T H E S I S

THE WESTERN ROSE-CURCULIO

RHYNCHITES BICOLOR WICKHAMI CKL.

Submitted by

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for the Degree of Master of Science

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Fort Collins, Colorado

May 11, 1927

THIS THESIS HAS BEEN READ

APPROVED AND RECOMMENDED

FOR CREDIT

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INTRODUCTION.

The western Rose-curculio, Rhynchites bicolor wickhami Ckl., is one of the most destructive insects attacking the rose in Colorado. After witnessing severe injury to the roses in several small gardens around Fort Collins in the summer of 1924, a study of the life history and control measures were undertaken to see if a practical control could be worked out for this insect. Accordingly, the work embodied in this paper was started in July 1924, and continued until February 1927.

HISTORY

According to available references, the western rose-curculio was first described as Rhynchites bicolor wickhami by T. D. A. Cockerell (1) from a type specimen taken at Boulder, Colorado, in 1912. At this time it was

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The writer is indebted to Dr. C.P. Gillette under whose direction the work was undertaken; to Geo. M. List, Kenneth Arbuthnot, and Gilbert Schenk for assistance in taking care of the life history material; to Dr. E. P. Sandsten for permission to carry out dusting experiments on roses on the Campus, and to E. A. Tubby for aid in determining the varieties of roses.

suggested that the form from Oregon of LeConte's three "races" was probably identical with the Colorado form. In 1888, James Cassidy (2) reported Rhynchites bicolor as injuring wild and cultivated roses and puncturing raspberries in Colorado. This report was undoubtedly the variety wickhami Ckll., as bicolor has never been reported in this State.

In 1913, Pierce (3) uses the genus Merhynchites founded by Sharp in 1889 and gives the material studied as coming from Kaslo and North Bend, British Columbia; Victoria, Vancouver; Washington; Oregon; California; Idaho; Utah; Wyoming, Manitoba; Arizona; New Mexico; North Dakota; and North Carolina. All these specimens are western except four labeled N. C. which may be in error. The western United States is probably the original home of this variety. Essig (4) 1926, gives the same distribution taken from Pierce and lists it as an enemy of the cultivated and wild rose.

SYSTEMATIC POSITION.

Rhynchites bicolor Fab., the species of which wickhami is at present recognized as a variety, was described by Fabrecius (5) in 1789. According to Pierce (3), Schneider founded the genus Rhynchites in 1791 and gives

this preference over Herbst, 1797, and Latreille, 1810. The family Rhynchitidae was founded by LeConte in 1874, the name being derived from that of the typical genus Rhynchites, meaning "snout." By recent European authors this family has been combined either with the Attelabinae or as a subfamily of Curculionidae. This latter arrangement was preferred by Blatchley and Leng (6) in 1916. They also give preference to Herbst for the genus Rhynchites and establish the family Curculionidae founded on the old Linnaean genus Curculio which, in turn, was derived from the Latin and meant "corn worm" or weevil.

In 1898, Sharp founded a new genus, Merhynchites, for Rhynchites bicolor Fab. and an European species, based upon the presence in them of a minute centrosternal piece of the prosternum which separates the apicies of the proepimera. This character is absent in other Rhynchites. In 1912, Cockerell (1) described the variety wickhami, separating it on color characters. Pierce (3) lists the family Attelabidae of Kuby (1837) and the subfamily Rhynchitinae of Pascoe (1870). He places this species in a new tribe Rhynchitini and makes four new varieties, cockerelli, ventralis, piceus and viridilustrans in addition to bicolor Fab. and wickhami Ckll. In 1916, Pierce (7) lists the superfamily Attelaboidea as containing the families Apionidae, Belidae, Attelabidae, Tachygonidae, Pter-

ocolidae, and Oxyrhynchidae. Leng (5) in 1920 lists the following: Curculionidae of Blatchley and Leng (1916), Rhynchitinae and Rhynchitini of Pierce (1913), Rhynchites of Herbst (1797) and the same species as Pierce in 1913 . In this same year Green (9) pointed out that wickhami had additional characters to those recorded and that there seemed to be good reason for considering this a species peculiar to the Western States. In 1924, Cockerell and Harris (8) added another variety designated as erythrosoma .

DISTRIBUTION

The distribution in the United States is shown by states on the map Fig. 1. Undoubtedly it occurs in Nevada, although it is not recorded as occurring there. The four specimens recorded by Pierce from North Carolina, as he suggests are probably in error.

The distribution for the state of Colorado are shown on the map Fig. 2. Pierce records it as occurring in this state at Ouray, Berkeley, (This is probably in error as no town or station is listed in the state by this name.) Colorado Springs, Breckenridge, and Leadville. The writer has taken specimens at various points over the state. These with records of specimens in the collection of the Agricultural College give the additional distribution in the state as Rist

Canon, Sapinero, Fort Collins, Cherokee Park, Poudre Canon, Greeley, Chambers Lake, Paonia, Delta, Littleton, Denver, Kutch, and Boulder. In this distribution the elevation ranges from 4,664 feet at Greeley to 10,185 feet at Leadville. The writer has found this insect quite abundant on wild roses in all elevations from the foothills west of Fort Collins to almost timberline in Pingree Park.

ALLIED VARIETIES

According to literature there are seven varieties of this species separated on color phases, all of which feed on wild and cultivated roses. The following table given by Pierce (3) with the addition of *erythrosoma* will serve to separate the varieties.

Table 1.

Family *Attelabidae* Kirby (1837)

Subfamily *Rhynchitinae* Pascoe(1870)

Key of Tribes of *Rhynchitinae*.

1. Elytra striately punctate; third joint of tarsi more or less dilated ----------Rhynchitini, new tribe
2. Elytra not striately punctate; third joint not dilated ---------- Auletini, new tribe

Rhynchitini, new tribe

Key to genera of *Rhynchitini*.

Posterior coxae transverse, reaching metepisterna, which are very narrow.

1. Head arcuately emarginate at base; antennae with first joint, only, of funicle sensibly longer than wide; centro-sternal piece separating the apices of the proepimera ----------Deporaus Leach.

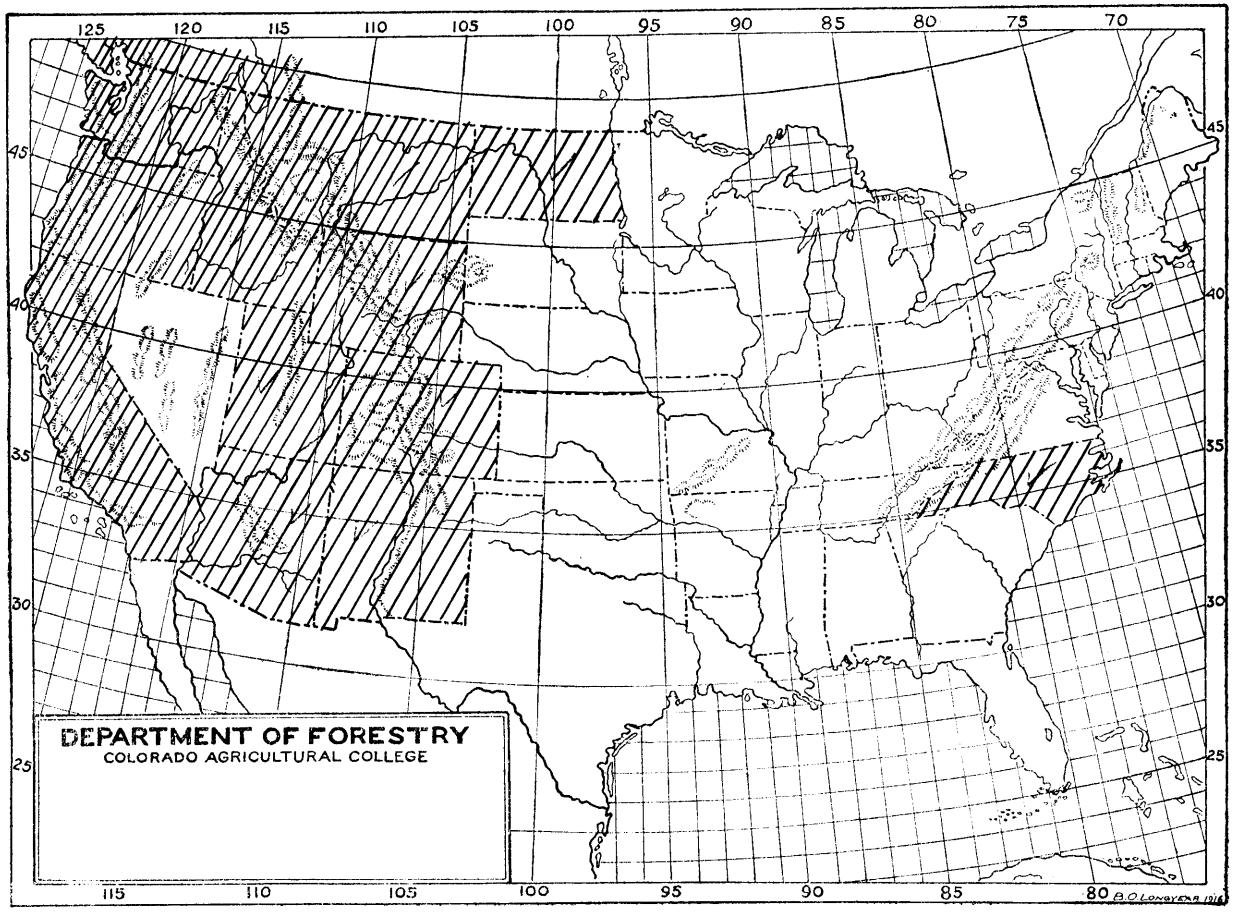

Fig. 1. Showing the distribution of Rhynchites bicolor wickhami Ckll. in the United States.

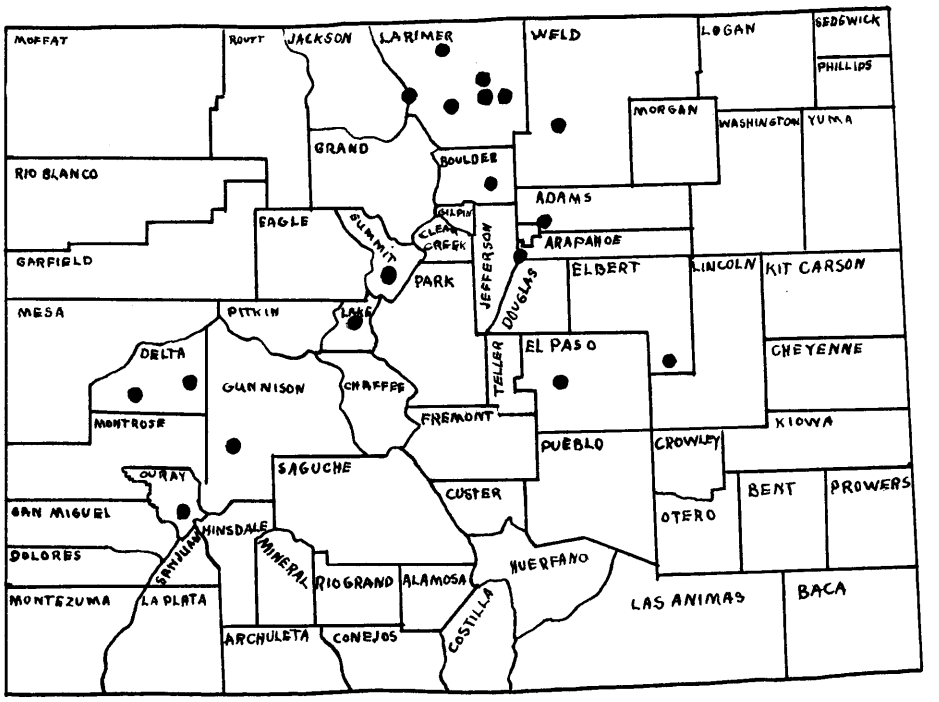

Fig. 2. Showing the distribution of Rhynchites bicolor wickhami Ckll. in the state of Colorado.

2. Head not emarginate or truncate at base; antennae with funicular joints 2 to 4 at least, longer than wide
   a1. Pygidium covered by elytra----Eugnamptus Schonherr
   a2. Pygidium exposed
      b1. Apicies of proepimera separated by centre-sternal piece----------Merhynchites Sharp.
      b2. Apicies of proepimera joined
         Rhynchites Schneider.

The centre-sternal piece of the prosternum is a tiny piece behind or separating the epimera. The term was first used by Sharp. This character merits considerable study.

Genus Rhynchites Schneider (1791).

Rhynchites Schneider 1791
Rhynchites Herbst, 1797
Rhynchites Latreille, 1810

The type of this genus is bacchus Linnaeus, as designated by Latreille (1810).

Genus Merhynchites Sharp (1889).

Sharp separated the two nonmetallic species, hungaricus Herbst and bicolor Fabricius from Rhynchites because of differences in the centro-sternal piece. Whether this character is of valid generic rank has not been carefully studied out, although it is undoubtedly of considerable value and merits further research. In the absence of type designation we may consider bicolor as type.

Merhynchites bicolor Fabricius.

The large series of this species is readily separated into varieties or races.

Table 2.
Table of varieties of Merhynchites bicolor Fabricius.

1. Elytra red, body with greenish luster.
   a1. Red through, except on the venter of the mesothorax, and abdomen, which are black; California to North Dakota.-- var. cockerelli, new variety.
   a2. Red through except beak (which has the base red, or may be practically all black), the knees, and ends of the tibia and of the tarsal joints or the sides of the mesothorax and the base of abdomen may be blackened . Colo. ---------- var.erythrosoma Cockerell.
   a3. Elytra, prothorax and head red; ventral parts reddish piceous; beak, antennae and legs piceous black. South Dakota ----------var. ventralis, new variety.

a4. Elytra, prothorax and base of head to eyes red; remainder of body black; New Hampshire to Iowa; Utah and New Mexico.----------var. bicolor Fabricius.

a5. Elytra and prothorax only, red; remainder of body black; British Columbia to New Mexico and North Dakota---------- var. wickhami Cockerell.

2. Elytra piceous or black; body with greenish luster

b1. Elytra piceous black; remainder of body black; strial punctures indistinct; Oregon--var. piceus, new variety.

b2. Body unicolorous ; black with a bluish-green luster; Elytra with a slight piceous undertone; strial punctures very distinct; Arizona.

var. viridilustrans, new variety.

Merhynchites bicolor bicolor Fabricius.

The typical specimens have the elytra, prothorax, and base of head to the eyes red, the remainder of the body black. These specimens usually have the elytra strail punctures quite plainly larger than the interstitial punctures . The front between the eyes is moderately punctate, and rugose near base of beak. Material of this form is at hand from Washington, District of Columbia; Durham, New Hampshire; Ogonquit, Maine; Milton and Melrose Highlands, Massachusetts; Winnipeg and Aweme, Manitoba; New Jersey; Wisconsin; Iowa City, Sioux City, and Spirit Lake, Iowa; Utah; New Mexico. With two exceptions then, this form is eastern.

Merhynchites bicolor wickhami Cockerell.

The commoner form in the collection has the elytra and prothorax only red, and the remainder of the body black. The elytral strial punctures are less easily separable from the interstitial punctures . The front in both sexes is strongly rugosely punctate to the vertex. The material comes from Kaslo and North Bend, British Columbia; Victoria , Vancouver; Seattle, Yakima, Tacoma, Easton, and Everett, Washington; Fuller, Oregon; Humboldt County, Eureka, Los Angeles, San Diego, San Mateo County, Los Gatos, Dunsmuir, and Kaweah, California; Pocatello and Fort Sherman, Idaho; American Fork Canon, City Canon, Fort Douglas, and Salt Lake City, Utah; Cheyanne , Wyoming; Havre, and Kalispell , Montana; Ouray, Berkely, Colorado Springs, Breckenridge, and Leadville, Colorado ; Williams, Arizona; Santa Fe, New Mexico; University, North Dakota; North Carolina. All these specimens are western except four labelled only "N.C." These may be in error.

Merhynchites bicolor cockerelli, new variety

This form is red through except on the venter of the mesothorax, and abdomen, which are black . The sculpture is as in variety wickhami. San Francisco County, California, is chosen as the typical locality. Specimens are at hand also from Los Angeles County, California; Pocatelli, Idaho; American Fork Canon, Utah; and Williston, North Dakota. The latter specimens have the basal half of the beak black.

Type.-- Cat. No. 14628 , U. S. Nat. Mus.

Merhynchites bicolor ventralis, new variety.

Two specimens from Volga, South Dakota (Wickham collection), have the beak, antennae, and legs pieceous black, ventral parts reddish piceous; head, thorax and elytra red.

Type.-- Cat. No. 14629. U. S. Nat. Mus.

Merhynchites bicolor piceus, new variety.

Two specimens from Oregon (Hubbard and Schwartz collection) are too closely allied to be separated as a distinct species. The head, thorax and under parts are black and the elytra are piceous black. The front is strongly rugosely punctured. The striation is even more distinct than in wickhami.

Type.-- Cat. No. 14630. U. S. Nat. Mus.

Merhynchites bicolor viridilustrans, new variety.

A single specimen from near the Bright Angel Trail in the Colorado Canon, Arizona (Pipe Creek, 3,700 feet altitude), collected May 10, 1903, by H. S. Barber, represents the opppsite extreme of coloration from cockerelli. The entire body is unicolorous black, but shining with luster which from some angles is brilliant green, from others a rich blue and yet again may show a piceous undertone. The elytral strial punctures are quite plainly larger than the interstitial punctures. The front is strongly rugosely punctate. This form is readily separable from piceus by the strial punctation.

Type .-- Cat. No. 15263, U. S. Nat. Mus.

The six varieties described above are readily separable in the material at hand, but there are undoubtedly intermediate forms.

Merhynchites bicolor erythrosoma Ckll.

This form is red through except the beak (which has the base red, or may be practically all black) the knees, and the ends of the tibia and of the tarsal joints or the sides of the mesothorax and base of the abdomen may be blackened. The sculpture of the elytra is practically as in wickhami, but the thorax resembles that of bicolor in form, instead of being strongly convex as the sides of wickhami. Front conspicuously pubescent. Described by Cockerell and Harris from specimens taken near Boulder, Colorado. Three specimens taken at Fort Collins fit the description.

Separating these varieties or races on a color bases is not entirely satisfactory, as there appears to be intermediate forms which will fit about as well under one variety as another. In the College collection of eight specimens of bicolor, one was found with a red tip on the beak, one had traces of red on the legs, especially the tarsal joints and one had the base of the antennae red. One beetle taken at Fort Collins will fit about equally well into erythrosoma or cockerelli. This specimen has the beak darkened at the base and tip; the ocular sclerite, club of the antennae, venter of the thorax, and abdomen, and legs are darkened. Another specimen taken at Fort Collins appears to be typically erythrosoma except the beak and antennae are almost black.

ECONOMIC IMPORTANCE.

This insect is one of the most destructive enemies of the rose in Colorado. A few beetles are capable of destroying the entire crop of roses on small bushes. On large clumps of roses the injury ranges from about 10 percent to almost 100 percent. For a number of years the injury from this beetle has been severe, in some sections to such an extent that it is almost impossible to grow roses out of doors. James Cassidy (2) in 1888 reported it as injuring raspberries. The writer has never observed it feeding on this plant, although in rearing cages, the adults feed readily on raspberry buds when no rose buds are available.

HOST PLANTS.

This insect has been observed to feed readily on all forms of wild and cultivated roses. It does not go so readily to the climbers and ramblers, but feeds readily on these and raspberry buds in rearing cages when no other food is available. Teas and hybrid-teas are favorites.

CHARACTER OF INJURY

The feeding punctures of the adult beetle are seen as small holes in the buds. Most of these punctures are made in the petals, sometimes thru the sepal into the petal or in the base of the bud. Occasionally they are made in the stem

below the bud. When buds are not plentiful the young tips of the shoots may be eaten off or the stem punctured so that the tip will curl and dry. Some of the buds that are punctured from feeding will open and the petals will be riddled full of holes, giving the flower a ragged unsightly appearance. It is difficult to tellthe feeding punctures from those in which eggs are deposited. In addition to the egg punctures the female will puncture the stem of the bud so that it will wilt, usually bend over and dry leaving the mummified bud in which the larva developes. A pair of beetles in rearing cages have made as high as 99 punctures in rose buds in 24 hours. The maximum eggs obtained from one caged female was eight. This means as many as eight buds may be destroyed daily by one female in egg deposition, and in addition, may make a large number of feeding punctures, which disposes of rose buds rather rapidly. All sizes of buds, from very small to those about ready to open, are destroyed.

METHOD OF STUDY.

Detailed observations on the life history of the rose curculio were made in the natural temperature laboratory on the adults, by means of battery jars about five inches in diameter. A pair of beetles were placed in a jar with a few rose buds , which were removed daily and the eggs counted by picking the buds apart. A few cages were carried which contained a number of males and females. In these, the average

number of eggs was obtained. The eggs were placed in three ounce tin salve boxes where they could be examined daily. A small moistened brush was used to transfer the eggs. This same proceedure was used for the pupae and in addition moist earth was added to the box. For the larval period several unsuccessful moethods for daily observation were tried and discarded. The results given for this period were obtained by exposing buds to laying females for one-day periods, then removing them and kept separate until the larvae emerged from the buds. By subtracting the average period of egg incubation, the larval period in the rose bud was approximately obtained. Records of all proceedures were kept. The material, all of which was kept in a natural temperature laboratory was compared at different intervals with the field material and found to correspond very closely . Field notes were made through the year.

DESCRIPTION OF THE STAGES.

Egg. The eggs (Plate 1) are about 1/20 inch long by 1/25 inch wide, being easily seen with the naked eye. They are elliptical in shape and pearly white in color. Under the microscope the surface is pitted or reticulated. Twenty-five eggs measured under the binocular averaged 1.24 mm. by 1.1 mm. The largest -- 1.5 mm. by 1.3 mm. and the smallest-- 1.0 mm. by .9 mm. Table No. 5 shows the measurements of 25 eggs.

The Larva. The larva when first hatched is rather robust and tough measuring about 1/12 by 1/25 inch, coiled, and white in color. The full grown larva (plate 2) is about 1/4 inch long and about 1/8 inch wide. The larva is a legless grub, sub-cylindrical in shape. The widest part is back of the head thru the third, fourth, and fifth segments, tapering bluntly to the head and gradually to the posterior end. The dorsum sides, and sternum are strongly wrinkled. The general color is pale yellow or straw colored. The head is much narrower than the body, sub-ovate, with the anterior third brown. Mandibles dark brown, maxillae and labium light browh. Labrum almost transparent showing a double line of brown on the meson . The head is retractile so that only the tip and mouth parts show. The antennae are located at the lateral angle of the frons. The thoracic shield shows as a pale yellow spot on the anterior half of the dorsal part of the first segment. The thoracic segments have the legs represented by enlarged tubercles, each bearing a number of setae. The abdominal segments are well defined, about equal in length. Each segment of the thorax and abdomen bears a few scattered dorsal, lateral, and ventral hairs which are visible only under the microscope. Spiracles occur on all segments except 2, 3 and 12. A larva 6 mm. long which is slightly smaller than the average had the width as follows: head,.61 mm;

1st segment, 1.73 ; 2nd, 1.8; 3rd, 1.9mm.; 4th 1.9mm. 5th 1.9 mm.; 6th, 1.8 mm.; 7th 1.8mm.; 8th, 1.7mm.; 9th 1.7mm.; 10th, 1.5 mm.; 11th, 1 mm.; and 12, .7 mm. The measurements of 24 larvae are shown in Table 3.

Table 3. Rhynchites bicolor wickhami Ckl.
Measurements of Full Grown Larvae.

Average	Length	Width
	6.31	2.18
1	6.3	2.0
2	6.5	2.0
3	7.0	2.0
4	7.0	2.5
5	6.0	2.0
6	6.5	2.2
7	6.0	2.0
8	6.5	2.5
9	6.0	2.5
10	6.0	2.2
11	6.0	2.2
12	5.0	1.8
13	6.5	2.2
14	6.0	2.0
15	7.0	2.5
16	6.5	2.2
17	6.0	2.0
18	6.0	2.0
19	6.5	2.2
20	6.5	2.2
21	7.0	2.5
22	6.5	2.2
23	5.7	2.0
24	6.5	2.5

Table 4. Rhynchites bicolor wickhami Ckl.
Measurements of Pupae.

	Length	Width
Average	4.95	2.66
1	5.0	2.7
2	5.1	2.5
3	4.9	2.6
4	5.2	2.7
5	5.2	2.9
6	5.0	2.7
7	5.0	2.8
8	4.8	2.6
9	4.5	2.5
10	4.8	2.6

Table 5. Rhynchites bicolor wickhami Ckl.
Egg Measurements.

	Length mm.	Width mm.
Average	1.24	1.1
1	1.2	1.0
2	1.2	.9
3	1.2	1.0
4	1.5	1.1
5	1.2	1.0
6	1.2	1.1
7	1.4	1.1
8	1.3	1.0
9	1.2	1.0
10	1.2	1.1
11	1.5	1.3
12	1.2	.9
13	1.3	1.1
14	1.1	1.0
15	1.2	1.0
16	1.2	1.0
17	1.2	.9
18	1.3	1.0
19	1.3	.9
20	1.3	1.0
21	1.0	.9
22	1.3	.9
23	1.1	.95
24	1.3	1.1
25	1.2	1.0

Pupa. Uniformly white in color when first transformed, length about 1/5 inch, width across the mesothorax about 1/7 inch. The head is bent downward with the beak along the sternum. Antennae exposed, tarsi of pro and mesothoracic legs partly concealed beneath the beak. The metathoracic legs largely concealed beneath the wings. The end segment of the abdomen bears a pair of curved appendages. The measurements of 10 pupae are shown in Table 5, drawing, Plate 1.

Adult. Blatchley and Leng (6)1916 gave the description of Rhynchites bicolor Fab., as follows: "Robust, convex, pyriform. Elytra thorax and head behind eyes bright red; under surface, femora and beak black; tibiae, tarsi and antennae piceous black. Beak as long as head and thorax, rather sparsely marked with elongate punctures; antennae inserted at its middle, their grooves distinct. Thorax cylindrical, as long as wide, rather densely and finely punctate. Elytra striae indistinct, their punctures but little coarser than those of intervals which are very dense. Beak of female shorter and stouter than the male. Length - 5-6.5 mm."

Cockerel (1) 1912, in his original description of this variety records the following: "Rhynchites bicolor . This beetle is common in New Mexico and Colorado, often destroying roses. When at Woods Hole, Massachusetts, last July, I found it equally common there, but somehow the beetles did not look right, so I brought some home for comparison. It appears

that the Colorado insect , as compared with that from Woods Hole is sculptured and without the rows of evident coarse punctures, also I find the head entirely black, whereas it is largely red in the Woods Hole insect. I consulted Professor H. F. Wickham about this and he kindly informed me of Le Conte's three "races" of which a form from Oregon and California is probably the same as my Colorado insect. As Professor Wickham knows of no available name and I have found none, I propose to call the Colorado insect Rhynchites bicolor wickhami, taking as the type, one from Boulder, Colorado collected by myself on roses in June. It is surely not more than a subspecies or race, but I think valid as such."

Green 1920 (9) under notes on American Rhynchites writes: "Rhynchites bicolor Fab. It is my opinion that some of the forms listed as varieties of bicolor by Pierce are capable of specific definition by means of constant structural and sculptural differences. An examination of wickhami and bicolor in my limited material shows the terminal joint of the antennal club to be consistently more elongate in the latter. Also the outer funicular joint exhibit considerable variation, some of which is probably sexual. This I have been unable to determine. In addition to the differences pointed out by Cockerell, wickhami has the sides of the thorax more strongly rounded and converging toward base and apex, and femora smooth, shining and more sparsely punctate. There is room for further investigation in this group by those possessing sufficient material and especial attention should be given the secondary

sexual modifications of the antennae and rostrum.

Le Conte states that the beak of the female of bicolor is shorter than that of the male. I have noticed that specimens with the longer beak always have a more convex abdomen, and if these are males it is certainly contrary to the usual rule in the Rhynchophorous series.*

Combining these various characters and adding a few, a more complete description would be somewhat as follows: Robust, convex, pyriform. Elytra and thorax bright red; under surface, femora, beak, tibiae, tarsi, and antennae black. Beak almost as long as the head and thorax, rather sparsely marked with elongate punctures; antennae inserted at its middle, their grooves distinct. Front in both sexes strongly rugosely punctate to the vertex. Thorax subcylindrical, about as long as wide, sides strongly rounded and converging toward base and apex, rather densely and finely punctate. The elytral strial punctures are not easily separable from the interstitial punctures. Entire animal sparsely covered with short setae. Measurements of 12 males are shown in Table 7 and 15 females are shown in Table 6. Drawings, Plates 4 and 5

Table 6. Rhynchites bicolor wickhami Ckl. Measurements of adult females.

	Elytra		Thorax		Head		Beak	
	Length	Width	Length	Width	Length	Width	Length	Width
Average	3.32	2.68	1.55	1.65	.78	1.09	1.95	.52
1	3.3	2.4	1.3	1.4	.6	.9	1.8	.5
2	3.5	3.0	1.7	1.8	.8	1.2	1.9	.6
3	2.3	2.2	1.2	1.3	.7	.9	1.7	.4
4	3.4	2.7	1.6	1.7	.8	1.2	1.8	.6
5	3.4	2.6	1.6	1.6	.8	1.1	2.0	.5
6	3.3	2.8	1.6	1.8	.8	1.1	1.9	.5
7	3.5	2.7	1.7	1.6	.8	1.2	2.0	.5
8	3.5	2.9	1.7	1.8	.8	1.2	2.0	.5
9	3.5	2.7	1.6	1.8	.8	1.1	2.2	.6
10	3.6	2.9	1.8	1.7	.9	1.2	2.2	.6
11	3.5	2.8	1.5	1.7	.7	1.1	2.2	.5
12	3.5	3.0	1.8	1.8	.8	1.2	2.1	.6
13	3.6	3.0	1.7	1.9	.9	1.1	2.3	.6
14	3.3	2.6	1.5	1.6	.9	1.1	2.0	.5
15	2.6	2.0	1.0	1.3	.7	.75	1.25	.3

Table 7. Rhynchites bicolor wickhami Ckl. Measurements of adult males.

	Elytra		Thorax		Head		Beak.	
	Length	Width	Length	Width	Length	Width	Length	Width
Average	3.37	2.73	1.61	1.78	.81	1.09	1.82	.49
1	3.2	2.6	1.6	1.6	.7	1.0	1.7	.5
2	3.5	2.9	1.8	1.8	.9	1.1	2.0	.5
3	3.1	2.2	1.2	1.4	.7	.9	1.4	.4
4	3.4	2.6	1.6	1.8	.8	1.1	1.8	.5
5	3.5	3.0	1.8	2.0	.9	1.2	2.0	.5
6	3.0	2.3	1.6	1.5	.7	1.0	1.5	.5
7	3.5	3.0	1.9	2.0	.9	1.2	2.0	.6
8	3.4	2.4	1.3	1.6	.6	.9	1.6	.4
9	3.3	2.8	1.7	1.8	.9	1.1	2.0	.5
10	3.5	3.0	1.7	2.0	.8	1.1	1.8	.55
11	3.4	2.8	1.4	1.8	.9	1.2	2.0	.5
12	3.7	3.2	1.8	2.1	1.0	1.3	2.1	.5

These measurements, while based on only a few individuals indicate that the beak of the female is typically longer than the male. The sex of these beetles was determined by squeezing out the genitalia (See Plate 6.)

DISSEMINATION

The adults are strong flyers and this is probably the most important means of spreading.

LIFE HISTORY AND DEVELOPMENT.

Summary of life cycle

The winter is passed as full grown larvae in the soil. About April or early May the larvae pupate in the soil and in about 9 days transform to adults, emerging from the ground about two weeks later. The adults feed on the young rose shoots and buds, mate and deposit the eggs in the rose buds, puncturing the stem beneath so that it withers and dries, sometimes falling to the ground. About 40 eggs are laid by each female.

The eggs hatch in about 10 days and the larvae feed inside the dry rose bud, leaving it in the fall to enter the ground where the winter is passed. There is one generation a year.

The egg.

The eggs are deposited in punctures in the rose buds at a depth varying from just beneath the surface of the bud to about 2 mm. below the surface. These punctures are invariably plugged and can seldom be detected except as a slight

scar on the bud, or sometimes as a small protuberane on the side of the wilted rose bud. In the three year's observations only two eggs were found in the base of buds , all the rest were deposited in the folded petals. In the few cases where females were observed in the act of ovoposition, the stem of the bud was punctured before making the egg puncture in the bud. One female when first seen had already eaten holes thru the stem and was on the bud with the beak about half buried in the petals. She spent about 8 minutes more on this puncture, inserting the beak up to the eyes, and twisting the head on the flexible neck joint as if enlarging the hole on the sides and bottom. Turning around about 50 seconds were consumed in inserting the ovipositor and depositing the egg. The opening was then plugged with the beak by chewing off bits of petal along the edge of the puncture and placing them in the opening. This operation took about 2 and one half minutes more and when finished looked like a slight scar on the rose bud.

Occasionally an egg is found upon the petals of an open rose, but in these cases the female may have been distributed, or perhaps instinct varies sometimes so that the bud stem would not be punctured as is the usual custom. A few buds were found which were wilted with the stem punctured, but no egg or larva in side. Rarely more than one egg is found deposited in a bud under field conditions, and here the

second egg was probably deposited by a second female. In the rearing cages where the available buds are limited, several eggs may be placed in one bud.

Examining a large number of buds containing eggs, there appears to be no definite position in the bud preferred for deposition. Eggs are placed anywhere in the petals of the bud from the tip to the base, rarely in the base. Sometimes removing one of the petals would expose the whole egg then again, four or five thicknesses of petal may be removed and expose only the tip of the egg. A few eggs were observed that were placed inside the petal so that the egg was detected only by a protuberance or bulge in the petal that appeared somewhat clearer in color than the surrounding parts. In wild roses or in buds with a few petals the eggs may be placed directly among the stamens.

The number of eggs laid.

The number of eggs deposited by females varies considerably. In 1925 the average number of eggs deposited by 24 females was 44.16. The maximum for one female 143. In 1926, 40 females averaged 34 eggs with a maximum of 87. The largest number deposited by one female in 24 hours was 8.

The following tables, 8 and 9, show the egg deposition for 1925 and 1926.

Table 8. Rhynchites bicolor wickhami Gkl.
Egg Deposition. 1925.

Cage Number	1	1A	2	3	4	5	6	7	8	9
Date Caged	5-31	6-18	5-21	6-16	5-28	5-28	6-2	6-2	6-8	6-8
Number of Females	1	1	12	1	1	4	1	1	1	1
May 27			5							
28			2		2	3				
29			2			4				
30			2			8				
31	2		1		3	7				
June 1	2		3		2	2				
2			8		2	5				
3	2		2			2		3		
4			8		1	3		3		
5			6		1	2				
6	1		4		1	4		1		
7	1		5		2			2		
8	2		3		3	2		2	4	2
9	3		16		4	5		5	5	1
10	2		7		2	11	1	5	2	3
11			3		1	4	1		3	3
12			7		2	6	2	4		
13			4		3	3			5	2
14	1				1	3	1	4	3	3
15					5	4	3	1	2	3
16						4	5	5	2	6
17							3	1	2	
18		2				8	4	7	3	4
19			8	3	3	7	3	4	4	2
20		4	14	1	1	7	3	3	2	
21		2	12	1	4	10	4	3	3	6
22		3	9	3	2	5	5	4	4	4
23		1	19	1	1	9	2	4	4	3
24		1	15	2	1	10	5	3	4	2
25		1	5	3	3	9	5	4	4	1
26			14	3	3	8	7	7	3	2
27		2	8		3	5	1	4	3	2
28		2	6		2	6	5	3	2	1
29			12		3	8	1	4	3	1
30		1	19		2	7	2	4	1	

Table 8 Continued.

July	1		12		4	9		8	1	
	2		8			5	4	7	1	1
	3		4			5	4	2		
	4		4		1	3	3	3	4	
	5		5				3	4	2	
	6		12		3	3	2	3	1	
	7		5		1	2	2	2	2	
	8		4		1	2	2	2	2	
	9		13		1	4	5	3		
	10		4		3	2	3	2		2
	11		5		2		4	2		1
	12		7	1		2		2	1	
	13		2							
	14		1			1			1	
	15		2					3		
	16		5					1		
	17		2					1		
	18		2					4		
	19							1		
	20							2		
	21								1	
	22									
	23		3					1	4	
	24								2	
	25		1						2	
Total		16	19 330	18	79	219	95	143	92	5

Average for 24 females, 44.16 eggs.

Maximum for one female 143.

Table 9. Rhynchites bicolor wickhami Ckl.
Egg deposition. 1926.

Cage Number:	1	2	3	4	5
Date caged	5-19	5-20	5-22	5-23	5-31
Males	1	10	20	1	1
Females	1	4	33	1	1
May 27			1		
28		1	1		
29	1	3	4	1	
30	1	1	3	1	
31		1	6		
June 1	1	2	11		
2	2	5	11	3	3
3	2	9	16	4	1
4			20	3	2
5	2	6	23	2	2
6	2	3	25	3	3
7	1	4	32	4	4
8	2	3	38	2	3
9	1	2	12		4
10		5	31		3
11	3	5	36	3	2
12	2	3	42	2	4
13	1	1	26	2	1
14		1	9	2	2
15	1	2	16	3	
16	1	2	20	1	3
17		1	14	1	
18	1		19	1	1
19		1	30	1	1
20		1	23		2
21			18		1
22		1	16	1	1
23			9	1	1
24		1	22	2	2
25			15	1	
26		1	15	2	1
27			17	1	2
28			21		2
29			31		1
30	1		19	1	2
July 1	2		11	4	2
2			20		3
3	1		6		1
4			20	1	2
5			12	1	2
6			20	2	3
7	2		12	1	4
8			15	3	1
9			15	1	2

Table 9. ontinued.

10	1		1	2
11		19	2	4
12		16	1	1
13	1	25	2	4
14		22	1	2
15		19	1	
16	1	18		
17	1	21	3	
18		11	1	
19	2	12	1	
20		4		
21		3		
22		4		
23		7		
24		7		
25		8		
26q		7		
27		8		
28		6		
29		3		
30		7		
31		6		
August1		1		
2		2		
3		4		
4		1		
5		6		
6		12		
7		5		
8		12		
9		5		
10		3		
11		9		
12		4		
13		3		
14		4		
15		5		
16		1		
17		4		
18		1		
19				
20		1		
21		1		

Average for 40 females, 34 eggs

Maximum for one female 87

Most of the eggs, as the tables show, are deposited from the latter part of May to the middle or latter part of July. One record shows eggs deposited as late as August 21, but this is unusual.

Influence of Moisture.

Moisture appears to have very little influence on the hatching of the eggs as those that were kept dry hatched quite well. In the rearing cages no moisture was added to the egg containers and some hatched 100 percent.

Influence of temperature.

Temperature is an important factor in the incubation of the eggs. In the latter part of May, the eggs hatched in about 11 or 12 days; in July, when the temperature was considerable higher, they hatched in 8 or 9 days. The average period of egg incubation for 1924, 1925 and 1926 was 10.47 days. Minimum 8 days, maximum 15 days as shown in Tables 10 and 11. Eggs deposited on the same day varied as much as 4 days in the hatching time.

The eggs when first laid are almost pearly white in color turning pale yellow in about 6 or 8 days. The mouth parts especially the mandibles can be seen through the egg shell about 36 hours before hatching. Movements of the larva inside the shell can be seen about 24 hours ahead of emergence of the larva .

Table 10. *Rhynchites bicolor wickhami* Ckl.
Egg Incubation Period.

Date Deposited 1924.	Number of eggs	Number hatched	Number not hatched	Number of Days. 8	9	10	11	12	13	14	15
July 22	4	3	1	2	1						
16	6	4	2		4						
17	5	5			3			2			
15	9	8	1		3	4	1				
14	8	6	2	4	2						
7	1	1		1							
9	3	2	1	1	1						
10	6	6		1	5						
11	6	5	1	4	1						
13	3	1	2	1							
Total	51	41	10	14	20	4	1	2			
1925.											
May 31	7	5	2								5
June 3	5	4	1						4		
6	9	9						9			
7	9	9					9				
9	29	28	1		4	24					
11	21	21		2	19						
12	19	16	3		16						
13	17	7	10	7							
2	14	14								13	1
17	6	6			6						
18	14	14		14							
19	21	19	2		19						
23	19	19		13	6						
24	30	30		30							
July 12	5	5		5							
17	3	3		3							
18	3	3			3						
19	1	1			1						
Total	232	213	19	74	74	24	9	9	4	13	6

Table 11. Rhynchites bicolor wickhami Ckl. Egg Incubation Period.

Date deposited 1926	Number of eggs	Number hatched	Number not hatched	Number of Days. 8	9	10	11	12	13	14	15
May 19	1	1	0					1			
28	2	2	0						2		
30	8	6	2					5	1		
31	9	7	2				3	4			
June 1	11	10	1				10				
2	25	19	6			9	10				
3	29	29	0			9	18	2			
4	19	18	1			9	9				
6	19	19	0			1	9	7	2		
7	26	24	2				4	6	14		
8	39	38	1					10	27	1	
9	7	5	2					3	2		
10	33	29	4					3	20	6	
11	36	35	1					11	14	10	
13	22	20	2							17	3
14	13	10	3							10	
15	20	14	6						8	5	1
16	19	16	3					1	15		
17	11	9	2					8	1		
18	15	8	7				4	3	1		
19	23	22	1				16	5	1		
20	19	16	3			1	11	4			
21	13	11	2			7	4				
22	11	10	1			10					
23	13	10	3		3	7					
24	22	16	6		13	3					
26	17	17	0	6	11						
27	12	8	4	7	1						
July 1	27	24	3		2	22					
3	4	4	0			4					
4	22	22	0			14	8				
5	12	10	2			4	6				
6	24	22	2			19	3				
7	16	14	2			11	3				
12	7	5	2	5							
13	24	20	4	17	3						
14	14	10	4	4	6						
15	14	13	1	2	11						

Table 11. continued.

July	19	9	7	2			3	4					
	24	5	3	2		3							
	25	8	7	1		6	1						
	27	8	7	1				7					
	28	2	2	0		2							
	29	3	2	1		2							
	30	7	5	2	2	2	1						
	31	5	4	1	3	1							
Aug.	1	1	1	0		1							
1926	Total	706	611	95	46	67	135	129	73	108	49	4	
1924	"	51	41	10	14	20	4	1	2				
1925	"	232	213	19	74	74	24	9	9	4	13	6	
Total		989	856	124	134	161	163	139	84	112	62	10	

3-year average 10.47 days.

The Larva

The most difficult stage was the larval period . The larvae feed entirely inside the dried bud so that they can be osberved only by removing them. Several larvae were marked with India ink and examined every few days in an attempt to determine the length of instars, but this was given up, as disturbing the larvae retarded their growth far behind the undisturbed ones.

Although considerable time was spent attempting to see a larva emerging from an egg, that event was never observed.The larva can be seen moving inside the eggs about 36 hours before hatching. The remaining egg shells have a small cut in them as though the larvae used the mandibles in cutting the hole thru the shell. The empty shels kept their shape and are somewhat transparent.

The newly hatched larvae are about 2 mm. long by 7 mm. wide and coiled. The mouth parts are somewhat darkened. Transferring the newly hatched larvae to rose buds was seldom

successiull . The small larvae under natural conditions in the dried buds are found amongst the stamens in most cases. Probably the pollen is their main food when first hatched. Later when the larvae become 2/3 or almost full grown they are practically always found in the base of the dried bud. The buds may remain attached to the plant or fall to the ground. With some varieties the injured buds drop readily.

When full grown the larvae leave the buds and enter the ground where they pass the winter in small earthen cells about 6 mm. in diameter and about 1/2 to 2 inches below the surface. Larvae were dug up from the soil beneath rose bushes in October, November, February, March, April, and early May. From other observations made, this period may extend from July to May. A few larvae dug up in April did not pupate but remained all summer and winter as larvae. This would indicate that a few larvae may not transform to pupae the following spring, but remain over two winters as a safety factor against unfavorable conditions. When about ready to transform the larvae become somewhat thickened and less coiled.

A few larvae periods were obtained by exposing buds to laying females for a day and keeping these buds until the larvae emerged from them as shown in Table 12. This gave larval periods of 93 and 142 days. From field material collected

in early summer, larvae emerged from the buds July 16th to October 6th. This would indicate that the larvae period may be as short as 45 or 50 days. Results are shown in Table 13.

Table 12. Rhynchites bicolor wickhami Ckl.
Larval period in rose bud (rearing cages).

Eggs Deposited 1926	Larvae emerged	Length of Period
June 10	Sept. 26.	108
" 10	" 27	109
" 11	Nov. 10	152
" 11	" 10	152

Table 13. Rhynchites bicolor wickhami Ckl.
Larval emergence from rose buds collected in the field.

Number of Larvae.	Date emerged 1926.
2	July 16
1	" 21
1	" 24
1	Aug. 8
4	Sept. 26
2	" 27
2	Oct. 5
1	" 6

Pupa

When first transformed the pupa is about the size of the adult and white in color. In a day or two the facets of the compound eye show as brown spots. In five or six days more the eyes , mandibles, tarsi, and caudal spines become light

brown. These gradually darken until it transforms to an adult. A pupa record card contains the following notes:

April 28, 1926. Pupated.
29, Facets of eyes showing.
May 6, Eyes and mandibles dark brown.
7, Middle of beak and tips of metathoracic wings getting dark in color.
8, 9: 00 A. M. Head, beak, mouth parts, legs and tarsi fully formed and showing thru the pupal skin.
8, 11:05A. M. Adult emerged.

Pupation takes place in the earthen cells. The pupae habitually lie on their back and can move around quite readily in their cells by means of abdominal movements aided by the candal spines.

Adult emerging from pupa.

The emergence of the adult from the pupa takes about an hour. Notes from pupa record card are listed below.

May 12, 1926. 3:00 P. M. Abdomen contracting at about three minute intervals.
3:42 P. M. Mandibles moving. Pupal skin somewhat wrinkled, very thin and almost transparent.
3:43 to 3:44 P. M. No movement.
3:44 P. M. Abdomen contracting and expanding, with legs moving slightly.
3:47 to 3:49 No movement.
3:50 P. M. Abdomen contracting periodically. Mandibles and legs moving slightly. Pupa skin collecting in wrinkled condition at caudal end.
3:54 to 4:00 P. M. No motion.
4:00 P. M. Pupa moistened with a drop of water and placed under watch glass.
4:12 P. M. Slight moving of head, giving the head an up and down motion.
4:20 P. M. Legs moving , antennae moving with beak,
4:23 P. M. Pupae skin collecting more and more at the caudal end of the abdomen.
4:24 P. M. Head moving from side to side, tarsal claws holding to each other.

4:32 P. M. Pupal skin breaking over the top of head and beak, and slipping off of prothorax.
4:34 P. M. Elytra base and pro-legs free from pupal skin.
4:35 P. M. Beak and antennal base free from papal skin.
4: 36 P. M. Tibia of legs free.
4:37 P. M. Legs free and used to pull pupal skin from antennae.
4:38 P. M. Antennae free.
4:39 P. M. Using meta thoracic legs to push skin off abdomen.
4:32 P. M. Legs scarping each other while resting upon the tip of abdomen.
4:48 P. M. Entirely free from pupal skin; a small drop of liquid ejected from alimentary tract.
The Pupae period for 18 individuals is shown in the following Table.

Table 14. Rhynchites bicolor wickhami Ckl.
Length of Pupal Period.

No. of Individual	Pupated	Emerged	Period in Days.
Average			9.33
1925.			
1	April 25	May 4	9
1926			
2	23	4	11
3	25	3	8
4	25	3	8
5	25	4	9
6	25	4	9
7	27	6	9
8	27	7	10
9	28	8	10
10	May 2	11	9
11	3	12	9
12	6	15	9
13	8	18	10
14	9	19	10
15	11	19	8
16	12	22	10
17	14	24	10
18	14	24	10

The adult at the time of transformation was resting on its back. The legs and beak moved at irregular intervals and the metathoracic wings extended full length. Compound eyes dark brown, beak and base of antennae black. Club of antennae, metaepesternum, coxae, trochanter, tibia, tarsi, ends of femora,and tip of abdomen showing traces of black. Two hours later the elytra were showing a light orange color. Sixteen hours later the beetle was still resting on its back and moving the legs and antennae. The prothorax and elytra had taken on a dark orange color. The meta-wings still extended and projecting from beneath the elytra. Sternal sclerites and ventral side of abdomen lighter in color than the legs, antennae, beak, and head, which were black. Sutures between segments of abdomen, and tip of abdomen almost black. The beetle was able to crawl at this time, and gradually darken to full color in about 48 hours.

Emergence of adult from pupal cell.

To determine the age of the adult beetle before it works its way to the surface of the ground two pupae that were about ready to transform into adults were placed in the bottom of a small glass vial covered with a pupal cell and covered with an inch of dirt. The glass bottom permitted observations, the following notes show the results.

May 22, 1926, Pupae placed in observation tubes and covered with soil.

May 23 No change, still pupae,

May 24, Transformed to adults,

May 25, Adults almost fully colored.

May 26, No change.

May 27, No change.

May 28, Adults apparently fully colored.

May 29, One adult in moist soil working way to top. The other adults in dry soil still at bottom of tube.

May 30, Beetle almost at surface in moist soil, the other bettle in dry soil still at the bottom of tube, apparently unable to work way thru dry soil.

May 31, Beetle at surface of moist soil. Second beetle in dry soil still at the bottom of tube. Soil moistened in second tube.

June 1, Beetle at surface of moistened soil.

June 2, Adults feeding.

This procedure is probably similar to what happens in field conditions. It takes the adult four or five days to become fully colored and hardened and a day or two to work its way to the surface. In the dry soil the adult was apparently unable to work its way to the surface, but when the soil was moistened it reached the surface in a day and started feeding soon after. In the rearing cages where the pupae were not covered with earth, feeding took place in four days. This is probably sooner than what would take place under natural conditions.

Feeding Habits.

The beetles after emerging soon begin feeding, usually on the young growing tip of the rose shoots, eating the young leaves or stems, or on the rose buds. The tip of a shoot may be killed. Feeding punctures may be numerous in buds and flowers, which when fully open, gives them a riddled and ragged appearance. The adult beetles emerge the latter part of May and the first part of June, and at that time feed largely on the early varieties of roses such as the yellow Persian. Later as the buds on these become scarce, they feed on the later varieties such as the Hybrid -Teas and wild roses.

When making the puncture for egg deposition, the female removes the material by eating it. Females in rearing cages have deposited as many as 8 eggs in 24 hours, which would destroy as many buds. Feeding punctures may be made at the rate of four or five per minute and as many as 40 to 50 a day in the cages.

When disturbed the beetles draw in the feet, depress the beak, usually dropping off the plant, and remain motionless for some time. When falling at the base of a rose plant amongst the prickley stems, they are well protected and difficult to find. Rarely the beetles fly when disturbed.

Mating.

Mating was observed to take place at all times of the day both in the rearing cages and under natural conditions.

In the cages, the males often attempted copulation with the other males. The females, sometimes , will continue to feed and pay no attention to the male upon her back that is attempting coitis. Each male and female may mate several times with different individuals. On several occasions, both in cages and out of doors, males were seen fighting using their beak raised above the opponent and brought down with considerable force. One male, attemptiong copulation with a female, was approached closely by another male. The first male left the female and drove the second smaller male away and then returned to the female.

Length of Life.

The average length of life of the adults after emerging is about seven weeks. In 1925 the average length of life of 36 beetles was 42.3 days. In 1923, 73 beetles averaged 41.78 days. In this year the males averaged 43.06 days and the females 40.72 days. Two females lived 97 days, but this is unusual. There is one brood annually. Tables 15 and 16 show the length of life of each beetle.

Table 15. Rhynchites bicolor wickhami Ckl.
Length of life of beetles.

1925.										
Cage No.	1	1A	2	3	4	5	6	7	8	9
Date Caged:	5-31	6-18	5-21	6-16	5-28	5-28	6-2	6-2	6-8	6-8
Beetles	1	2	17	1	2	5	2	2	2	2
Days:										
May 21 1										
22 2										
23 3										
24 4	1									
25 5										
26 6										
27 7										
28 9									1	
29 10										
30 11										
31 12										
June 1 13										
2 14										
3 15			2							
4 16			1							
5 17										
6 18										
7 19										
8 20										
9 21			1							
10 22										
11 23										
12 24										
13 25										
14 26										
15 27										
16 28										
17 29										
18 30		1								
19 31		1								1
20 32										
21 33										
22 34										
23 35			1			1				
24 36			1							1
25 37										
26 38										
27 39										
28 40										
29 41										
30 42			3				1			

Table 15 continued.

July1	43									
2	44									
3	45					1				
4	46									
5	47									
6	48					1				
7	49					2				
8	50									
9	51		3							
10	52									
11	53									
12	54		1					2		
13	55									
14	56		1	1	1					1
15	57		2							
16	58									
17	59				1					
18	60						1			
19	61									
20	62									
21	63									
22	64									
23	65									
24	66									
25	67									
26	68		1							

Average life, all beetles 42.30 days.

Table 16. Rhynchites bicolor wickhami Ckl.
Length of Life of Beetles.

1926.						
Cage No.		1	2	3	4	5
Date Caged		5-19	5-20	5-22	5-23	5-31
Males		1	10	20	1	1
Females		1	4	33	1	1
	Days					
May 19	1					
20	2					
21	3		1	2		
22	4					
23	5		1	5 7		
24	6		1	1 1		
25	7			3		
26	8			1 1		
27	9					
28	10					
29	11					
30	12			1 1		
31	13					
June 1	14		1			
2	15		1	1		
3	16					
4	17			2		
5	18			1		
6	19		1			
7	20					
8	21					
9	22					
10	23					
11	24			1		
12	25					
13	26					
14	27					
15	28					
16	29					
17	30					
18	31			1		
19	32					
20	33					
21	34					
22	35					
23	36		1			
24	37					
25	38					
26	39		1			
27	40	1				
28	41					
29	42					
30	43					

Table 16 Continued.

1926.						
Cage No.		1	2	3	4	5
Date Caged		5-19	5-20	5-22	5-23	5-31
Males		1	10	20	1	1
Females		1	4	33	1	1
	Days.					
July 1	44					
2	45					1
3	46					
4	47					
5	48					
6	48					
7	50			1		
8	51					
9	52			1		
10	53					
11	54					
12	55					
13	56					
14	57			1		
15	58		1	1		
16	59		1			
17	60			1		
18	61					
19	62		1	1		
20	63					1
21	64					
22	65	1				
23	66					
24	67					
25	68					
26	69					
27	70					
28	71		1			
29	72		1	1		
30	73					
31	74					
Aug. 1	75			1		
2	76			1		
3	77		1			
4	78			1		
5	79					
6	80			1	1	
8	81					
9	83					
10	84				1	
11	85					
12	86					
13	87			1	3	
14	88			1	1	

Table 16 Continued.

1926.						
Cage No.		1	2	3	4	5
Date Caged		5-19	5-20	5-22	5-23	5-31
Males		1	10	20	1	1
Females		1	4	33	1	1
	Days					
Aug. 15	89					
16	90					
17	91			2		
18	92					
19	93					
20	94			1		
21	95			1		
22	96					
23	97			2		

Average life, all beetles 41.78 days.

Average length of life of males 43.06 days

Average length of life of females, 40.72 days.

NATURAL ENEMIES

In studying this insect only one larval parasite was found associated with it, but it evidently is not numerous enough to check the development to any great extent. In 1926 about 100 larvae were dug up from natural conditions in the soil, and only 6 were parasitized. Of this number four spun cocoons and only one adult was secured. This parasite was determined by R. A. Cushman, specialist on Ichneumonidae U. S. Department of Agriculture, Bureau of Entomology as Temelucha sp.

The parasitized larvae were first noticed as being more sluggish and less coiled than the normal ones. The ends of the larvae also showed a small clear place and the larvae became somewhat distended so that the whole head was visible. Normally the head is about half concealed by the first body segment.

One larva with the skin somewhat wrinkled showed the parasite moving inside. While looking at this larva, the skin was seen to rupture near the posterior end and the parasitic larva emerged caudal end first, taking only a few minutes to cast off the host skin over its head. The parasitic larva started spinning silk for a cocoon almost immediately. The date was May 4th 1926. By May 7th a cocoon was formed so that the larva inside was completely hidden from view. Another larva emerging on this same day failed to make a complete cocoon and left a small hole, thru which a pupa was seen on May 11th. The adult emerged June 3d was killed, pinned and sent to Washington, D.C. for determination as previously mentioned.

PREVENTION AND CONTROL MEASURES

In working out control measures for this pest two methods showed promise of being practical. First, the destruction of the adults as they appeared on the plants before injury was done; and second, the destruction of the overwintering larvae in the soil.

According to the available published accounts on Rhynchites bicolor Fab., hand picking of adults and arsenical sprays have been recommended as control measures.

Hand picking of the adults can not be relied upon to control a pest of this kind. At best it reduces slightly the number of adults; some beetles will escape by dropping to the ground and others will be overlooked. If clumps of roses are near the plants to be protected, they will furnish an almost continuous supply of beetles which will sooner or later find the prized plants and destroy many of the buds. If the picking is carried out daily, the beetles may find their way to the plants shortly after the operation has been carried out and destroy many buds before the next picking time. Having two Teplet plants in the yard at home, the writer made a practice of examining the rose plants regularly every day or two for beetles. No beetles were found during June or the first part of July. This inspection was carried out rather hastily, as the injured buds show up rather prominently on small bushes. On the 16 th of July the first injured bud was found. Close examination showed two beetles and 22 buds injured. The injured buds as well as the beetles were removed to prevent the larvae from developing in the near vicinity of the bushes.

A number of different materials were tried out for control of the adults in cages where a definite check-up on results could be obtained. The results are shown in Table 17.

Table 17. Rhynchites bicolor wickhami Ckl. Showing results Poisons on caged beetles.

Cage No.	Poison Tests on Caged Beetles 1926 — Material used	Amount used	Date	No. of beetles	Length of Life in Days. 1	2	3	4	5	6	7	8	9	Beetles alive	Total punctures	% Kill	No. of days in test.
1	Paris green	1 lb.- 100	Je.4	10		2		1		2	3		1	1		90	9
		Feeding punctures			9	129	140	34	40	36	42	7	12		449		
2	Lead arsenate	1 lb. to 40	Je.4	10		1	1	1	2		3			2		80	9
		Feeding punctures			68	140	126	49	52	60	50	48	42		635		
3	Lead arsenate	1 lb. to 40	Je.4	10		1				5	1		1	2		80	9
		Feeding punctures			90	174	75	49	35	40	49	30	15		557		
4	Calcium arsenate dust		Je.4	10	9	1										100	2
		Feeding punctures			9										9		
5	Sodium fluosilicate dust	1 lb. to 9	Je.4	10		2	7	1								100	4
		Feeding punctures			21	129	29								179		
6	Sodium floride dust.	1 lb. to 9	Je.4	10		3	6	1								100	4
		Feeding punctures			74	54	64								192		
7	Check		JJe4.	10				2						8		20	9
		Feeding punctures			178	176	66	57	120	129	235	147	151		1259		
8	Caclium fluosilicate dust.	1 lb. to 9	Je.4	10	1	2	1	3		2	1					100	7
		Feeding punctures			61	97	69	50	16	6					299		
9	Calcium arsenate dust.	1 lb. to 9	Je.12	10	1	3	2	2	2							100	5
		Feeding punctures			7	3	10	7							27		
10	Calcium arsenate dust	straight	Je.12	10	7	2	1									100	3
		Feeding punctures			0	0	0								0		
11	Check		Je.12	10				1						9		10	9
		Feeding punctures			180	120	59	244	86						699		
12	Sodium fluosilicate	straight	Je.16	9	2	3	4									100	3
		Feeding punctures			3	2									5		
13	Calcium fluosilicate	straight	Je.16	9	1	2	3	1	1	1						100	4
		Feeding punctures				12	11	2							25		
14	Calcium arsenate	"	Je.16	7	4	2	1									100	3
		Feeding punctures			0	0	0								0		
15	Calcium	" straight	Je.29	15	6	6	3									100	3
		Feeding punctures			3	3	3								9		
16.	Calcium	" Straight	Je.29	15	9	6										100	2
		Feeding punctures			0	0									0		

Explanation of Table 7. In Numbers 2 and 3 the poisons were used at the rate of one pound to 40 gallons of water. No. 3 contained calcium casinate at the rate of 4 oz. to 40 gal. Some of the dust materials were used straight, others were mixed 1 part to 9 parts of hydrated lime. The liquid materials were applied to the rose buds by means of a bucket pump and the dust materials, with a hand duster.

It will be noticed that while the liquid sprays of Paris green and lead arsenate gave some protection, it was much less than the materials applied as dust. Both the Paris green and lead arsenate appeared to repel the beetles from feeding for a time. Of the poisons applied as dusts, the calcium arsenate gave the quickest kill and the least number of punctures. Several tests gave 100 percent kill without a single puncture. This fact led to special observations to see how the beetles obtained the poison without feeding on the foliage. It was found that the beetles crawling over the dusted material soon became covered with dust and the dust sticking on their feet made them unable to crawl up the sides of the glass cage. This is easily done when no dust is present. The beetles also had difficulty in crawling over the dusted rose buds. Within a few minutes time, some of the beetles began cleaning their feet and legs by rubbing them together and over the body. The antennae were cleaned by pulling them thru the mouth parts by the aid of the front legs.

When the antennae passed thru the mouth parts, the mandibles were held open and the maxillae worked rapidly scraping the dust from the surface. It appears that in cleaning the antennae in this matter, the beetles obtain a lethal dose of poison and are killed in 24 to 72 hours.

Several field tests with calcium arsenate showed very promising results. Here as in the cages, the beetles were seen cleaning themselves soon after encountering the dusted material. One beetle was unable to crawl up the dusted surface of a leaf which was at an angle of about 85 degrees. This beetle was only able to keep from falling off the leaf by the tarsal claw which caught over the edge of the leaf. Another beetle was observed to be having great difficulty in crawling over the surface of a dusted bud.

On July first, which is past the period of heaviest injury, seven Teplet bushes were dusted with calcium arsenate after removing 27 injured buds. On July 6th one adult was seen feeding on this plot and the plants were again dusted. On July 12, beetles were again seen feeding on the buds. This time 3 injured budes were removed before dusting. No more beetles or injured buds were noticed on this plot. Other tests on small plots showed similar promising results, but as already suggested, these experiments show promise but have not been carried out on a sufficiently large scale to be conclusive.

Table 18. shows the results of treating the larvae with carbon disulphide emulsion.

Table 18. Rhynchites bicolor wickhami Ckl. Carbon disulphide emulsion on larvae.

Experiment No.	Emulsion No.	%CS_2 in Emulsion	Date treated	No. of larvae	Larvae dead at end of 3 days	Larvae missing	% larvae killed
			1926.				
1	2	.075	May 15	4	0		0
2	2	.35	" 18	4	4		100
3	2	.35	Nov. 15	3		3	
4	2	.35	" 16	5	4	1	80
5	2	.35	" 24	10	10		100
6	2	.35	" 24	10	9	1	90
7	Check		" 24	10	0	1	0
8	"		Dec. 29	10	1	1	10
9	2	.35	" 29	10	9		90
10	2	.35	" 29	10	7	1	70
11	3	.35	1927 Feb. 15	15	14	1	93

In preparing carbon-disulphide emulsion for larval control, several methods were tried in preparing it. Leach (10) gives two methods of making it. The ingredients of his emulsion, No. 1 are: 10 parts by volume of carbon disulphide, 1 part by volume of cold water-soluable rosin fish oil soap and three parts by volume of water. The emulsion is prepared by placing the soap and water in a churn or ice cream freezer and turning the handle until an even mixture is obtained. The carbon disulphide is then added to the mixture of soap and water in the churn and the handle turned for about two minutes or until the mixture emulsifies as is indicated by a change in color and the cream-like consistency of the liquid. The writer used a bucket pump and obtained a good even emulsion.

This emulsion has the disadvantage that if left standing in containers for any length of time it has a tendency to separate or stratify and must be thoroughly shaken before being used.

Leach's emulsion No. 2 is made up containing 135 cc. of 7 percent sodium hydroxide solution, 50 grams of powdered rosin. Four hundred forty cc. of water are added and the mixture thoroughly agitated. To this, 50 cc. of oleic acid is added and again mixed thoroughly. Only the best grades of sodium hydroxide , rosin, and oleic acid should be used. Thirty parts of this mixture are added to 70 parts of carbon disulphide and the mixture agitated in a churn or with a bucket pump until emulsification occurs.

This emulsion will separate or stratify but very little on standing or when stored.

The most satisfactory emulsion was obtained by following the recommendations of Fleming (11). This emulsion is made containing 13.5 gms. of potassium hydroxide, 193 cc. of 95 per cent ethyl alcohol, 77 cc. oleic acid, 700cc. carbon disulphide and 30 cc. cotton seed oil. Prepare the emulsion by first dissolving the potassium hydroxide in alcohol and filtering off the unsoluble carbonate. The concentration is then determined and enough added to produce 13.5 gms. in 193 cc. of alcohol. To this 77 cc. of oleic acid are added. Then add 700 cc. of carbon disulphide and 30 cc. of cotton seed oil to

each 270 cc. This emulsion is homogeneous and does not separate when standing for long periods. This emulsion is designated as No. 3 in Table 18.

All of these emulsions appear equally effective against the larvae. In diluting the stock emulsion with water it is best to mix the emulsion with an equal amount of water and thoroughly agitate before mixing with large volumes of water.

In the first test of the emulsion on larvae only small numbers were used as the material was saved for life history work. In these tests the emulsion was diluted 4.5cc. to 6 liters as recommended by Leach and Johnson (12) for control of the larvae of the Japanese beetle. This strength which is about .075 percent carbon disulphide was found to be too weak to kill the larvae. After 48 hours in the soil moistened with this solution the larvae appeared to be killed but recovered soon after. The second strength used was one part stock emulsion to 199 parts water, making a carbon disulphide content of .35 percent and applied at the rate of 1 quart to a square foot of soil surface. This gave satisfactory killing as is shown in Table 18.

To see if this strength of .35 percent would injure lawn or rose bushes, 4 different tests were made on lawn and 4 on rose bushes a plying it at the usual rate of 1 quart to one square foot. No injury was noticed on either lawn or rose bushes. Testing out double this strength of emulsion (.7 percent) showed that the lawn was readily killed in 48 hours

and the leaves of a baby rambler rose showed drooping. The leaves fell off a few days later, but in 3 weeks new growth was appearing. This same strength did not injure Teplet roses when traated in a similar manner.

The ideal procedure for control of this insect would be a combination of carbon disulphide emulsion treatment on the larvae, dusting with calcium arsenate for the adults, and hand picking the injured buds and any beetles noticed.

Treatment of the soil around rose bushes, on which no previous control had been used, would prevent most of the adults from appearing. This would probably not be practical on bushes treated the season before. Probably 50 to 95 per cent of the larvae could be killed, but this could not be relied on to prevent beetles coming in from surrounding bushes.

Dusting with calcium arsenate could be carried out very effectively alone or in combination with the carbon disulphide treatment.

Hand picking and destruction of injured buds would eliminate the possibility of development of a few beetles that would be missed by the other two methods.

SUMMARY OF CONTROL MEASURES.

1. Hand picking of the beetles as they appear on the rose buds does not prevent serious injury.

2. Hand picking the injured buds and destroying them prevents the development of the larvae and gives protection for the following year.

3. The adults are controlled best by the use of calcium arsenate applied as dust to the foliage of the plants.

4. Carbon disulphide emulsion .35 percent strength gave good control on the over wintering larvae.

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Key to separate varieties of R. bicolor with range of each.

Rhynchites bicolor wickhami Ckl.

Type of duster used.

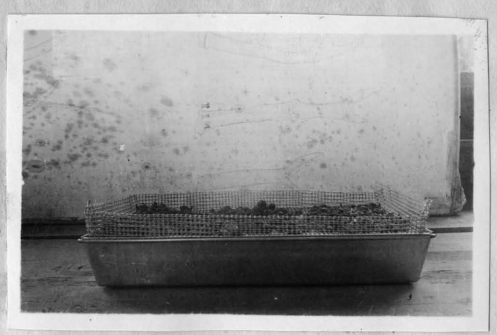
Rose curculio paradise.

Dusting roses.

Rhynchites bicolor wickhami Ckl.

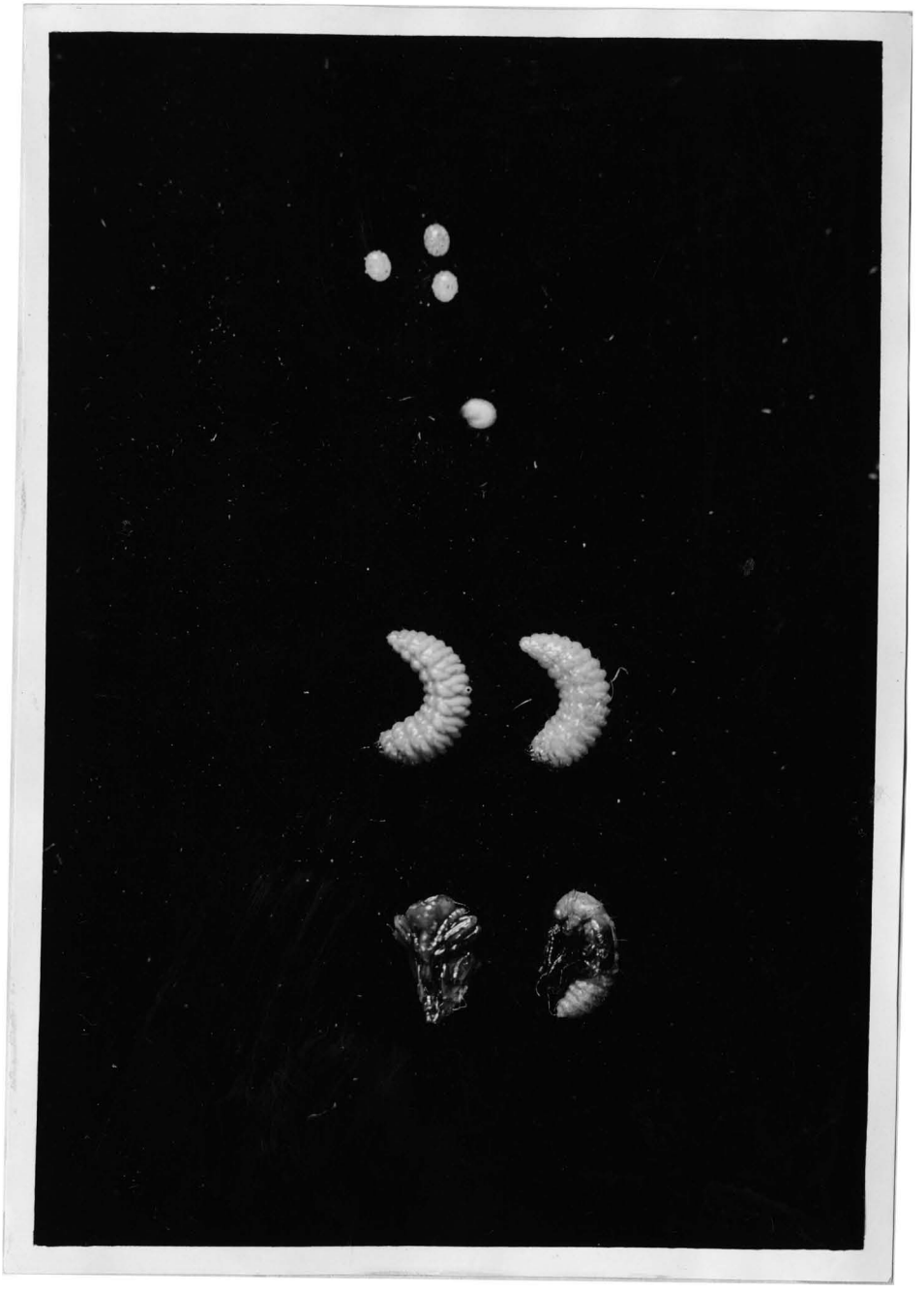
Type of cage used for studying life history

Group of cages



Apparatus used for obtaining length of larval period.

Rhynchites bicolor wickhami Ckl.



Eggs, small larva, mature larvae and pupae. Enlarged.

Rhynchites bicolor wickhami Ckl.

Adult beetles and eggs in situ.
Enlarged.

Rhynchites bicolor wickhami Ckl.

Feeding punctures on rose flowers and injured buds.

Rhynchites bicolor wickhami Ckl.

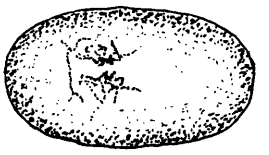
Typical injury to buds.

Plate 1.

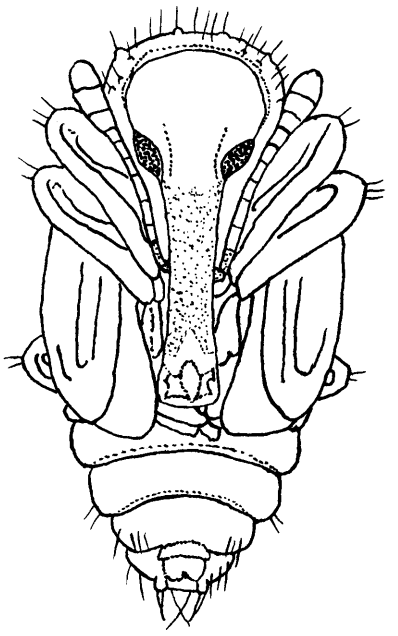
Rhynchites bicolor wickhami Ckl.

Egg X15

Egg surface X110



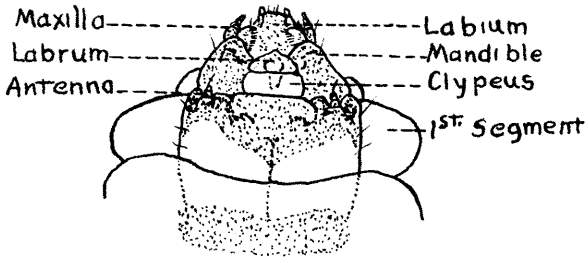
Egg 24hrs. before hatching X30



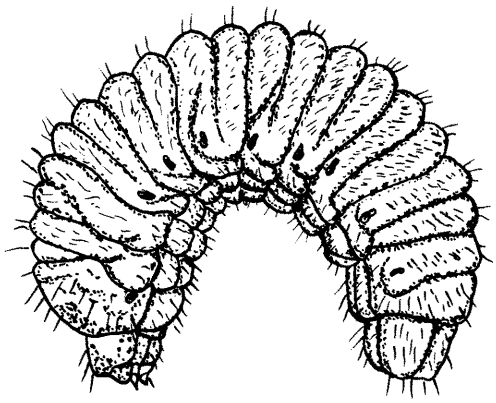
Pupa X15

Plate 2.

Rhynchites bicolor wickhami Ckl.

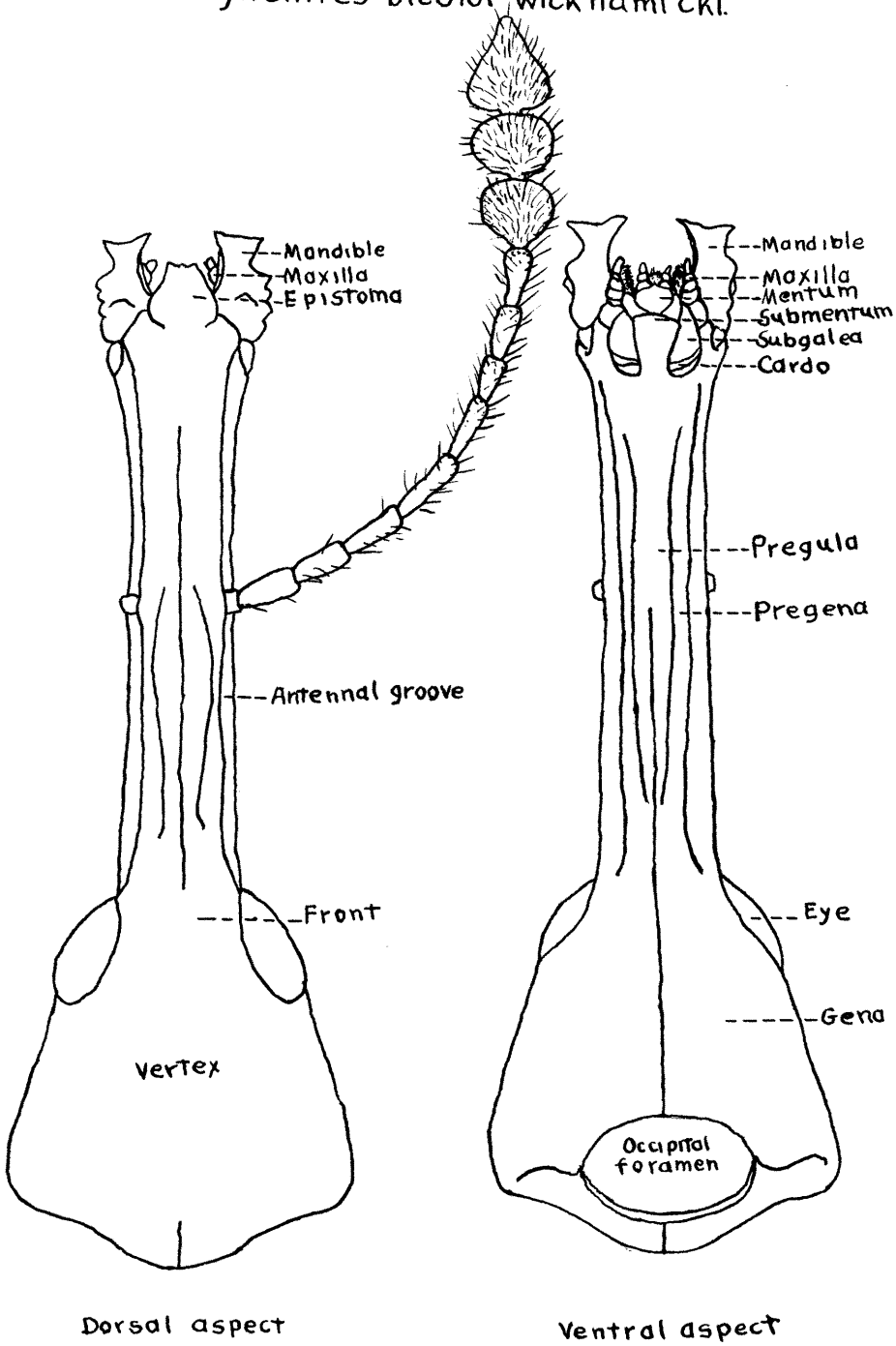


Larval head x 40



Larva x15

Plate 3.
Rhynchites bicolor wickhami Ckl.

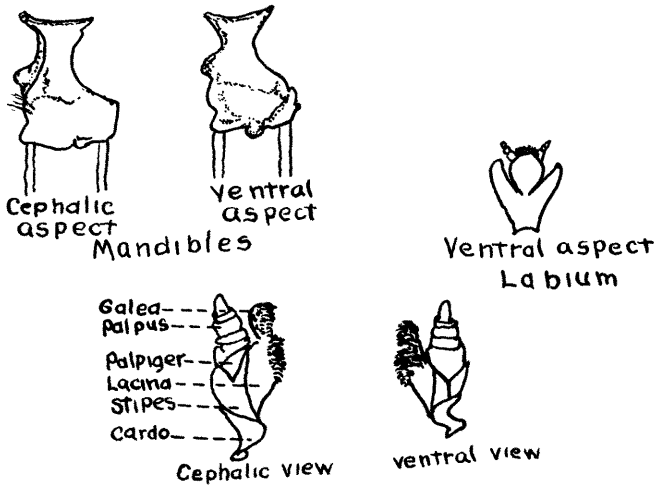


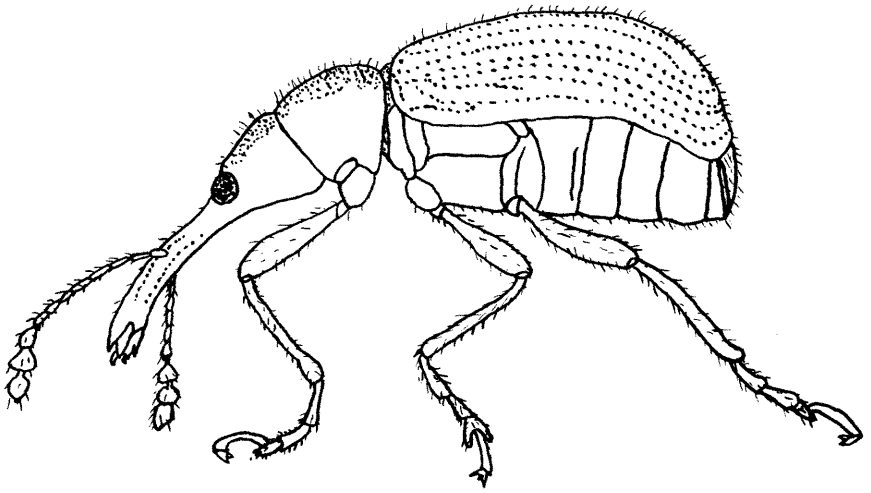
Dorsal aspect

Ventral aspect

Plate 4.

Rhynchites bicolor wickhami Ckl.

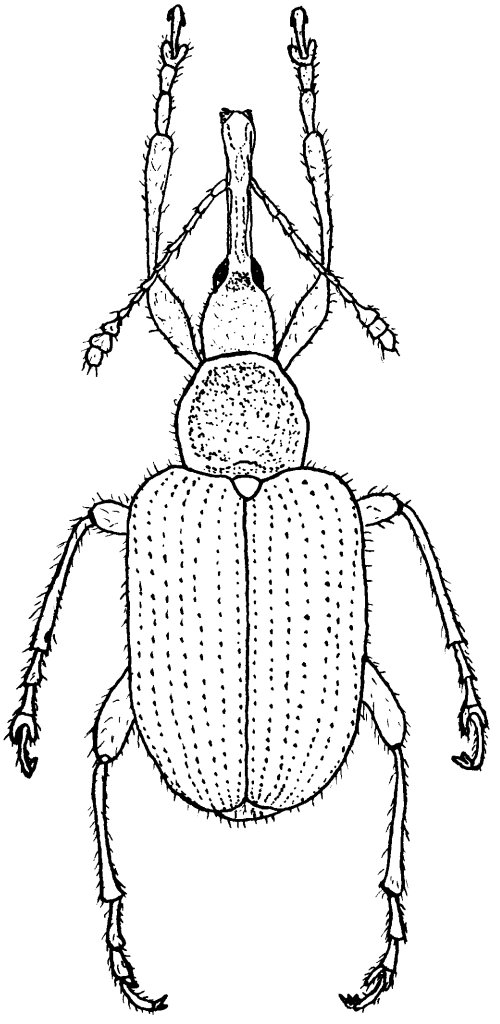




Adult. Lateral aspect X15

Plate 5

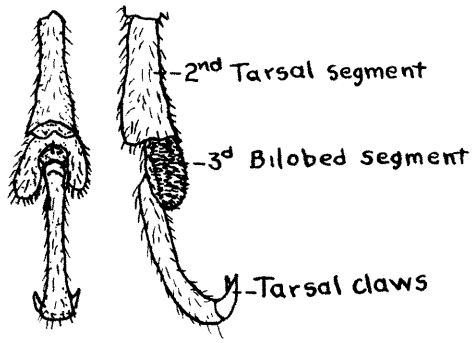
Rhynchites bicolor wickhami Ckl.



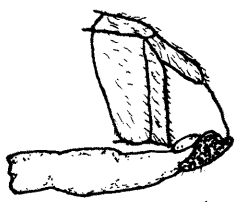
Adult. Dorsal aspect X15

Plate 6.

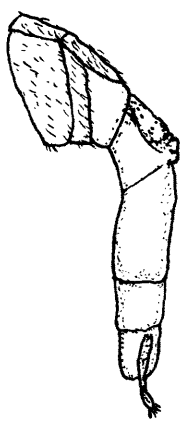
Rhynchites bicolor wickhami Ckl.



Tarsal Segments X45



Abdomen tip of male
Genitalia partly extruded
X20



Abdomen tip of female
Ovipositor partly extruded
X20