and was slender in comparison to the thorax. The diameter of the head capsule averaged .50 mm. and the average nymphal length was 2.16 mm. (Fig. 25). Nymphs at this stage became more active when disturbed than in previous instars.

Fifth Instar.- The fully developed nymphs had well developed wing pads. The pads were about three times as long as broad and extended to about the middle of the fourth abdominal segment. The rounded or slightly conical head averaged .62 mm. across the compound eyes. The nymph measured 2.77 mm. long and was covered with very robust, hyaline hairs, slightly bent at the tips and arranged in a characteristic pattern on the head, thorax and abdomen (Fig. 25). Nymphs at this stage were also fairly active when disturbed, moving forwards, backwards or sideways with equal agility.

Characters separating Nymphs of two similar species

R. tenerrima (H.-S.) and E. rosae (Linn.).

Since the bramble leafhopper, R. tenerrima, and the rose leafhopper, Edwardsiana rosae, appeared to have similar life cycles and since the nymphs of both species were very similar in appearance, it became necessary to determine some taxonomic difference between nymphs of the two species. The characters separating nymphs of the two species are shown in the drawing of a fifth instar E. rosae nymph (Fig. 27) and a similar stage R. tenerrima nymph (Fig. 26). The author separated the nymphs of the two species on the following characteristics:

1. Head (Dorsal view).- E. rosae.- vertex truncate with sides of head in front of eyes concave. R. tenerrima.- vertex rounded, approaching a conical shape.

2. Head capsule width.- Average measurements of twenty specimens of each instar of both species show that head capsules of E. rosae measured approximately .03 mm. (1 micrometer division) wider than R. tenerrima in each of the first four instars and approximately .07 mm. (2 micrometer divisions) wider in the last instar (Table IV).

3. Length of nymph.- E. rosae nymphs were longer than R. tenerrima nymphs by approximately .01, .07, .08, .15 and .18 mm., respectively, for each of the five instars (Table IV).

4. Hairs.- The appearance of the hairs on the head, thorax and abdomen of each species was the best single character by which

nymphs of the two species could be separated. The hairs on R. tenerrima nymphs were very conspicuous. They were robust, hyaline and slightly bent at the tip. Hairs on E. rosae nymphs were not so conspicuous. They were finer, generally dark and slightly curved. The hair pattern was similar in both species except that four small hairs on the dorsal aspect of the meta-thorax and two short hairs near the dorso-median line on the third abdominal segment were absent in the former species whereas they were present in the latter (Figs. 26 and 27).

5. Eyes.— In the first two instars E. rosae nymphs had bright red eyes. In the first instar R. tenerrima nymphs had dark red eyes approaching a purple colour. The eyes of the second instar of the latter species were often colourless, and when coloured, the red was indistinct often with only the centers of some of the facets coloured. The remaining three instars of both species had eyes that were generally colourless, and when coloured, the nymphs of E. rosae were more inclined to retain the eye colouring and to have eyes that were a brighter red than nymphs of R. tenerrima. In general, the eye colour did not prove to be a reliable factor on which to separate the two species. There was some indication that the eye colour appeared and disappeared according to the time of day specimens were taken. In this respect, Christian (4, pp.1112-1113) found that it was possible to collect specimens of the same species of *Typhlocyba* showing both light or dark coloured eyes by collecting on both

shaded and sunny sides of a single tree or by collecting at different times of the day. Specimens collected at night or in the shade frequently had dark eyes when they came to the light, but the eye colour became lighter as they remained at the light for some time. Wigglesworth (17, pp.139-141) indicates that eye colour is caused by the migration of dark colour pigments in the iris cells of the compound eye. When the insect is in a dark place the dark pigment moves toward the surface of the eye, but when exposed to the light the pigment moves away from the surface of the eye.

ADULT

Examination of specimens collected on South Vancouver Island and identified as R. tenerrima by H. R. Hollinsworth (1956) of the Canada Science Service Systematic Unit showed that they agree with the most recent description of the species by Christian (4, pp.1122-1123). The points of agreement are as follows:

Male:

Length.- 3.26 mm.

Color.- Head, pronotum, and scutellum pale white to light yellow, without dark markings; fore wings white to yellow; abdomen black on basal half of dorsum of each segment, venter light yellow, or with narrow black basal band on each segment, basal half of pygofer black.

Genital capsule.- Male pygofer, in lateral aspect (Figs. 10 and 16), subquadrate, ventral angle projecting slightly beyond dorsal angle.

Internal male genitalia.- Connective (Fig. 17) triangular; aedeagus (Figs. 11, 12 and 17) with pair of atrial processes elongate, slightly flattened on distal half, length exceeding aedeagal shaft, gradually reduced to acute apices; aedeagal shaft expanded on basal third, laterally compressed shortly before apex, with a pair of short slender basally fused processes arising on posterior margin near middle, another pair at apex directed laterocephalad from anterior margin, and with unpaired dorsally directed processes arising from posterior margin at apex; aedeagal apodeme one sixth length of shaft, as broad as narrowest width of shaft in lateral aspect.

Female.-

Length - 3.49 mm.; colouration as in male; eighth sternite as in figures 9 and 13.

LIFE HISTORY AND HABITS

OVERWINTERING FORMS

The major portion of the leafhopper population overwinters in the egg stage in the bark of many bramble canes such as blackberry, loganberry, boysenberry, and raspberry. Female leafhoppers were observed ovipositing in the new cane growth during October. When these canes were examined under a microscope the eggs appeared as tiny blisters in the bark with a slit or puncture at the end of each blister. There was some indication that a small portion of the population of R. tenerrima may overwinter as adults, since adult leafhoppers of this species were observed in the field during April in 1952 and were collected in the field as late as January 29, 1956. Adults collected in the winter of 1956 were located on the undersides of leaves which were near the ground and which were protected from freezing temperatures by a cover of snow. Protected

in this manner, adults survived air temperatures as low as 12.5°F. In 1956 E. rosae (Linn.) adults were present on logan leaves near the ground in November but no adult specimens were taken after November 24.

EMERGENCE

Emergence studies on first generation nymphs and adults were made in 1954. Second generation emergence studies were carried out in 1955. The problem was complicated by the presence of both E. rosae and R. tenerrima species which appeared to have similar life cycles. Furthermore, the nymphs of both species were very similar in appearance. The following emergence data refers mainly to R. tenerrima, with occasional reference being made to E. rosae nymphal counts. The seasonal emergence is illustrated in Figure 1.

In 1954 the overwintering eggs hatched during the first two weeks in May or when the fruiting arms were 4 to 6 inches long. The heaviest infestation of first generation nymphs occurred in mid-May. At this time as many as 10 to 15 early stage E. rosae and R. tenerrima nymphs could be found on the underside of a leaf. The 1955 season was late and first generation nymphs did not appear until mid-May.

In 1955 first generation adults appeared during the first two weeks in June, or when loganberries were in full bloom. By the third week in June the majority of first generation nymphs had transformed to adults and by the end of June only the

occasional nymph could be found. This is in comparison to the 1954 season, when the first adults were noticed on June 4, and by June 15 approximately 90 per cent of the nymphs had transformed to adults.

In 1955 second generation nymphs emerged over approximately a three-week period. Nymphs began emerging approximately August 4, and first instar nymphs were present in the field until August 29. By mid-August both second generation nymphs and first generation adults were plentiful, especially on the leaves of the old canes. On August 21 as many as 17 E. rosae and R. tenerrima nymphs per leaf were counted. Second generation nymphs began to transform to adults on August 31. By September 10 all but a few of these nymphs had transformed and by October 18 only the occasional nymph could be found.

Second generation adults began ovipositing approximately October 1. Oviposition was very heavy October 18, and the occasional female was observed ovipositing as late as November 7.

ABUNDANCE

Since both E. rosae and R. tenerrima were present in the field in conspicuous numbers, both species are referred to in the following data on abundance.

Leafhoppers were removed daily from sticky-board traps set out September 29 to October 7. At this time the adult leafhopper population was very high. Preliminary observations indicate that male leafhoppers of the tenerrima and rosae species were more

more readily trapped than females of the same species (Table I). Population studies made by trapping would therefore seem to be limited. However, sticky-board counts indicate that the leaf-hoppers were more attracted to yellow boards than to green; with 52 R. tenerrima and 160 E. rosae adults caught on the yellow boards compared to 7 R. tenerrima and 61 E. rosae respectively, caught on the green during the same period (Table II). Table II also indicates that ammonium carbonate might have some attractiveness to the adults, since over a 2-day period a total of 150 R. tenerrima and 537 E. rosae adults were caught on a board with attractant in comparison to 95 and 494 adults, respectively, caught on traps without attractant. Sticky-board counts also indicate that E. rosae is more abundant than R. tenerrima in this location, the ratio being approximately 4:1 respectively.

TABLE I

NUMBER OF MALE AND FEMALE E. ROSAE AND R. TENERRIMA ADULTS
CAUGHT ON STICKY-BOARD TRAPS OCTOBER 7 TO OCTOBER 13.

TRAP	<u>R. TENERRIMA</u>		<u>E. ROSAE</u>	
	NO. MALES	NO. FEMALES	NO. MALES	NO. FEMALES
1	22	1	312	76
2	45	6	244	90
TOTAL	87	7	556	166

TABLE II

DAILY COUNTS OF E. ROSAE AND R. TENERRIMA ADULTS
CAUGHT ON STICKY-BOARD TRAPS SEPTEMBER 29 TO OCTOBER 7.

DATE	<u>R. TENERRIMA</u>			<u>E. ROSAE</u>		
	TRAP NO.			TRAP NO.		
	1(YELLOW)	2(YELLOW)	3(GREEN)	1(YELLOW)	2(YELLOW)	3(GREEN)
SEPT. 29	52		7	160		61
" 30	61			181		
OCT. 1	26	31		87	126	
" 2	28	39		127	139	
" 3	31	27		151	210	
" 4	8	23		91	93	
" 5	46	38		179	165	
" 6	70 ¹	40		207 ¹	238	
" 7	80 ¹	55		380 ¹	256	
DAILY AV.	44.7	36.1	-	173.7	178.1	-

¹Ammonium carbonate attractant added.

Ratio $\frac{R. \text{tenerrima}}{E. \text{rosae}} = \frac{1}{4.3}$

LONGEVITY

Two first generation R. tenerrima females collected July 26 and caged on logans, remained alive until October 13, a period of 80 days. At this time second generation adults had developed and were laying overwintering eggs. From this observation it appears that first and second generation adults of R. tenerrima may be present at the same time. Second generation adults which transformed during late August and early September were collected in the field as late as January 29 in 1956. There was some evidence that females outlived males. Late in the season females were very

prevalent in the field, while males were hard to find. Also, when male and female pairs, transforming on the same date, were transferred daily to new foliage in cages during pre-oviposition studies, females were observed to outlive males often by as much as 3 weeks.

SEX RATIO

Since male leafhoppers were attracted to sticky-board traps more readily than females (Table I), and since sampling methods for the adults were not entirely satisfactory, nymphal collections were used to determine sex ratio rather than adult collections.

The external genitalic structures that differentiate the male and female in the adult stage were also readily apparent in the fourth and fifth instar nymph. The male nymph was characterized by the "plate" which was broad at the base, narrow and turned out slightly at the tip, and resembled the plate of the adult male (Figs. 14 and 18). The female nymph was characterized by the spear shaped ovipositor which was outlined on the ventral terminal segments of the nymph and resembled the ovipositor of the adult female (Figs. 13 and 18).

Examination of the genitalia of 522 fourth and fifth instar nymphs collected at approximately two-day intervals from August 10 to September 31 showed that 274 were males and 248 were females. These figures indicate that the males were slightly more abundant than the females but the difference in numbers between the two was so small that the sex ratio may be considered to be 50:50.

FEEDING

Nymphs were observed to be negatively phototropic, which may explain why they feed almost entirely on the shaded undersides of the leaves. They developed equally well on old or new leaves, and appeared to feed continually except during ecdysis.

Adults have been observed to feed on the leaves, petioles, and succulent canes, but they prefer to feed on the undersides of the leaves in the same manner as the nymphs. Feeding was observed to be heaviest during the day. Observations made during early morning and late evening showed the leafhoppers to be very inactive at this time.

Both nymphs and adults have piercing and sucking mouthparts and feed by inserting the mouthpart stylets into the leaf tissue and removing the sap.

MATING

Leafhopper mating habits were observed in the field and in insectary cages containing newly transformed adults (Fig. 29). In cages male and female pairs were observed to line up side by side on the foliage prior to mating. This behavior may be explained by the recent work of Ossiannilsson (13, pp.82-84) who indicates that mating of leafhoppers is usually preceded by the production of sounds which are inaudible to humans without the assistance of special apparatus. During mating male and female assumed the

tail-to-tail position common to leafhoppers. Several pairs were observed mating for over an hour, with one pair remaining attached for two and one quarter hours. Pairs have also been observed to mate a second time after an interval of several days. Two pairs of R. tenerrima adults were in coition eleven days after they transformed into adults, and another pair fifteen days after transforming. Similarly, two pairs of E. rosae adults were in coition twelve and fifteen days, respectively, after they had transformed to adults.

In the field pairs were observed mating on the canes and leaves, especially the undersides of the leaves. Mating pairs were most evident during morning and evening or when dull humid weather prevailed. They were rarely observed to mate during the warmer hours of midday. Many pairs were observed mating just prior to or during a shower. Copulating pairs were quite active when disturbed and were able to fly readily from leaf to leaf while attached.

OVIPOSITION

Location of Eggs.- Eggs of the first generation were laid in the tissue of mid ribs, petioles and fruiting arms of the bearing canes during July and the early part of August. The eggs of the first generation were difficult to locate since they were nearly transparent and appeared to be incorporated in the plant tissue. The majority of eggs of the second generation were laid in the new cane growth. They were deposited just beneath the surface of the bark. Very often three or four eggs were laid side by side in

clusters. Females were observed to oviposit over the entire length of the cane, although the heaviest oviposition occurred in the middle part of the cane. A 33-inch cane was cut into six inch lengths and the number of egg blisters in each length was counted under a microscope. Eggs were found to be distributed over the entire length of the cane, with the majority deposited six to eighteen inches from the base. Canes hidden by dense leaf growth were only lightly infested whereas the canes exposed on the outside of the row were generally heavily infested.

Examination of leaves and petioles taken from the field in late fall showed that occasionally eggs were laid in the mid ribs of the leaves. However, very few eggs were laid in this location in comparison to the number laid in the new cane growth.

Examination of the old cane growth from the field in late fall failed to show any eggs present. At this time the old cane growth was hard and dry. When a number of gravid females were caged for a suitable period on an old cane, only three eggs were found in the bark in the caged area.

Method of Oviposition.- Oviposition by first generation females were seldom observed since at this time the females were very easily disturbed. Just prior to ovipositing the females of the second generation became sluggish and were not so easily disturbed as those of the first generation. They searched among the spines on the canes, apparently testing the texture and succulence of the cane tissue. Many attempts were made before

actual oviposition took place. Upon finding a suitable spot the female lowered her ovipositor and started the tip into the cane tissue. At this time the posterior part of the abdomen was bent downward and the middle of the abdomen was raised (Fig. 19). By putting weight on the middle of the abdomen and at the same time moving the posterior up and down in a series of rhythmical movements, the ovipositor was worked down and backwards in a curving motion until it was completely submerged in the tissue and the ventral part of the posterior was resting on the cane (Fig. 20). Oviposition required approximately ten minutes after which time the female had a short rest and then she proceeded to search for other suitable spots to lay eggs.

FECUNDITY

An attempt was made to determine how many eggs a single female leafhopper deposited during her adult life. A pair of second generation adults, after they had been observed to mate, were caged on each of two small raspberry plants. A thornless variety of raspberry was used in order that eggs could be observed more readily. After each pair had died every part of the raspberry plant was examined under the microscope for eggs. No eggs were found in one of the plants; the female apparently died before ovipositing. Only 7 eggs were found in the second plant. This low fecundity does not seem logical, since, in the field, a very low population of adults in the fall has been observed to lay enough eggs to produce a high nymph population the following spring.

Since it was found difficult to hold small potted bramble plants through the winter until eggs could hatch in the spring, in the future it would be advisable to use first generation adults and count the number of nymphs that appear when the eggs hatch, rather than search for the eggs in the tissue.

PRE-OVIPOSITION PERIOD

An attempt was made to determine the pre-oviposition period of second generation R. tenerrima adults under insectary conditions. Male and female pairs which transformed to adults on the same date, were kept for ten to eleven days in cylindrical plastic cages enclosing a single raspberry leaf and petiole held in a vial of water (Fig. 30). At the end of this time pairs were transferred daily to a new leaf and vial with an aspirator (Fig. 32). This foliage was in turn examined for eggs. Single pairs were placed in each of four cages, while two to three pairs were placed in each of five other cages. Females laid eggs in two of the cages containing single pairs and in three of the cages containing more than one female. In one of the cages containing a single pair, oviposition occurred five days after the pair was observed mating, which indicated a pre-oviposition period of sixteen days. In the remaining four cages no mating was observed but oviposition occurred 16, 23, 26, and 30 days, respectively, after the last moult, indicating an average pre-oviposition period of 23 days.

HATCHING

During August nymphs were observed to hatch from leaf petioles at approximately 9.00 a.m. under insectary conditions. Temperature undoubtedly plays an important part during hatching. Nymphs hatched very successfully from logan canes and completed their development when kept in the temperature control cabinet at approximately 68°F. and 75-85 per cent relative humidity. In comparison, when kept at room temperature, which was generally warmer than control cabinet temperatures, many nymphs pushed out of the egg chamber but died before they had extricated themselves from the embryonic membrane. In relation to this, Severin (14, p.187) in his work with the blue-green sharpshooter, Neokolla circellata, (Baker), stated that hatching was usually completed successfully when early morning temperatures were between 54° and 68°F.

It was observed that when nymphs were ready to hatch, they were invested in a membranous sheath or "embryonic membrane", which in turn was enclosed in the "chorion" or egg shell. The head of the nymph appeared to develop adjacent to the puncture made in the plant tissue during oviposition. During the process of hatching, the nymph, enclosed in the chorion and embryonic membrane, began to expand the oviposition puncture with its head and to push its way to the outside. After extrication from the chorion which was left in the egg chamber, the nymph, still enclosed in the embryonic membrane, remained suspended with the tip of the abdomen in the egg chamber. Suspended in such a manner, many undulating nymphs were seen protruding from the

petioles and fruiting arms. By such movements they extricated themselves from the embryonic membrane, which in turn was left in the aperture of the egg chamber. In some cases the nymph appeared suspended by a thread from the emergence hole. This thread in reality was a vestiment of the embryonic membrane which the nymph had not yet cast off. The newly emerged nymph remained near the emergence hole until the exoskeleton hardened. The nymphs then generally crawled to the undersides of the newly formed leaves to feed.

DURATION OF NYMPHAL INSTARS

Male and female R. tenerrima adults were caged over small logan plants where they deposited eggs in the plant tissue in July. Second generation nymphs that hatched from these eggs were used to determine the number of nymphal instars and the periods between moults of this generation under insectary conditions.

Newly emerged nymphs were removed daily with a camel hair brush and placed in shallow clip-on cages (Fig. 31) clipped to a logan leaf and petiole supported in a vial of water. Each moult was determined by the presence of a cast skin, by a perceptible increase in head capsule diameter, and generally by an increase in the length of the nymph shortly after each moult. Cast skins were removed after each moult. Daily observations for the presence of cast skins, plus measurements of the diameter of head capsule and length (head, thorax and abdomen) of six nymphs one day after hatching and one day after each moult, showed that the nymphs passed

through five stadia (Table III).

Table III also shows that four of the six nymphs transformed to females and two to males. Under insectary conditions the average interval or period between each of the five moults was 5, 5, 6.8, 10 and 18.8 days, respectively, for the females and 5.5, 4.5, 5.5, 6.3 and 11 days respectively, for the males. Table III further indicates that the female required from 40 to 54 days, with an average of 45.3 days, to complete the nymphal stage. The two males required an average of 33.5 days to reach the adult stage. These observations indicate that the males may complete their development in a shorter period than the females and therefore emerge earlier in the field as adults. Examination of the genitalia of second generation nymphs collected during early August showed that male and female nymphs were present in almost equal numbers at the beginning of emergence. The above observations would indicate that the male and female nymphs emerge in approximately equal numbers at the same time but that the male nymphs complete their development in a shorter period of time and emerge in the field as adults approximately one week before the females appear.

There was some variation in the duration of each instar between nymphs emerging on approximately the same date. It was observed, however, that where one nymph was slow in completing one instar it would acquire its growth more quickly in another, resulting in average developmental periods that were fairly uniform.

TABLE III

DURATION OF PERIODS BETWEEN MOULTS OF NYMPHAL
STADIA OF SECOND GENERATION R. TENERRIMA.

DATE NYMPHS HATCHED	DURATION OF INSTARS (DAYS)					DAYS REQUIRED TO COMPLETE NYMPHAL STAGES
	FIRST INSTAR	SECOND INSTAR	THIRD INSTAR	FOURTH INSTAR	FIFTH INSTAR	
FEMALES						
AUGUST 25	7	4	5	9	15	40
AUGUST 26	4	5	5	10	17	41
AUGUST 28	4	5	7	11	19	46
SEPTEMBER 1	5	6	10	10	24	54
AV. PERIODS BETWEEN MOULTS	5	5	6.8	10	18.8	43.3
MALES						
AUGUST 11	6	4	7	5	10	32
AUGUST 25	5	5	4	8	13	35
AV. PERIODS BETWEEN MOULTS	5.5	4.5	5.5	6.3	11	33.5

MEASUREMENTS OF NYMPHAL INSTARS AND ADULTS

Since the bramble leafhopper, R. tenerrima, and the rose leafhopper, E. rosae, appeared to have similar life cycles, a mixed population of these two species was often encountered in the field. The nymphs of both species were very similar in appearance, and in order to carry on further studies it became necessary to separate the two. For the above reasons measurements of the diameter of head capsules and overall length of twenty specimens of each nymphal instar of both species, plus fifty adults of each sex, male and female, of both species, were taken and the average

measurements recorded in Table IV.

Since the range of head capsule diameters for successive instars of each species taken separately do not overlap, measurements in Table IV may also be used to determine the number of instars entailed in each case. From the range of measurements it was evident that both species passed through five instars. The average diameter of head capsule for each of the instars of R. tenerrima was .25, .32, .40, .50 and .62 mm., respectively. The average length of each nymphal instar of the same species was .94, 1.15, 1.54, 2.16 and 2.77 mm., respectively. In comparison, the average diameter of head capsule for each of the five instars of E. rosae was .27, .32, .43, .54 and .69 mm., respectively. The average length of each nymphal instar of this species was .95, 1.22, 1.62, 2.31 and 2.95 mm., respectively. These figures indicate that E. rosae nymphs are slightly larger than R. tenerrima in each nymphal instar. E. rosae head capsules measured on the average .03 mm. (approximately one micrometer division) wider than R. tenerrima in each of the first four instars, and approximately .07 mm. (two micrometer divisions) wider in the last instar. A comparison of the average length of nymphs of both species indicates that nymphs of the first instar of both species were approximately the same length, but in the remaining four instars E. rosae nymphs were slightly longer than those of R. tenerrima.

Table IV further shows that the average diameter of head capsules of R. tenerrima adults was .56 mm. for the males and .60 mm. for the females. The average length of male and female of the

same species, when measured from the vertex to the tip of the wing, was 3.26 and 3.49 mm., respectively. In comparison, the average diameter of head capsule of E. rosae adults was .66 mm. for the males and .68 mm. for the females. The average length of male and female of this species was 3.75 and 4.03 mm., respectively. These figures indicate that in both species the females were larger than the males, and that E. rosae adults were larger than R. tenerima adults. Both male and female head capsules of E. rosae measured approximately .08 mm. wider than those of R. tenerima. In addition, the former species measured longer than the latter by approximately .46 mm. for the males and .51 mm. for the females.

MOULTING

Certain indications that moulting was about to occur appeared a day or two before the last moult took place. The full grown nymphs became quiescent and were not easily disturbed. The body became longer, the membranous connections between the head, thorax and abdomen, and between the abdominal segments appeared stretched. During the process of moulting, which always takes place on the under surface of the leaves, the nymph first of all set its claws firmly into the leaf tissue. A short time later a split occurred along the dorso-median line of the head and thorax. The imago extricated itself from the nymphal skin by a series of undulating, up and down movements, and by making liberal use of the coarse hairs on the body and legs to drive itself free. It remained suspended with the tip of the abdomen in the exuviae while the body and legs

TABLE IV

AVERAGE MEASUREMENTS OF NYMPHAL INSTARS AND ADULTS OF
TWO SPECIES OF LEAFHOPPERS, R. TENERRIMA (H.-S.)
AND E. ROSAE (LINN.) COLLECTED FROM THE FIELD.

INSTARS AND ADULTS	DIAMETER OF HEAD ACROSS CPD. EYES (mm.)			LENGTH OF SPECIMENS (mm.) [*]		
	MAX.	MIN.	MEAN	MAX.	MIN.	MEAN
<u>R. TENERRIMA</u>						
NYMPHS						
FIRST INSTAR	.25	.25	.25	1.04	.79	.94
SECOND INSTAR	.32	.31	.32	1.30	.90	1.15
THIRD INSTAR	.43	.40	.40	1.66	1.37	1.54
FOURTH INSTAR	.52	.49	.50	2.40	1.95	2.16
FIFTH INSTAR	.65	.58	.62	3.15	2.40	2.77
ADULTS						
MALES	.58	.54	.56	3.45	3.15	3.26
FEMALES	.65	.58	.60	3.66	3.30	3.49
<u>E. ROSAE</u>						
NYMPHS						
FIRST INSTAR	.29	.25	.27	1.12	.72	.95
SECOND INSTAR	.36	.32	.35	1.33	1.04	1.22
THIRD INSTAR	.43	.40	.43	1.76	1.37	1.62
FOURTH INSTAR	.58	.50	.54	2.70	1.95	2.31
FIFTH INSTAR	.72	.65	.69	3.45	2.25	2.95
ADULTS						
MALES	.72	.61	.66	3.90	3.60	3.75
FEMALES	.72	.65	.68	4.20	3.75	4.03

^{*}LENGTH OF NYMPH - COMBINED LENGTH OF HEAD, THORAX AND ABDOMEN (mm.)

^{*}LENGTH OF ADULT - LENGTH FROM VERTEX TO END OF WINGS (mm.)

were freed. The body emerged first. The pro-, meso- and metathoracic legs, in that order, were pulled free and spread apart. The immature adult then gripped the surface of the leaf with its claws and pulled itself free from the old skin. At this time the newly emerged adult was pale white, with wings curled inward against the sides and posterior part of the thorax. The wing covers uncurled first and were often well spread before the insect left the old skin. They uncurled from the body towards the tip and when fully uncurled were in a position partly folded back and held off the abdomen. Before the wing covers were completely expanded the under wings began to uncurl at right angles to the abdomen. The two sets of wings were kept apart in this position until dry. Wing venation began to appear almost immediately after they were fully distended. The venation appeared as cloudy channels in the translucent wing and around the costal margin. The newly emerged adult did not take on the dark body colour and characteristic wing markings until one or two days after transformation to adult. The transformation from nymph to adult required approximately thirty minutes. The newly emerged adults were very docile and remained quiet for several hours before attempting to fly.

Moulting of the earlier instars was similar to that described above for the last moult, except that the earlier stages required a shorter period of time and the newly emerged nymphs became active almost immediately. Wind caused the cast skins to drop from the leaves, although some of the last instar exuviae were very persistent and remained attached to the leaf for some time.

PARASITES AND PREDATORS

While collecting adults in the field several specimens were observed to be sluggish and very inactive. Closer examination of these specimens found them to be parasitized by a small, pale white, legless grub which emerged from the posterior end of the adult. Attempts to rear this grub to the adult were not successful. Childs (3, pp.27-28) observed a similar type of parasite attacking E. rosae, a leafhopper closely related to R. tenerrima, which he determined to be a Dryinid species.

A number of adults were found on the leaves with their heads missing. Closer observation showed that two small species of spiders were responsible. Specimens were identified by Dr. W. Gertsch. The first of these spiders was placed in the subfamily Erigoninae; genus Cornicularia; although in this case, the genus was uncertain because the specimens were immature. This spider belongs to a group of sedentary types which spin small webs on the ground or on vegetation. In the field it was noted that leafhopper adults often became ensnared in webs spun among the leaves. The spiders then generally dragged their victims to a nearby leaf where they fed on the head and body contents of the leafhopper. The other species was identified as Metaphidippus aeneolus Curtis. The Metaphidippus is a common diurnal jumping spider which places small reliance on silk and usually wanders about quite actively.

Overwintering eggs located in the canes were found to be parasitized by a minute, fringe-winged, hymenopterous parasite

determined by the writer as a Mymarinae species (fairy fly). The parasite adult developed within the leafhopper egg and upon emergence left a characteristic "shot hole" in the bark of the cane caused by a widening of the oviposition puncture when it emerged. The extent of parasitization appeared to be high.

SUMMARY

The biology of the bramble leafhopper Ribautiana tenerrima (H.-S.) is discussed in detail. This species is of Holarctic distribution. It is a native of Europe and was not recorded in North America authentically until 1947 when it was discovered causing damage to loganberries on southern Vancouver Island in British Columbia. Both adults and nymphs suck the sap from the leaves which causes the leaves to take on a mottled appearance and seriously inhibits the development of the leaves and fruit. Sticky-board traps are used to sample adult leafhopper populations whereas nymphal populations are estimated by sampling mottled leaves along the crop row and counting the number of nymphs per leaf. The hosts are a group of closely related vine plants belonging to the genus Rubus. They are loganberry, raspberry, blackberry, boysenberry and thimbleberry. The taxonomic position of the bramble leafhopper is based mainly on the wing venation, the shape of the pygofer and genitalia in the male, and the eighth sternite in the female. This species has been placed in the Order - Homoptera; Family - Cicadellidae; Subfamily - Typhlocybinae; Tribe - Typhlocybini; Genus - Ribautiana; Species - tenerrima.

The egg is translucent, hyaline, later becoming opaque. It is elongate, slightly curved and narrow at one end. The average length is .76 mm., the average width .22 mm. Eggs hatch during early morning or during periods of high humidity. During hatching the nymph is enclosed in a chorion and embryonic membrane which are both split open and left in the aperture of the egg chamber in the plant tissue when the nymph emerges.

Recently emerged nymphs are hyaline and almost translucent, later changing to pale white. The eyes are dark red at first changing to indistinct purple or becoming colourless in the later instars. They moult five times which requires approximately six weeks to complete and increase in length from .94 mm. in the first instar to 2.77 mm. in the last instar. During moulting the exuviae is split along the dorso-median line and the nymph emerges by making use of the coarse hairs on the legs. Special attention is paid to separating nymphs of R. tenerrima and the rose leafhopper Edwardsiana rosae (Linn.) which are very similar in appearance and life history. Nymphs of these two species are separated mainly on the shape of the head and the appearance of the hairs on the head, thorax and abdomen. The head of E. rosae nymphs is truncate, with the sides of the head in front of the eyes concave. The hairs are fine, generally dark and slightly curved. The hairs of the tenerrima species are robust, hyaline, and slightly bent at the tips.

Female adults are slightly larger than the males. The male and female measure 3.26 mm. and 3.49 mm. long, respectively. The colouration is the same in both sexes. The head, pronotum, and

scutellum is pale white to yellow without dark markings. The fore wings are pale greenish-yellow. The first cross veins and ends of apical veins are dusky. The abdomen is black on the basal half of the dorsum of each segment. The venter is light yellow, or with a narrow black basal band on each segment. The basal half of the pygofer is black.

The major portion of the leafhopper population overwinters in the egg stage in the bark of the canes. A small portion of the population overwinters as the adults on the undersides of leaves near the ground. The eggs hatch during the first two weeks in May. In a severe infestation as many as seventeen nymphs per leaf may be counted. The nymphs feed almost entirely on the undersides of the leaves. First generation adults appear during the first two weeks in June. Females of this generation may live as long as eighty days. Eggs are laid in the mid ribs, petioles and fruiting arms of the bearing canes during July and the early part of August. Second generation nymphs emerge during the first two weeks in August. By mid August both second generation nymphs and first generation female adults are plentiful in the field. Second generation nymphs transform to adults during early September. Females of this generation begin to oviposit in the new cane growth approximately October 1 and continue until as late as November 7.

Examination of the genitalia of fourth and fifth instar nymphs collected at intervals in the field indicates that the sex ratio is approximately 50:50. The male nymph is characterized by

the plate which resembles that of the adult male. The female nymph is characterized by the outline of the ovipositor which resembles that of the adult female.

Adult leafhoppers mate approximately ten days after transforming to adults. During mating they assume the tail-to-tail position common to leafhoppers. They generally mate on the undersides of the leaves during the morning and evening or when dull humid weather prevailed. They rarely mate during the warmer hours of midday.

Examination of new foliage exposed daily to second generation male and female pairs transformed to adults on the same date indicates that the average preoviposition period is 23 days.

Adults are parasitized by a small, pale white, legless grub. Spiders also prey on the adults. The eggs are parasitized by a tiny fringe-winged hymenopterous parasite determined by the writer as belonging to the subfamily Mymarinae (fairy fly).

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APPENDIX

Figures 2 - 5 from Young (18, p.145)
Figures 10 - 12 from Christian (4, p.1241)
Figure 33 by H. Andison, Dominion Entomological
Laboratory, Victoria, British Columbia

Remaining figures original drawings by author.

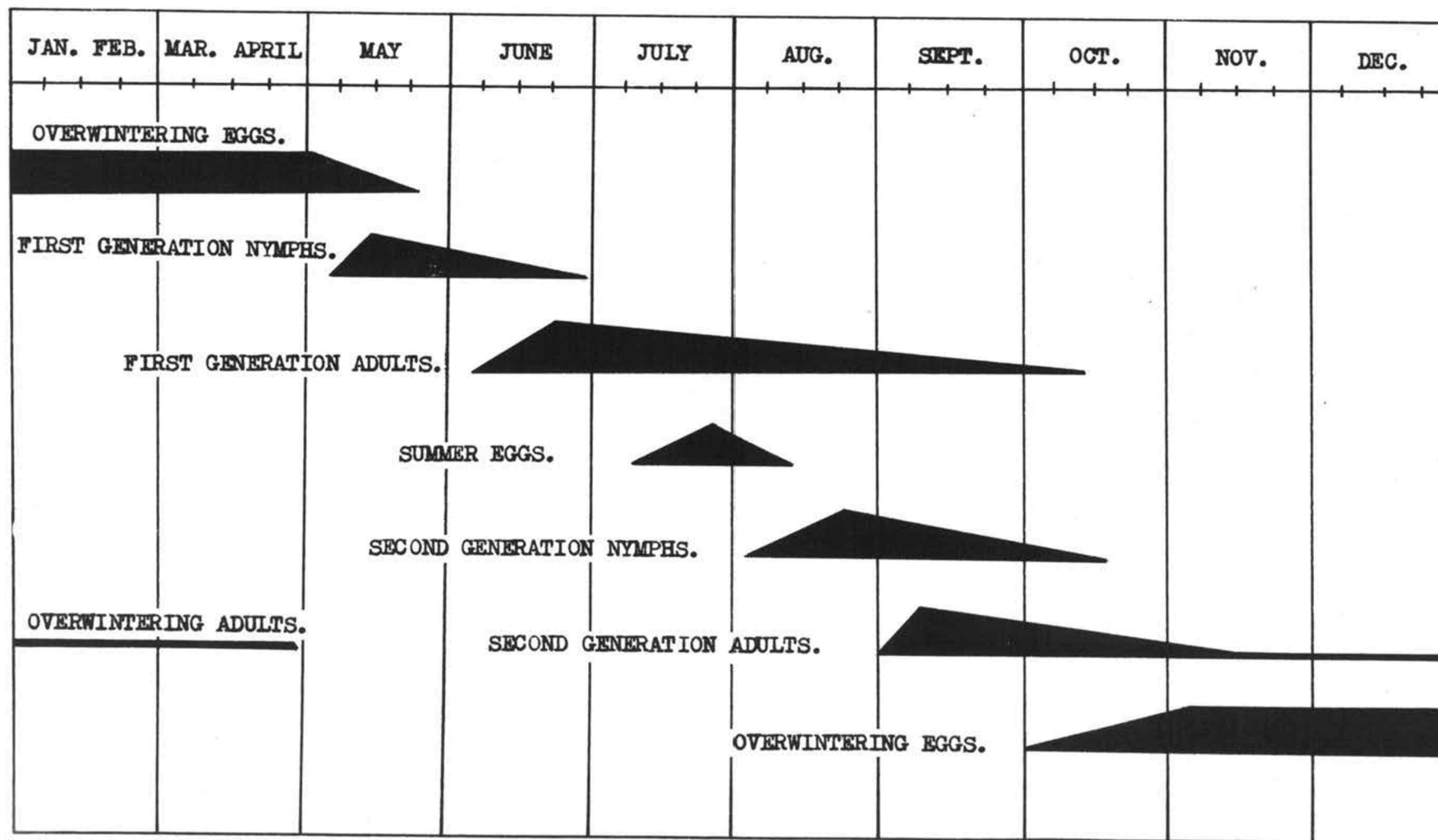


FIG. 1. SEASONAL LIFE HISTORY CHART OF THE BRAMBLE LEAFHOPPER R. TENERRIMA (H.-S.).

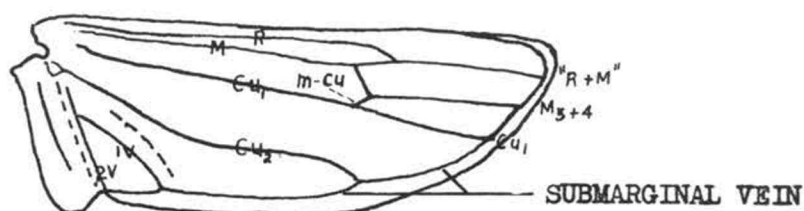


FIG. 2. HIND WING.

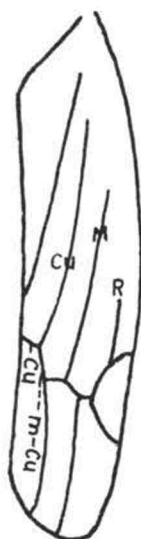


FIG. 3. FORE WING.

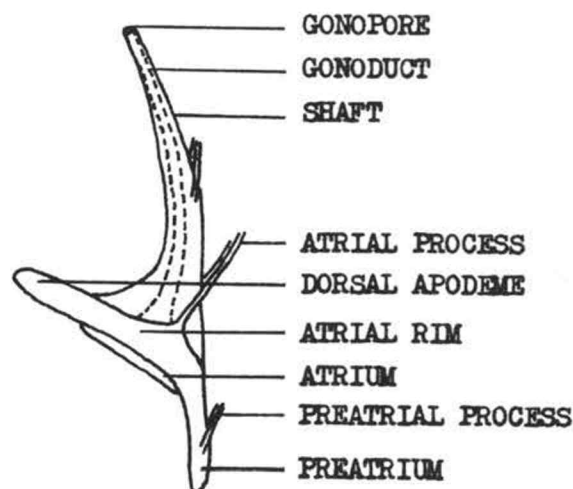


FIG. 4. AEDEAGUS, SCHEMATIC.

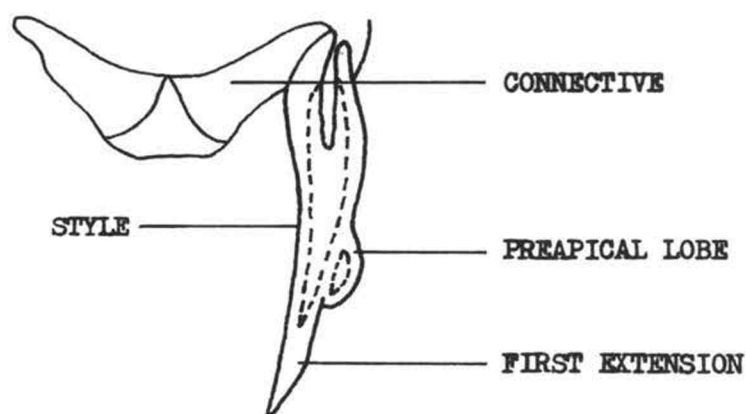


FIG. 5. STYLE AND CONNECTIVE.

FIGS. 2 - 5. DIAGRAMATIC DRAWINGS OF SOME OF THE STRUCTURES USED IN THE CLASSIFICATION OF TYPHLOCYBINE LEAFHOPPERS.

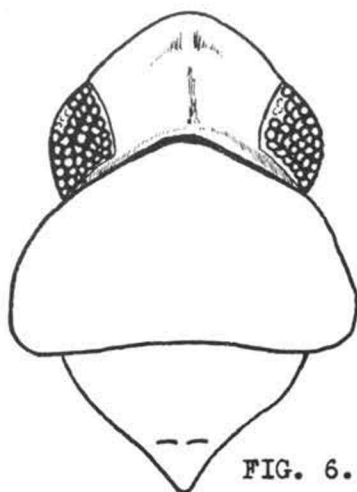


FIG. 6.

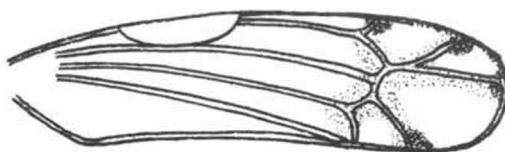


FIG. 7.

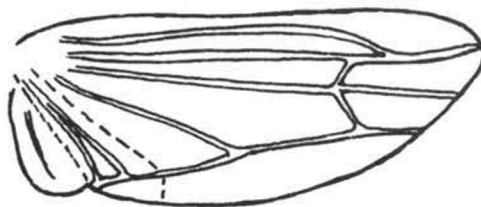


FIG. 8.

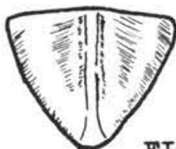


FIG. 9.



FIG. 10.



FIG. 11.



FIG. 12.

FIGS. 6 - 12. TAXONOMIC CHARACTERISTICS OF ADULTS OF
R. TENERRIMA (H.-S.) (GREATLY ENLARGED).

FIG. 6. HEAD PRONOTUM AND SCUTELLUM; FIG. 7. - RIGHT FORE WING; FIG. 8. - RIGHT HIND WING ; FIG. 9. - VIII ABDOMINAL STERNITE OF FEMALE; FIG. 10. - PYGOFER, LEFT LATERAL VIEW; FIG. 11. - VENTRAL VIEW OF AEDEAGUS; FIG. 12. - LATERAL VIEW OF AEDEAGUS.

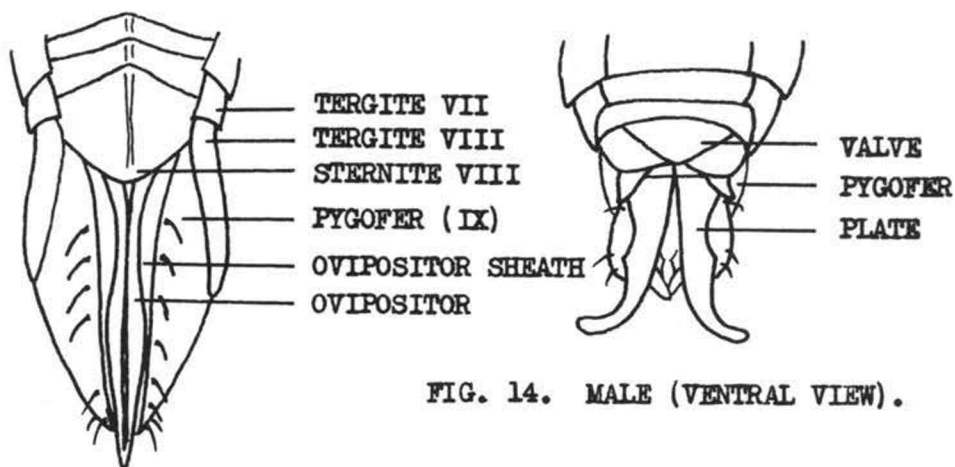


FIG. 14. MALE (VENTRAL VIEW).

FIG. 13. FEMALE (VENTRAL VIEW).

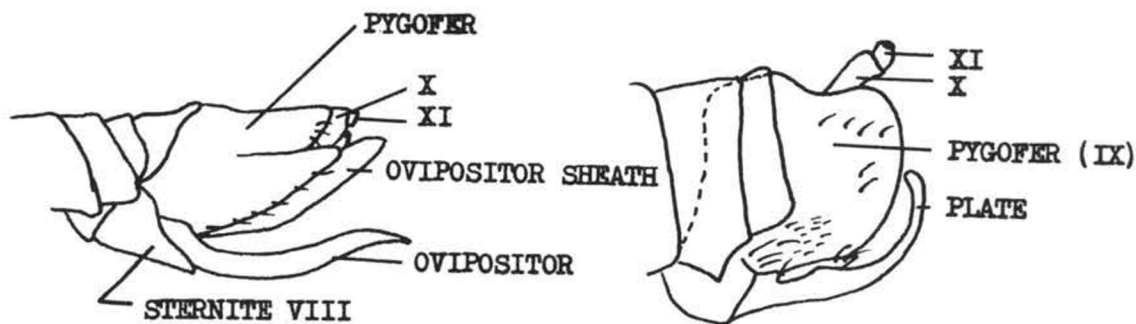


FIG. 15. FEMALE (LATERAL VIEW). FIG. 16. MALE (LATERAL VIEW).

FIGS. 13 - 16. TERMINAL SEGMENTS OF MALE AND FEMALE ADULTS OF THE BRAMBLE LEAFHOPPER R. TENERRIMA (GREATLY ENLARGED).

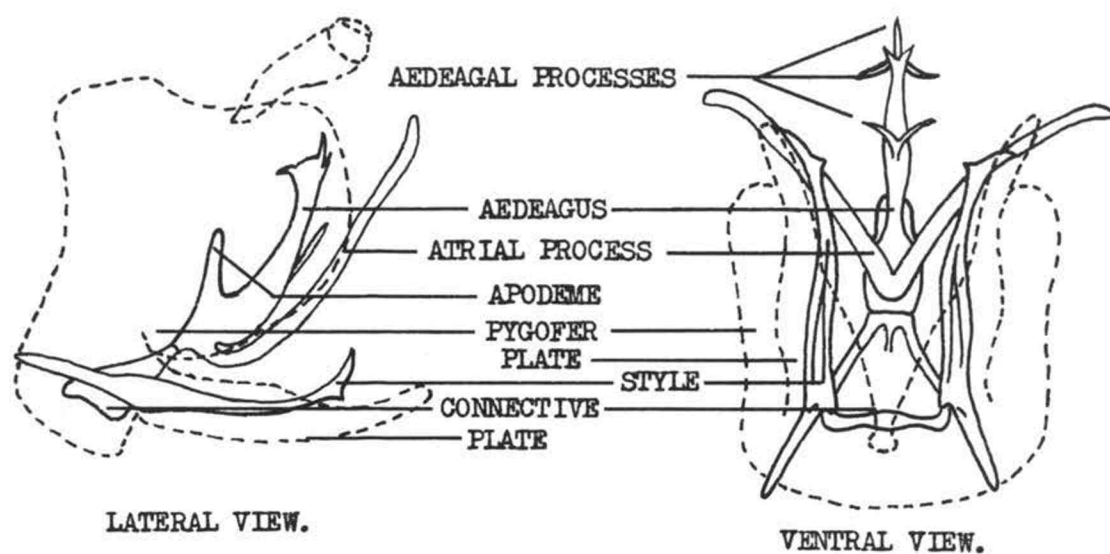


FIG. 17. POSITION OF MALE GENITALIA IN GENITAL CAPSULE (GREATLY ENLARGED).

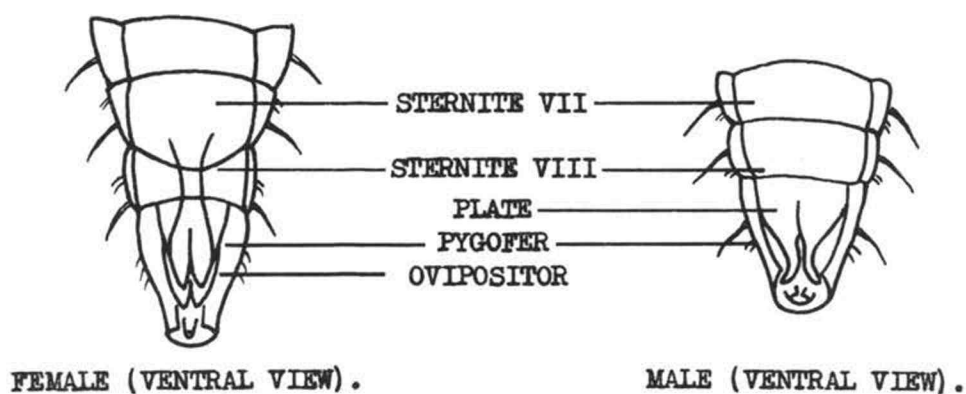


FIG. 18. GENITALIA AS SEEN IN FIFTH INSTAR NYMPHS (GREATLY ENLARGED).

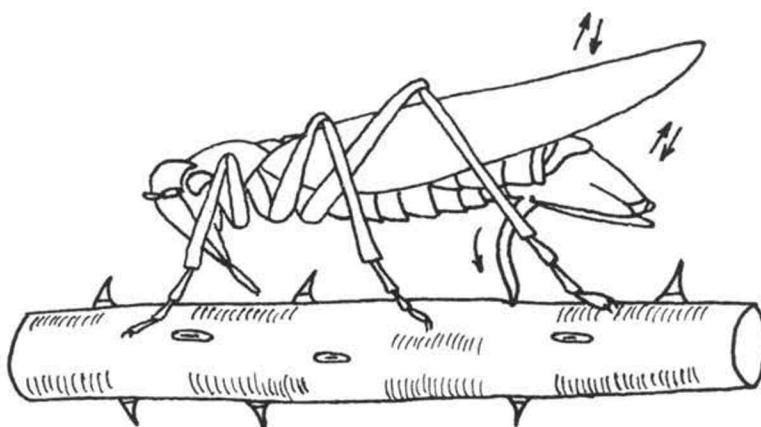


FIG. 19. DIAGRAM OF FEMALE ABOUT TO INSERT OVIPOSITOR IN CANE TISSUE.

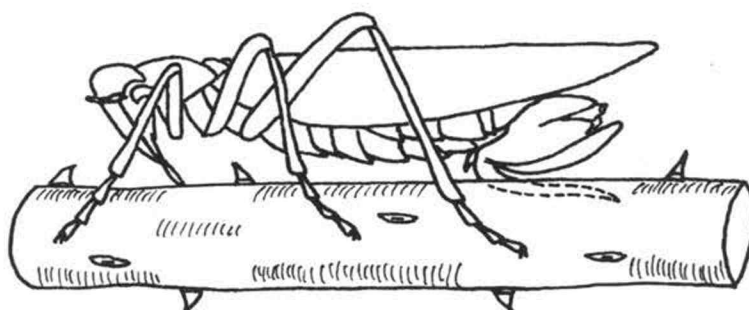


FIG. 20. DIAGRAM OF FEMALE WITH OVIPOSITOR INSERTED IN THE CANE TISSUE.

FIGS. 19 - 20. DIAGRAMS SHOWING METHOD OF OVIPOSITION.



FIG. 21. EGG OF R. TENERRIMA (AV. LENGTH - .76 mm.)

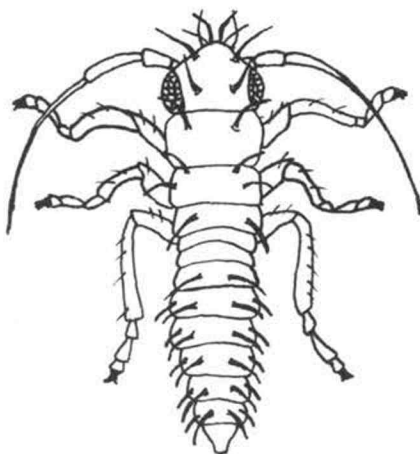


FIG. 22. FIRST INSTAR NYMPH OF R. TENERRIMA (AV. LENGTH - .94 mm.)

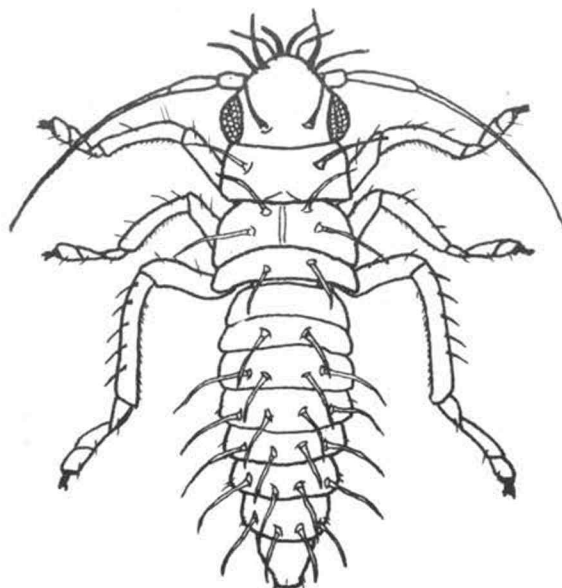


FIG. 23. SECOND INSTAR NYMPH OF R. TENERRIMA (AV. LENGTH - 1.15 mm.)

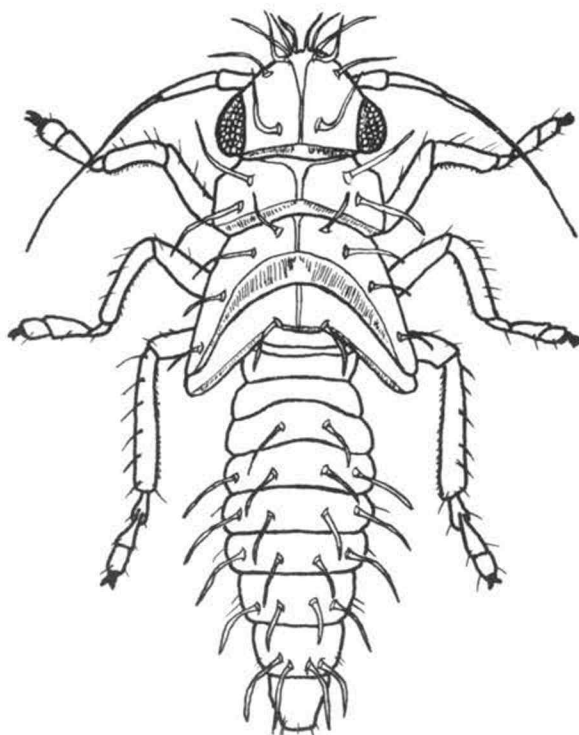


FIG. 24. THIRD INSTAR NYMPH OF R. TENERRIMA (AV. LENGTH - 1.54 mm.)

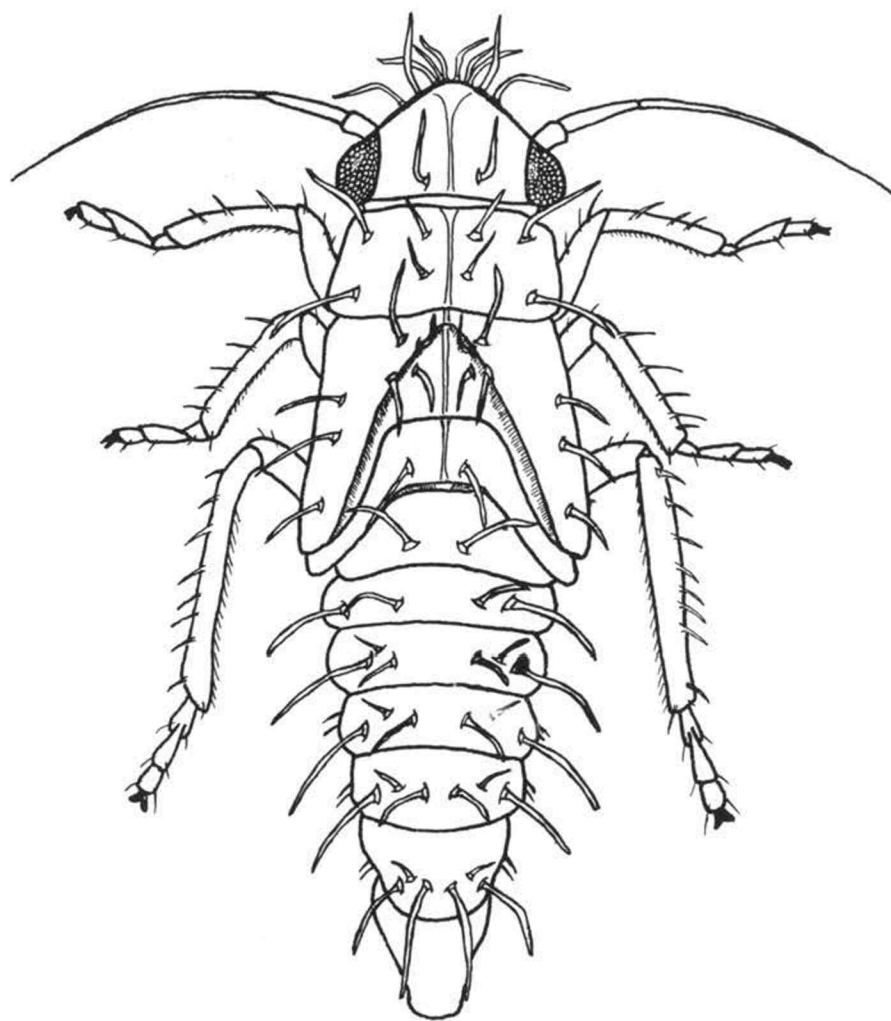


FIG. 25. FOURTH INSTAR NYMPH OF R. TENERRIMA (AV. LENGTH - 2.16 mm.)

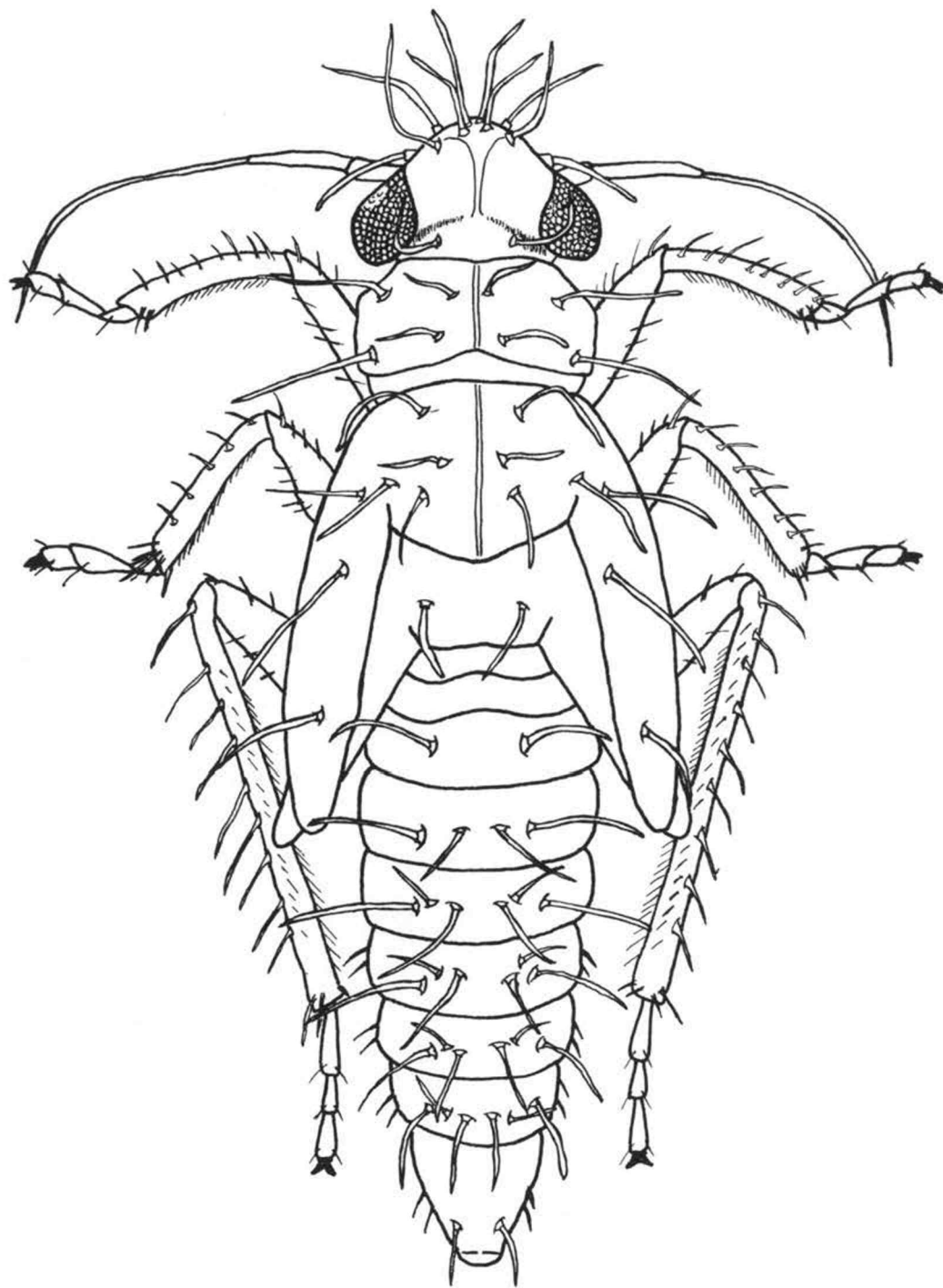


FIG. 26. FIFTH INSTAR NYMPH OF R. TENERRIMA (AV. LENGTH - 2.77 mm.)

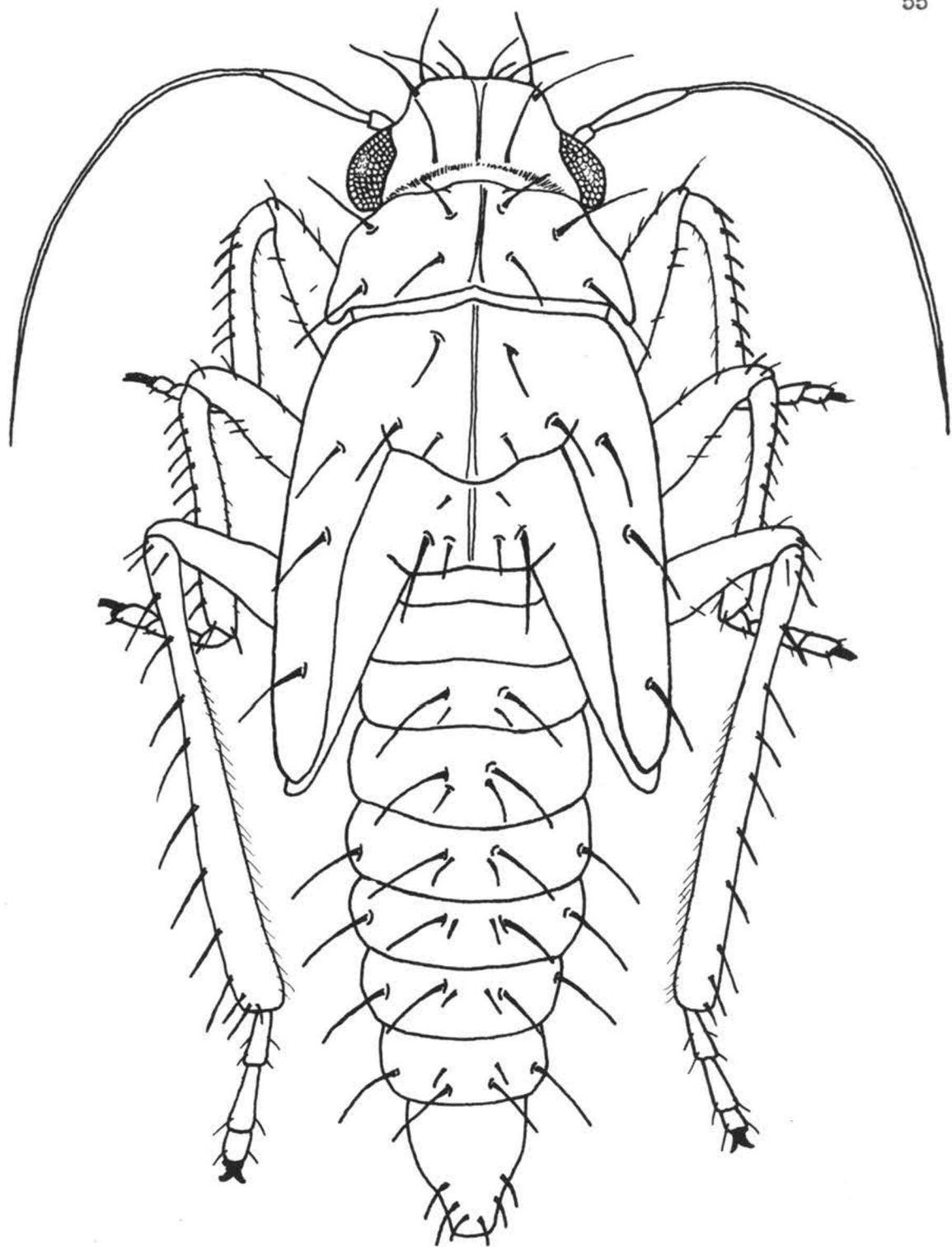


FIG. 27. FIFTH INSTAR NYMPH OF E. ROSAE (AV. LENGTH - 2.95 mm.)

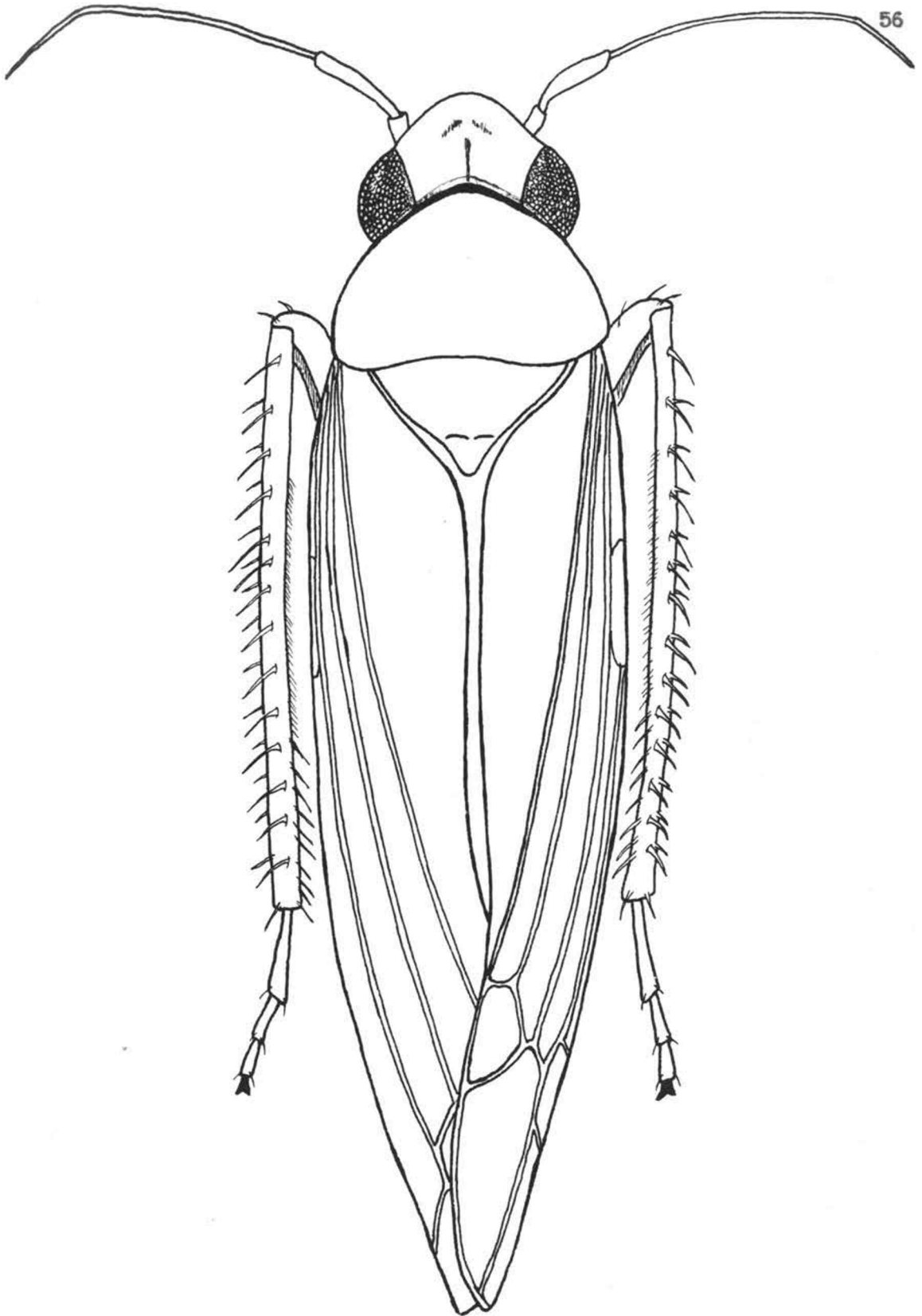


FIG. 28. ADULT OF R. TENERRIMA (AV. LENGTH OF MALE - 3.26 mm.;
FEMALE - 3.49 mm.)



FIG. 29. CAGE COVERED WITH PLASTIC SCREENING USED TO CONFINE ADULT LEAFHOPPERS.

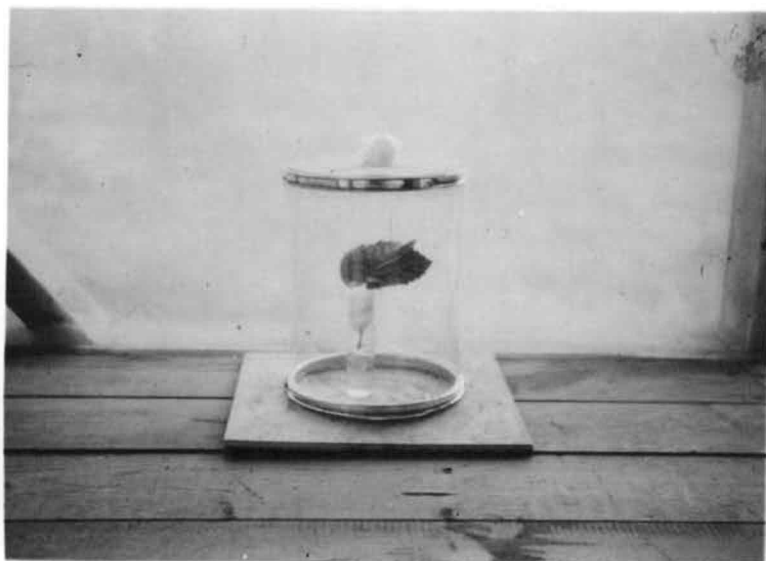


FIG. 30. CYLINDRICAL PLASTIC CAGE CONTAINING LEAF SUPPORTED IN A VIAL OF WATER. USED DURING OVIPOSITION STUDIES.

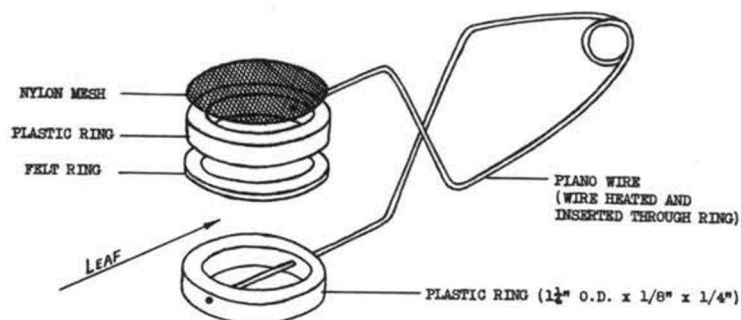


FIG. 31. EXPLOSION VIEW OF CLIP-ON CAGE USED TO CONFIN
NYPHS.



FIG. 32. TENT CAGE. USED TO ISOLATE FOLIAGE CONTAINING EGGS
DURING OVIPOSITION STUDIES, OR TO PREVENT ADULTS FROM ESCAPING
DURING TRANSFER.

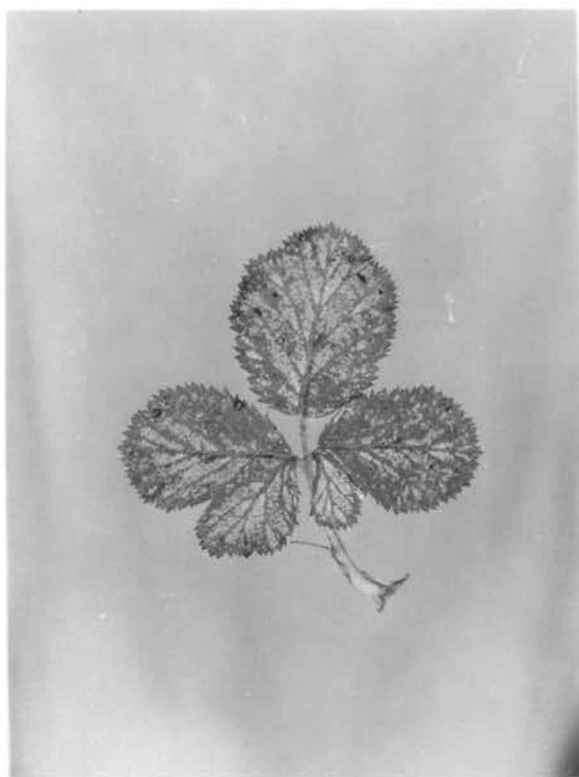


FIG. 33. INJURY TO FOLIAGE BY NYMPHS AND ADULTS OF THE
BRAMBLE LEAFHOPPER R. TENERRIMA.