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THE BIOLOGY OF THE MEXICAN CHICKEN BUG, HAEMATOSIPHON INODORUS (DUGES)

(Hemiptera: Cimicidae)

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Since its description in 1892 by Duges, little has been done with the Mexican poultry bug, *Haematosiphon inodorus*. Few locality records have been given for this species although Usinger (1947) mentioned that it is a common poultry pest found throughout the southwestern United States and Mexico. According to collection notes to be cited later and according to the observations of Townsend (1893) and others, colonies of *H. inodorus* may become quite numerous and troublesome. It is hoped that the following study will aid in the knowledge and control of this species.

The writer wishes to express his appreciation to Dr. Robert L. Usinger, University of California at Berkeley, under whose guidance this work was done. Special thanks are also due to Drs. Deane P. Furman and William C. Reeves, of the University of California, Berkeley, for their helpful advice and criticism of the project. To Raymond E. Ryckman, School of Tropical and Preventive Medicine, Loma Linda, California, goes my heartfelt thanks for his unfailing interest and help in making this study possible. For aid in collecting material, credit must be given to R. E. Ryckman, C. T. Ames, and K. Y. Arakawa. The author is indebted to Mrs. Frieda Abernathy for making the plate of *H. inodorus* and to Dr. I. Barry Tarshis for the photograph used in this paper. The School of Tropical and Preventive Medicine, Loma Linda, California, granted the author a one-year leave of absence for graduate study during which this work was done.

METHODS

Haematosiphon inodorus showed a reluctance to feed and oviposit from a few days to several weeks after being brought from the field to the laboratory. The colony as a whole was allowed to feed every three to five days and was maintained in an incubator at about 25.5–29.0° C. and 58 to 64 per cent relative humidity. Before any quantitative records were taken, the colony was established until the insects seemed to be laying eggs in what was thought to be a normal manner.

The bugs were kept in straight walled jars approximately 5⅝ inches high and 1⅛ inches in diameter or in shell vials principally of two sizes: 2 inches high by ½ inch in diameter; 2¾ inches high by ¾ inches in diameter. The size of the container used was determined by the number and age of the insects in the container. The main colony was divided into a number of the 1⅛ inch diameter jars. The openings of all of the containing units were covered with rayon cloth consisting of 85 by 67 threads per inch. This mesh was found satisfactory to keep first instars in and still permit adults to feed through. The cloth was held in place by a tight fitting rubber band. Masking tape was then put around both the rubber band and the edge of the cloth to prevent any escape. This feeding technique was suggested by Ryckman's (1951) method of feeding Triatominae.

Bugs in the largest units were supported by heavy blotter paper in accordion-like folds extending the length of the jar. This supplied the insects with a means of reaching the host during feeding time and provided them with ample space on which to lay eggs. For immature insects being kept separate from the main colony and for most of those involved in special experiments, another type of unit was found to be more satisfactory. A disk of blotter paper was placed on the bottom of each of the smaller units, and no folded paper reached the top. If the disk is made of the correct diameter, it will fit snugly without slipping out. If a drop of melted paraffin is dropped on the bottom of the vial just before the disk is placed in it, the security of the disk may be made more sure. The reason for this type of unit will be made clear below.

The principal laboratory host used was the chicken, and unless otherwise indicated in the following experiments it will be assumed that the chicken was the host used. The bird was secured for the most part by merely tying its feet together. However, on occasion it has been necessary to quiet the chicken by putting a hood over its head or even tying its feet and wings to a board. The feeding units were held inverted on an unfeathered area on the side of the fowl by a ring stand and burette clamp. (See Figure I). Those bugs having access to the chicken by the long folds of blotter paper could go and feed or remain away as they pleased. The insects in the smaller units containing disks of blotter paper were dropped to the cloth covering before application to the bird by inverting the vial and tapping it. This forced the insects to be close to the skin of the host, being separated from it only by the cloth through which they readily fed. This latter method proved highly successful and increased greatly the percentage of bugs feeding. It was especially adaptable to the youngest instars which had a tendency to remain away from the animal when the bugs were in jars containing folds of paper.

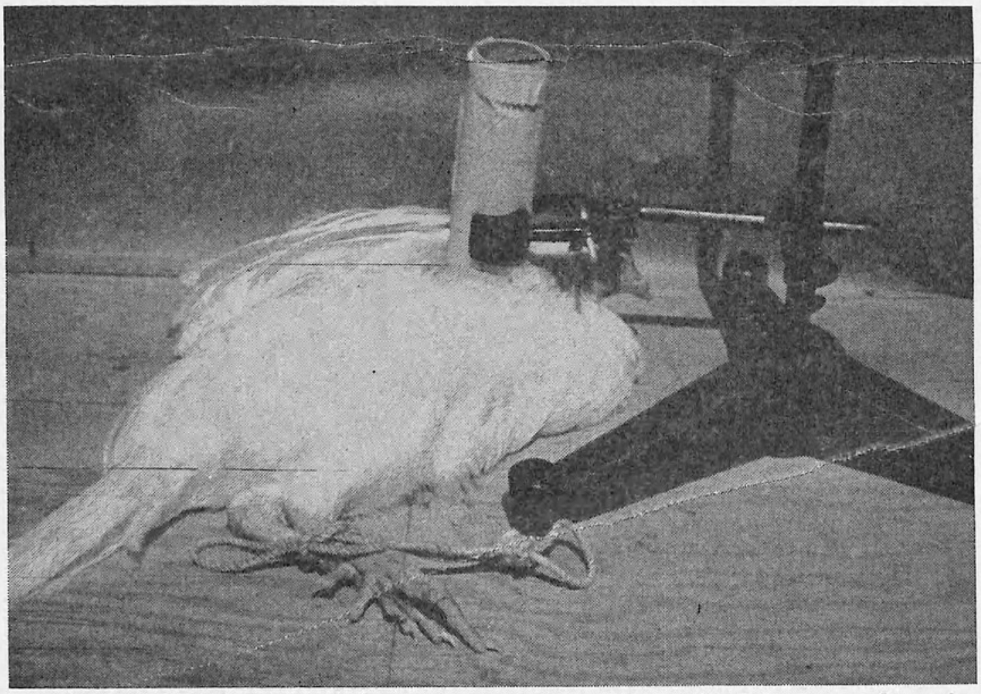

Fig. 1. Application of the colony rearing unit to the laboratory host for feeding of *Haematosiphon inodorus*.

It was found that the bugs tended to feed better if the feeding unit was covered with a cloth or paper before putting it in the burette clamp thereby allowing the bugs to feed in at least partial darkness. That darkness was not an absolute necessity is borne out not only by laboratory evidence but by the observation of Ryckman (personal communication) in which bugs were seen feeding on nestling owls in ample light.

SYSTEMATICS

In the original paper, Duges (1892) assigned *inodorus* to the genus *Cimex (=Acanthia)* and remarked that it warranted subgeneric recognition. In describing the adult, Duges erroneously pointed out that it had no scent apparatus; he reasoned that the absence of a scent gland was compensated for by the nimble action and long rostrum of the bug.

Champion (1900) proposed the genus, *Haematosiphon,* for the reception of *inodora* and stated that *H. inodorus* has a scent apparatus, in contra-distinction to Duges' findings. On the basis of differences in the bristles, the proboscises, and the sterna, Jordan and Rothschild (1912) divided the family Cimicidae into three subfamilies, one of which was the newly recognized subfamily Haematosiphoninae. Jordan (1922) noted in *Haematosiphon* the dorso-medial position of the organ now verified as the organ of Berlese. He suggested that the medial position is probably the primitive one for this structure.

Although several workers have given descriptions of the adult, no one has described the egg or all of the pre-adult instars. Townsend (1893) described one of the later nymphal instars.A redescription of both sexes of the adult and a description of the egg and all the instars is here presented. The measurements given below indicate the mean sizes of twenty-five freshly killed specimens.

Diagnostic Description. Contrary to what Matheson (1950) and others have said, *Haematosiphon inodorus* is not a relatively large bug. Instead it is considerably smaller than *Cimex lectularius* Linneaus; it is somewhat similar in size to *Oeciacus vicarius* Horv. *H. inodorus* is characterized by its broad head, long rostrum, subcontiguous mesocoxa and metacoxa, laterally margined elytra, and dorsal organ of Berlese.

Detailed Description. Egg. (Plate 1, a.) Chorion white, unhatched egg colored light brown because of contents. Fine irregular pattern imprinted on chorion; unlike regular geometric figures on *Cimex lectularius* chorion. Length .883 mm.; width at widest part .441 mm.; diameter of ring about operculum .261 mm. Operculum moderately smooth.

First Instar Nymph. (Plate 1, b.) Elongate-oval, flattened, sparsely bristled. Overall body length 1.14 mm.; abdomen width .517 mm.

Head triangular, somewhat rounded, proportion of width to length 25::16.5, head width .382 mm. Eyes about one-sixth as wide as interocular space, 3::17. Antennae inserted slightly behind middle of anteocular space on ventro-lateral aspect of head; fourth segment pointed apically. Proportion of antennal segments, 6:11:11:16.5. Rostral proportions, 15.5:12.5:13; rostrum extending to posterior of middle coxae; overall length .619 mm.

Pronotum subrectangular, anterior concave, posterior convex, humeri rounded, width .441 mm., ratio of length to width 12.5::30, bearing a single, long bristle on each posterior corner. Mesonotum and metanotum less rectangular in shape, shorter than pronotum, also bearing single long bristle on each posterior corner.

No indication of wing pads. First abdominal segment bearing single long bristle on posterior corner similar to those on thoracic segments.

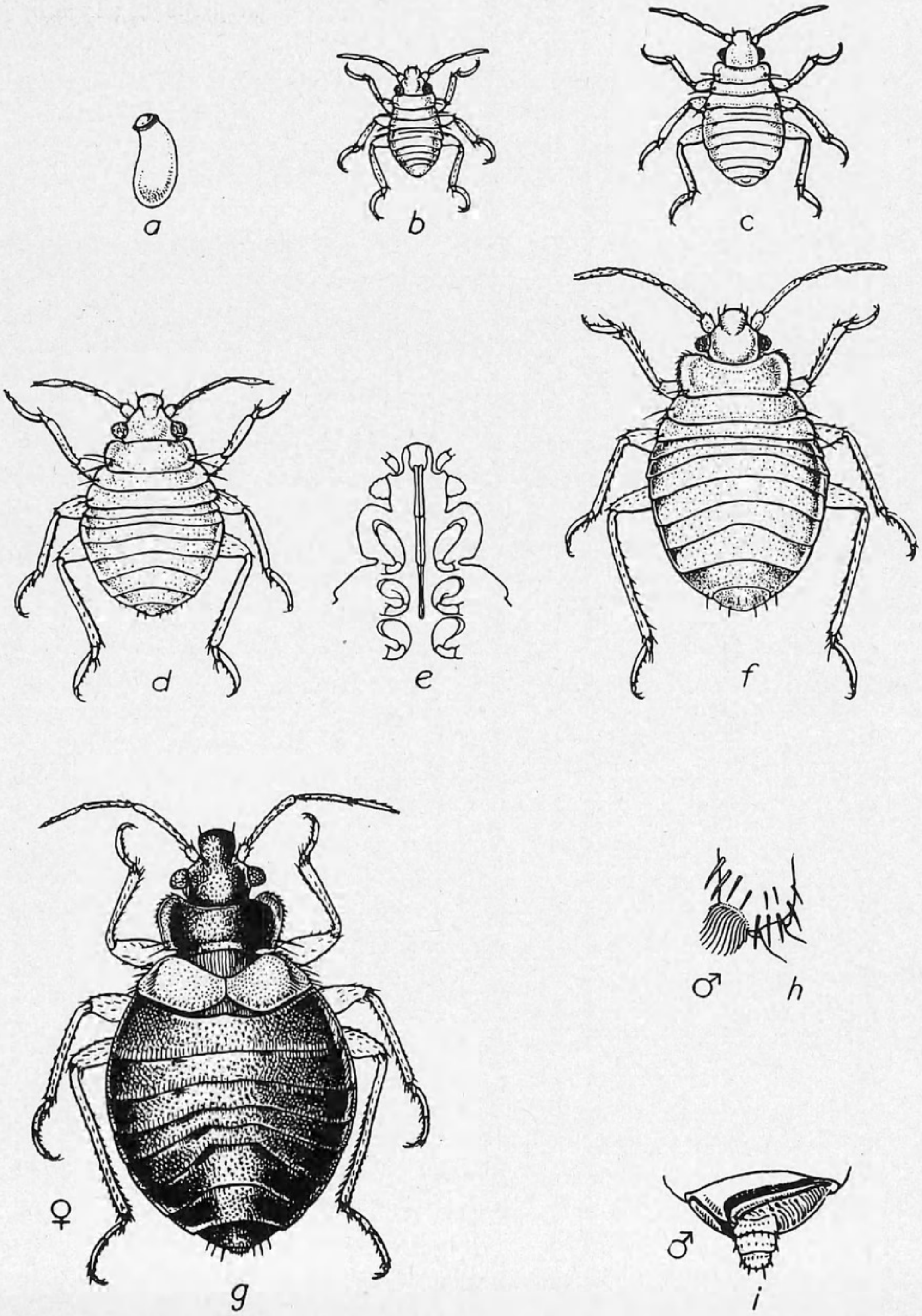

Plate I. Illustration of *Haematosiphon inodorus:* a) egg; b) first instar; c) second instar; d) third instar; e) ventral aspect showing rostrum; f) fourth instar; g) adult female; h) lateral view of disk on apical end of male mesotibia and metatibia; i) male terminalia.

Scattered bristles on venter, very few on dorsum, six long bristles extending beyond tip of abdomen; spicules present on legs. Tarsi two segmented; claws simple, curved. Small pads situated at base of claws.

Color uniformly pale amber except for bright ruby-red eyes.

Second Instar Nymph. (Plate 1, c.) Differing from preceding in following respects: more robust than first instar nymph. Head width .450 mm., width to length proportion, 31::21. Proportion of antennal segments, 7:16:15:19.5. Proportion of rostral segments, 19:17:18, overall length .727 mm.

Apparent first abdominal segment not bearing long bristle on posterior corner. Overall body length 1.45 mm.; abdomen width .770 mm.; prothorax width .564 mm.

Third Instar Nymph. (Plate 1, d.) Differing from preceding in following respects: proportionately larger than previous instars. Head width .582 mm.; width to length proportion, 11::8. Proportion of antennal segments, 10:25.5:21.5:23.5. Proportion of rostral segments, 26.5:21.5:24, overall length .983 mm. Prothorax width .775 mm; abdomen width 1.11 mm.; overall body length 2.14 mm.

Fourth Instar Nymph. (Plate 1, f.) Differing from preceding in following respects: proportionately larger than previous instars. Head width .741 mm.; width to length proportion, 24.5::17.5. Proportion of antennal segments, 13:34.5:24.5:25. Proportion of rostral segments, 15:13:14.5, overall length 1.28 mm. Prothorax width 1.01 mm.; abdomen width 1.51 mm.; overall body length 2.94 mm.

Adult Male. (Plate 1, i.) Elongate-oval, rather robust, surface polished, partly covered with short appressed hairs.

Head, including eyes, broader than long, 26.5::19, .825 mm. in width, somewhat pentagon shaped, tapering before eyes to front, broadly set into prothorax. Clypeus rounded, tapering abruptly behind widest part and attached in V-shaped invagination of head. Eyes one-fourth interocular space, 4.5::18, quite prominent. Antennae inserted behind middle of anteocular region, first segment somewhat globulose, third thinner than others, fourth pointed apically. Proportion of segments, 5:18:12.5:12.5. Rostrum extending to hind margin of mesosternum, approximately 1.44 mm. long, rather slender, bearing scattered sub-erect, short hairs particularly on last segment. Proportion of segments, 18:14:15.

Pronotum parallelogram shaped, a little more than twice as wide as long, wider in front than behind, sides convex, anterior angles produced beyond hind margin of head. Sides produced to plate-like border fringed with row of short, curved, simple hairs; posterior angles bearing two long, slightly curved bristles. Sparsely covered with short, appressed hairs, finely punctate. Width of pronotum at widest point, 1.11 mm.

Front margin of hemelytra together form rounded, V-shaped line across thorax, rounded behind. Hemelytra sloping laterally to form rounded, plate-like process extended beyond pronotum, wider behind than in front. Granular, with scattered, short hairs; row of long, slightly curved bristles on lateral edge.

Coxae stout, mesocoxae and metacoxae subcontiguous, mesocoxae closer together than metacoxae. Sparsely covered with short hairs. Ridge formed between meso- and metacoxae extending to fourth abdominal sternite. Femora rather stout, clothed with short hairs. An oval disk bearing numerous short hairs located on apical end of pro- and mesotibiae (Plate 1, h.); disk appears from side to be a brush. Protarsi clothed with scattered hairs and bristles; meso- and metatarsi also bearing spines, particularly at apical end. Legs moderately long, tarsal claws simple and curved. Small, elongate pad having V-shaped striations located between tarsal claws.

Abdomen of recently molted, unfed specimen 2.00 mm. wide. Overall body length 3.34 mm. First abdominal segment longer than others. Posterior margin of first tergite straight across body, those following slightly rounded forward. Terminalia asymmetrical; penis directed to left side. Copulatory organ slightly curved, fitted into groove that runs up to hind margin of seventh sternite. Nearly all of first segment and posterior portion of other principal abdominal segments rather coarsely punctate, with short, fine, inconspicuous hairs. Tip of abdomen clothed with 30 to 50 long stiff hairs.

Long hairs of body dentate at tips.

Color description is of living specimen. Body walnut brown, hemelytra white with brown lateral edges, legs and antennae amber, eyes red.

Adult Female. (Plate 1, g.) Differing from male in following respects: abdomen more oval; general size somewhat larger. Head width to length proportion slightly greater, 28.2::22. Head width .874 mm. Rostrum length 1.54 mm. Width of prothorax at widest point 1.18 mm.

Pro- and mesotibia lacking apical disks.

Abdomen width 2.27 mm.; body length 3.9 mm. Fifth tergite strongly sinuated medially. Entrance to organ of Berlese located dorso-medially at fifth segment. Tip of abdomen symmetrical. Abdominal sternites 1 to 5 medially sinuated.

In uncleared freshly killed or living specimens older than the first instar nymph, bodies containing a green pigment may be seen scattered about the internal organs. This pigment may be that spoken of by Wigglesworth (1943) which results from a series of changes in the hemoglobin of ingested blood.

Comparison of Head Widths. Taylor (1931), Forbes (1934), Harries and Henderson (1938), and a number of others have used and discussed Dyar's rule in the study of changes in the head widths of successive instars of various insects. Dyar (1890) and others have shown that each instar of a given insect generally shows a fairly definite percentage increase in head width. This has been used with some degree of success to show the probable number of instars a species should have. That is, if there is a large gap in the head width range from one apparent instar to the next, it may be suspected that an instar has been overlooked. The application of Dyar's principle to *H. inodorus* is briefly considered here.

Head width measurements were made of twenty-five individuals of each preadult instar and both sexes of adults. The ranges for these measurements are indicated in Table I and Figure 2. The means, the standard deviations of the means, and the growth quotients of the various age groups are also presented in Table I. The specimens used for these measurements were selected from groups being reared through from egg to adult. The groups were examined approximately every forty-eight hours; those individuals which molted were separated from the rest and were either used then for measurements of that particular instar or allowed to go on to later instars and adults.

TABLE I. Measurements of head widths and study of the progressive development in size from instar to instar in *H. inodorus*.

Age Group	Number Measured	Range in Size	Mean	Standard Deviation	Growth Quotient
Instar I	25	.356-.403 mm.	.382 mm.	±.0117	-----
Instar II	25	.425-.477 mm.	.450 mm.	±.0156	1.18
Instar III	25	.548-.616 mm.	.583 mm.	±.0183	1.30
Instar IV	25	.682-.806 mm.	.741 mm.	±.0311	1.27
Adult Male	25	.775-.884 mm.	.825 mm.	±.0298	1.11
Adult Female	25	.791-.930 mm.	.874 mm.	±.0326	1.18
					Average 1.21

When the logarithms of the means are plotted on coordinate paper, as in Figure 3, they fall approximately in a straight line and are fairly evenly spaced. The evidence indicates that *Haematosiphon inodorus* has but four preadult instars. This fact is also shown in the study made of the life history of this species. All other Cimicids and nearly all Hemiptera which have previously been studied have five preadult instars.

Life History Studies

Seventy-six eggs were placed individually in as many vials so that each specimen might be studied separately from its fellows; this permitted a much more accurate tabulation of the results than would have been possible otherwise. The vials contained disks of blotter paper on the bottom and were covered with cloth as described previously.

The eggs used were known to have been 48 hours old or less and were checked for hatching every second day after they were placed in the vials. On the second day after having hatched from the egg or molting from the previous instar, the bugs were allowed to feed. By thus waiting 48 hours after the period during which the insect

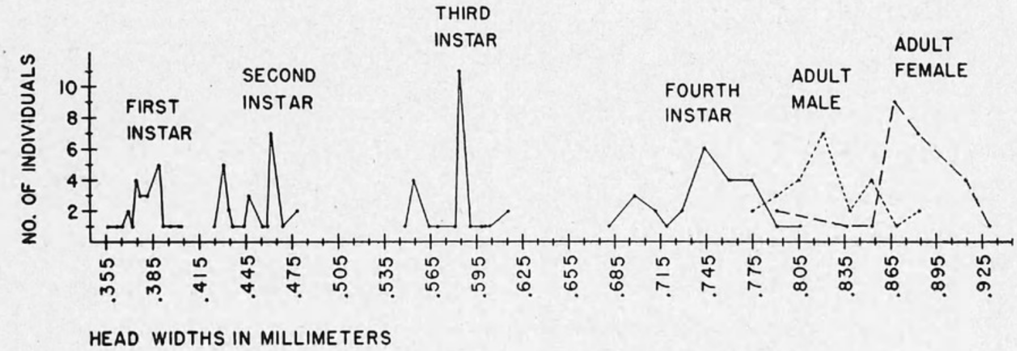

Fig. 2. Ranges of head widths of various instars of *Haematosiphon inodorus* shown graphically.

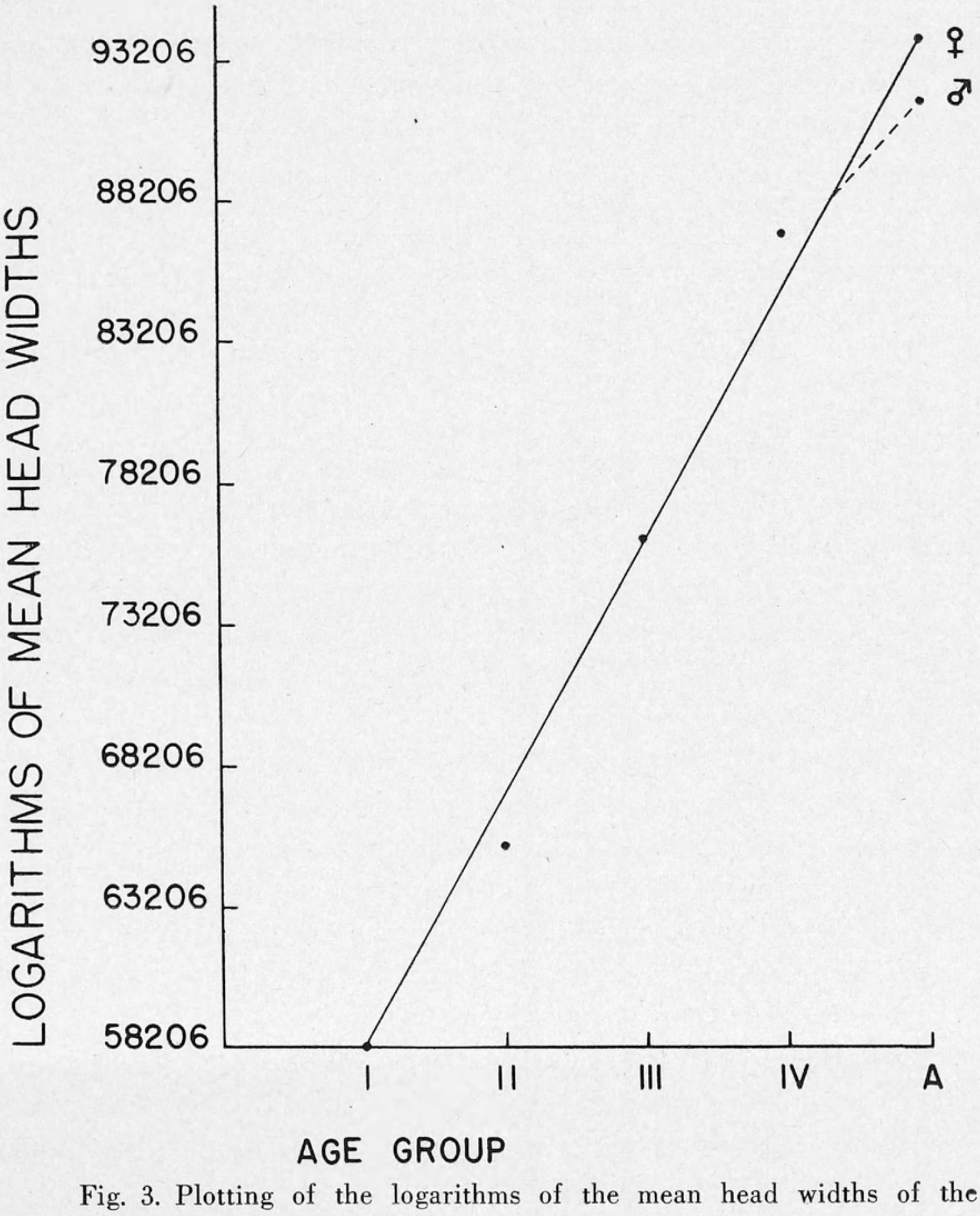

Fig. 3. Plotting of the logarithms of the mean head widths of the various instars of *Haematosiphon inodorus*.

hatched or molted, it was generally found that the bug would feed. There were exceptions as some individuals refused to feed for longer periods of time. Although this increased the length of time of the instar in which the individual hesitated to feed, it did not seem to affect the length of time of subsequent instars. Once having fed well in the "long" instar period, the bug generally progressed normally. Long instar periods were most frequent in the first instar.

Out of seventy-six eggs started in the life history study, seventy-two eggs or 94.7 per cent hatched. The average time required to hatch was 5.1 days. The average number of days required to develop from egg to adult was 36.5 days. The maximum was forty-six days, and the minimum was thirty. A summary of the remaining data of the life history study is presented in Table II.

TABLE II. Summary of life history data.

Instar	No. of Individuals	Percentage Molted	No. Days Required to Molt			No. died in each Instar
			Max.	Min.	Ave.	
I	72	73.6%	16	6	8.5	19
II	53	86.8%	12	6	7.8	5
III	48	93.7%	12	6	7.4	3
IV	45	91.1%	14	6	8.3	4
Adults	41	....	....	..	....	....

Out of 474 newly molted adult *H. inodorus*, 203 were females, and 271 were males. This gives a percentage ratio of males to females of 57.2::42.8. Although a still larger sample might change the figures somewhat, the indications are that there is a slightly greater percentage of males than females in newly molted, laboratory reared adults. Why there are more males than females is, as yet, a matter of speculation.

Reuter (1913) suggested that bats were the original host to *H. inodorus* and tried to substantiate this theory by stating that chickens (the only host other than man known for this species) were not native to the Western Hemisphere while the bugs were. Usinger (1947) recorded for the first time collections of *H. inodorus* from native hosts; they were the California condor, the great horned owl, and two unidentified owls.

Specimens used in this study were taken from the nests of barn owls, *Tyto alba pratincola* (Bonaparte). The nests were located ten to twelve feet from the top of a thirty-five foot bank along the Santa Ana River, thirteen miles southwest of Riverside, three-fourths of a mile northeast of Norco in Riverside County, California, at an elevation of about six hundred feet. The insects were found concentrated in cracks and crevices of the soft soil about the entrance and in the walls of the cave-like nests. From a single nest 1,425 bugs were taken; from another nest 1,778 specimens were collected. The bugs were by no means confined to the actual nest or its immediate entrance but were taken in numbers four to five feet and more away.

One of the first things the worker observes in handling *H. inodorus* is the swiftness with which the bugs, of all ages, move about.

H. inodorus is unable to climb a vertical, clean, glass wall. If, however, the angle is decreased from 90 degrees, a point is reached at which the insects are able to climb. The maximum angle which the bugs are able to climb depends on their age group. With the exception of the male adults, the younger the age group in which a given individual is, the better able it is to climb the wall. Maximum ranges for the various instars and for both sexes of adults were found to be: I, 45–49°; II, 40–44°; III, 32–36°; IV, 22–26°; adult female, 17–21°; adult male, 62–66°.

That the insects can climb at all on a clean glass wall is dependent at least in part on the presence of a small pad at the apical end of the last tarsal segment. The remarkable ability of the adult males to climb the glass wall is due to the presence of an additional "climbing organ" located on the apical end of the tibia of the first and second pairs of legs. This organ appears to be an oval disk bearing many hairs; from the side it looks like a small brush (Plate 1, h.). The climbing organ was observed in action by placing a living adult male upside down on a microscope slide and covering him with a cover glass. The organ appeared to be quite similar to that described by Gillett and Wigglesworth (1932) for *Rhodnius prolixus*, "an elastic sac distended with fluid." The fact that only the males have these tibial climbing organs might indicate that these are secondary sexual structures used during copulation.

Copulation takes place most frequently after feeding. The males run about in search of a female, and the act itself takes place in the following manner: the male climbs on the dorsal surface of the female, being lined up with her on a parallel axis. He inserts the copulatory organ into the sinuated fifth abdominal tergite which leads into the organ of Ribaga and the organ of Berlese.

The pair shakes vigorously from side to side much of the time while *in copulo;* the female may even run about with the male still in position. If there is a dearth of females in the colony, the males may be seen to mount other males and go through shaking motions similar to those that a copulating pair makes; this, however, lasts for a much shorter period than when the act takes place with a female. Both sexes need not have fed recently to become sexually excited when the colony as a whole is feeding. A well fed female seems to attract more males than an unfed one. If motion plays more of a role in attracting the male to the female than odor does, as Rivnay (1933) suggests for *Cimex lectularius,* then perhaps the larger size of the well fed female would explain its being more attractive than the unfed female. It would seem reasonable in this case to suspect that the warmth of the ingested blood is the attracting agent. However, males are attracted to fed females and not particularly attracted to fed males when enough females are present. Thus it would seem that neither motion nor the warmth of ingested blood serve primarily as the activators of the copulatory act. Whether or not a chemical stimulus or some other factor is the agent has yet to be solved.

Longevity without Food. The problem of how long the newly molted insect can live without food is an important one. This is particularly true when the host may be gone for several days before returning to the nest. An indication of the length of time that various stages may survive after molting is indicated in Table III.

TABLE III. Longevity of recently molted bugs without food.

Instar	Number Used	Number of days till death Max.	Min.	Ave.
I	34	7	3	5.1
II	24	7	4	6.1
III	32	13	5	8.3
Adult female	21	25	11	14.9
Adult male	19	17	8	12.4

Although *Haematosiphon* is not usually considered to feed on mammals, it is important to know what animals other than birds it will feed on, particularly for some laboratory experiments. Various instars of bugs were allowed to feed on the closely clipped abdomen of a laboratory rabbit. Little hesitation was evidenced by the insects to feed on the animal. Those which had fed to repletion molted to the next instar or to adults in a normal amount of time.

Poor results were obtained in an effort to feed second, third, and fourth instar nymphs on a young white rat. Eight out of thirteen bugs which had fed well on the rat were dead within four days after having fed. Although Mazzotti (1941) was successful in feeding *H. inodorus* on a mouse, the present writer did not meet with such success. Out of thirty-six hungry bugs of various instars which were placed for 24 hours in a small jar containing a suckling mouse, only eight fed at all, none to repletion. The insects were seen to crawl about on the mouse, but few were seen attempting to feed.

First, second, and third instar nymphs were allowed to feed on the abdomen of a bat *(Myotis* sp.) which had been stretched out and strapped down. Small numbers (3 to 5) of each instar fed; within 18 hours those bugs which fed were dead. Even though the insects were dead the blood was still the same bright red hue it was immediately after the bugs had fed. Still less successful results were obtained in an effort to feed the bugs on the Mexican free-tailed bat, *Tadarida mexicana* (Saussure).

Attempts to induce various instars of *H. inodorus* to feed on an unidentified cave toad and fence lizard met with failure.

Haematosiphon shows no reluctance to feed on human subjects at all. Duges' paper (1892) mentioned the fact that chicken growers complained of bites from this species. Townsend (1893) stated that this pest may "spread from roosts to dwelling-houses, where it proves more formidable than the bedbug". More recently (1952) Dr. J. N. Roney, Extension Entomologist of the University of Arizona, reported *(in litt.)* that in July, 1946, in Navajo County, Arizona, he "found the insects infesting two chicken yards and three homes to such an extent that the residents were forced to move out" so that a complete fumigation might be effected.

SUMMARY

Techniques used in rearing *Haematosiphon inodorus* for the first time in the laboratory are noted.

A detailed description is here presented for the first time for the egg and all the preadult instars. A redescription of both sexes

of the adult is presented in greater detail than has been done by previous workers.

By rearing this species from egg to adult in individual vials and by studying its life history in detail, the fact that *H. inodorus* has only four preadult instars was demonstrated. A comparison of the degree of change in head width from one stage to the next, based on Dyar's principle, shows biostatistically that no instar was overlooked in the life history study. This is the first Cimicid and one of very few Hemiptera which has been shown conclusively to have only four preadult instars. A brief study of the sex ratio shows that there are more males than females in a laboratory reared population.

Collection notes indicate a new host for this species and point out that populations may build up to large numbers in the nest of the host. Various behavior patterns of this bug are presented which give a clearer understanding of its life history.

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EMERGENCE OF THE CICADA OKANAGANA TRISTIS VAN DUZEE

(Homoptera: Cicadidae)

Okanagana tristis Van Duzee is a common California species, but the only record for Mendocino County given by Simons (1954. The Cicadidae of California. Bull. Calif. Insect Survey, 2(3):177) is "Mendocino Co.: Unknown locality, 1♀, VII-20-23 (E. R. Leach, C.A.S.)."

Virtually all insects labeled "Mendocino Co." by Mr. Leach were taken on or close to his property at the junction of Yale Creek with Rancheria Creek, about two miles south of the *old* site of the Yorkville Post Office on Highway 128. On July 24, 1954 I was camped in a small neglected orchard on this property, and at about 8:30 P.M. (Pacific Daylight Saving time) noticed cicada nymphs crawling up grass and weed stems. By 10:30 P.M. most of them had completely emerged from the nymphal skins, but were still of a creamy white color. I am indebted to Dr. J. N. Simons for identifying one of the resultant adults—HUGH B. LEECH, *California Academy of Sciences, San Francisco.*