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STUDIES ON MOSQUITOES OF THE GENUS HAEMAGOGUS IN COLOMBIA (DIPTERA, CULICIDAE) [1, 2]

By

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The purpose of this paper is to recount briefly the evidence against some of the species of the genus *Haemagogus* as vectors of jungle yellow fever; to give the results of our own studies on the distribution of the Colombian species and varieties; to give keys to the larvae, males, females and male terminalia; and finally to make suggestions regarding the nomenclature of the species-group which contains the proved vectors.

During the past decade certain species of the genus *Haemagogus*, Williston 1896, have been assuming increasing medical importance in South America because of their proved rôle as vectors of endemic jungle yellow fever. In 1937 Antunes and Whitman (1) showed that a species that they called *Haemagogus janthinomys* was infectible with yellow fever virus under laboratory conditions and that this species could transmit yellow fever by bite from rhesus monkey to rhesus monkey after an extrinsic incubation period of 14 days. A year later Shannon, Whitman, and Franca (2) secured naturally infected specimens of what they called *Haemagogus capricorni* near Bemposta in the State of Rio de Janeiro, Brazil. They pointed out at that time that the name *janthinomys* Dyar was probably a synonym of the species they designated as *H. capricorni* Lutz, the latter name having priority.

Several years later Bugher, Boshell, Roca, and Osorno (3) found mosquitoes that they identified as *Haemagogus capricornii* naturally infected with yellow fever virus in some of the endemic regions of Colombia that lie to the east of the Eastern Cordillera of the Andes. Not very long afterwards Boshell and Osorno (4) obtained further incriminating evidence against this species near San Vicente de Chucurí (Department of Santander) and in the environs of Muzo (Department of Boyaca) on the western slope of the Eastern Andean chain.

Other recent findings implicated *Aedes leucocelaenus* as a potential vector of jungle yellow fever, both in Brazil and in Colombia; but these were not surprising, since this species is so closely allied to the genus *Haemagogus* that some Brazilian entomologists have referred to it as *Haemagogus leucomelas*.

During May and June, 1943, yellow fever virus was isolated repeatedly and transmission was obtained by bite from

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female *Haemagogus*, resembling *capricornii*, caught in a patch of forest called Volcanes, near Caparrapí in the Department of Cundinamarca, Colombia. Three species of *Haemagogus* were present in this area, *H. equinus* and *H. lucifer*, and the species then identified as *H. capricornii;* but we were not able to reach any definite conclusion as to whether all of the virus isolated from these wild-caught females came from the latter, or whether certain specimens of *H. lucifer* also were infected with yellow fever. The reason for our uncertainty on this point was that at that period we had not yet learned how to distinguish female specimens of those species.

In addition to abundant evidence accumulated in Colombia, indicating the relative frequency with which the species resembling *H. capricornii* may be found naturally infected with yellow fever virus, a few positive transmissions in the laboratory have been secured by Bates (5) using Saimiri monkeys (*Saimiri sciureus* Allen) as the source of virus. On one occasion also, a single female *H. equinus* transmitted yellow fever by bite to a baby mouse. The adult insect had been infected by immersing its larva in a solution containing yellow fever virus.

Because of the proved importance of at least one species of *Haemagogus* in the natural transmission of endemic jungle yellow fever, a thorough, systematic study of all the Colombian members of this genus was indicated. It was essential to discover reliable characters for separating adult females, as well as larvae and males, if we were to evaluate correctly the rôles of *H. equinus* and *H. lucifer* as compared with the species previously identified as *H. capricornii* in those endemic areas where all three were common, such as Caparrapí and San Vicente de Chucuri. These, then, were the basic reasons for initiating the studies, the results of which are reported here.

To date, 8 species of *Haemagogus* have been obtained in Colombia. As careful collecting has been done in only 55 localities, large tracts of this Republic still remain unsurveyed. It is quite likely, therefore, that several other species would be found if this type of study were to be extended to include the rest of this country. Anduze (6) reported only 4 species from Venezuela, but his survey also was quite limited in its scope. Three of the 4 species encountered by Anduze in Venezuela have been secured in Colombia. The importance of these mosquitoes in the epidemiology of jungle yellow fever certainly warrants more intensive systematic investigations in the endemic zones of South America.

Haemagogus capricornii was originally described from Brazil by Lutz about 40 years ago. He gave it that name because he secured female specimens in the part of the State of São Paulo which is crossed by the Tropic of Capricorn. As there is nowhere in the literature a good colored plate showing the brilliant hues of the similar Colombian species, we are including one (plate I) painted by a local artist, Sr. Guillermo Varela S. Evidence will be presented later in this paper to show that the most important vector species in Colombia, which was previously identified as *H. capricornii* Lutz in Bourroul (10), is really a subspecies of *H. spegazzinii* Brèthes. For that reason it will be referred to in the remainder of this report as *H. spegazzinii* Brèthes, subspecies *falco* or *H. spegazzinii falco*.

Relative prevalence of the different species

In Colombia *Haemagogus spegazzinii falco* is not only more widely distributed than any of the other species of *Haemago-*

TABLE 1

Number of specimens of each species of Haemagogus *identified and number of localities in which each was found* *

Species of *Haemagogus*	Number of specimens of each species identified	Per cent of total number identified represented by each species	Number of localities in which each species was found	Per cent of total number of localities visited in which each species was encountered
H. anastasionis Dyar	75	6.7	2	3.6
H. andinus Osorno	52	4.6	4	7.3
H. boshelli Osorno	72	6.4	3	5.5
H. spegazzinii falco n. subsp.	563	50.1	37	67.3
H. chalcospilans Dyar	5	0.4	1	1.8
H. equinus Theobald	114	10.1	11	20.0
H. lucifer Howard, Dyar and Knab	195	17.4	10	18.2
H. splendens Williston	48	4.3	6	10.9
Totals	1,124	100.0		

* *Haemagogus* mosquitoes were obtained from 55 localities.

gus, but in addition it comprises more than half of the total number of specimens identified. The relative prevalence of the different species is shown in table 1. *Haemagogus andinus* and *Haemagogus boshelli* are two new species from Colombia, which were described by Osorno (7). It is noteworthy that *Haemagogus spegazzinii falco* is particularly abundant in those regions of Colombia which form part of the endemic zone of jungle yellow fever.

In the Volcanes area of the Department of Cundinamarca, there was some evidence of seasonal variations in the relative prevalence of the 3 species of *Haemagogus* encountered. In May and June, 1943, all the males caught were *H. lucifer*, whereas in October, 54.8 per cent of the males were *H. equinus*, and only 45.2 per cent were *H. lucifer*. Among the females that were accurately identified during May and June, *H. spegazzinii falco* accounted for 88.3 per cent, but only 39.8 per cent of the larvae reared from eggs laid by females captured in Volcanes in October and November belonged to that species. The relative prevalence of *H. equinus* was greater toward the end of the year, both among the females and among the males.

Methods of capture and handling of the specimens secured

Bugher et al (3) made the very important observation that adults of what they called *Haemagogus capricornii* were primarily arboreal, and Bates (8) confirmed this finding. The latter pointed out, in addition, that the peculiar zonal distribution in altitude of this mosquito was most marked during the rainy season. At times an apparent scarcity of *Haemagogus* at ground levels might not give a true indication of their real prevalence, because the adults were predominantly inhabitants of the upper forest canopy. It therefore became customary, in all localities where we wished to obtain *Haemagogus*, to collect

a sample of the local fauna from the treetops.

Another factor which complicated this study was that adult males of *H. spegazzinii falco* were never caught in nature. As a result, from localities in which we were unable to obtain larvae, it was usually necessary to bring females alive to the Bogotá laboratory and then to secure eggs from those females. In due course adult males and females were obtained by rearing larvae. Then the males of the first laboratory generation could be accurately identified as to species.

Not only were no male adults of *H. spegazzinii falco* captured in the forests of Colombia, but when Boshell recently made extensive catches near Ledesma in the Province of Jujuy, Argentina, he encountered the same difficulty. For that reason he brought female *Haemagogus* alive from Ledesma, Argentina, to Bogotá, Colombia, and from them he obtained eggs, larvae, and eventually males. Similarly Boshell took only female *Haemagogus* at Ribeirão da Fortuna near Ilhéus in the State of Bahía, Brazil, one of the known endemic zones of jungle yellow fever in that country. These also were identified by the same technique of securing eggs, rearing larvae, and then finally obtaining males. Thus in Argentina and Brazil, as well as in Colombia, it was a constant characteristic of *H. spegazzinii* and *H. capricornii* that adult males were never captured in the forest. If males were needed to make an accurate identification of the species present, it was always necessary to rear them from eggs laid by females caught in nature.

In sharp contrast to our inability to capture adult male *H. spegazzinii falco* in the forest was the relative facility with which we secured males of *H. equinus*, *H. lucifer*, and at times even *H. splendens*. The other 4 Colombian species, *H. anastasionis*, *H. andinus*, *H. boshelli* and *H. chalcospilans*, were usually taken only in their larval stages.

The most efficient method of transporting live female *Haemagogus* over long distances was to place them individually in shell vials with a disk of damp corrugated paper at the bottom. Usually a small amount of wet cotton was placed beneath the corrugated paper, so that the latter would remain humid for a longer period. The shell vials used were about an inch in diameter and 2 inches high. They were closed at the top with a cotton plug or else with a piece of metallic or cotton gauze. If the latter was used, a small cotton pledget, moistened with sugar-water, was placed on the top of the gauze. With the use of this technique, more than 80 female *Haemagogus* were brought alive from Ledesma in Northern Argentina to Bogotá in Colombia. They had travelled by train from Ledesma to Salta, and then by airplane from Salta to Bogotá via Lima, Guayaquil, and Cali. In order to secure plenty of eggs, Boshell fed the females on his own arm at the time of capture.

We made a few observations on the viability of *Haemagogus* eggs when preserved in a dry state. Eggs which had been obtained from females caught in the forest at Volcanes were ripened for 2 weeks on pieces of damp paper towels and then completely dried. Of the eggs that were submerged 2.5 months later, over 50 per cent hatched. Many remained alive for at least 6 months. Other batches of *Haemagogus* eggs were kept moist, and these showed a higher proportion of viable eggs after the 6-month period than those that had been completely dry. This study, however, was too superficial to permit definite conclusions to be drawn from it, beyond

the observation that a certain number of eggs remained viable for at least 6 months under both sets of conditions.

Geographical distribution in Colombia of the species captured, with notes on nomenclature

Of the 8 species of *Haemagogus* captured in Colombia to date, 7 are lowland species, and only one, *H. andinus*, can be classed as highland species. The latter, as shown in figure 1, is most abundant at altitudes approximating the 2,000-meter contour.

Haemagogus anastasionis Dyar, Insec. Inscit. Mens., IX, p. 155 (1921);

H. anastationis Dyar, Mosq. Amer., p. 137 (1928);

H. anastasionis Edwards, Dipt. fam. Culic., p. 179 (1932);

H. anastasionis Komp and Kumm, Proc. Ent. Soc. Wash., XL, p. 259 (1938);

H. anastationis Lane, Cat. Mosq. Neotro. São Paulo, p. 118 (1939). This species was named in honor of Dr. Anastasio Alfaro, a Costa Rican entomologist. The original spelling of the specific name is "*anastasionis*"; this was incorrectly emended by Dyar in 1928. The male terminalia were described by Dyar in 1921, and the larvae by Komp and Kumm in 1938 (9). It has been taken in but two places in Colombia; namely, in Villeta, Department of Cundinamarca, and in Zulia; Department of Santander de Norte.

Haemagogus andinus Osorno, n. sp. The name *Haemagogus andinus* was chosen for this species because it has so far been encountered only along the higher slopes of the Eastern Cordillera of the Andes, the type locality, Fusagasugá, being 1,746 meters above sea level. Osorno (7) described this new species from specimens secured in Fusagasugá, Santandercito and Sasaima, Department of Cundinamarca, and Jesús María, Department of Santander.

Haemagogus boshelli Osorno, n. sp. A new species was first found by Boshell and Osorno at Bahía de Solano, and subsequently at Ensenada de Utria and El Valle. All 3 places are on the Pacific coast of the Intendencia of the Chocó. The original description of *H. boshelli* was given by Osorno (7). Morphologically it is more closely related to *H. lucifer* than to any of the other Colombian species.

H. spegazzinii Brèthes, Bol. Inst. Ent. y Pat. Veg., I, p. 39 (1912);

H. janthinomys Dyar, Insec. Inscit. Mens., IX, p. 112 (1921);

H. spegazzinii Shannon and Del Ponte, Rev. Inst. Bact., Buenos Aires, V, p. 67 (1927);

H. janthinomys Edwards, Dipt. fam. Culic., p. 179 (1932);

H. spegazzinii Cerqueira, Mem. Inst. Osw. Cruz., Rio de Janeiro, XXXIX, p. 10 (1943). The first mention of the name *Haemagogus capricornii* in the literature is in a 5-line description in one of the keys of Bourroul's medical graduation thesis (10), which was published in 1904. A year later Lutz set forth in great detail the morphological characteristics of this mosquito, in an article in the *Imprensa Medica* of Brazil. On that occasion the name was spelled "*capricorni*" instead of "*capricornii*." Then in 1912, Brèthes (11) gave the name *H. spegazzinii* to a similar insect, which he thought was a new species. As the reports of Bourroul, Lutz and Brèthes were all based on females alone, it was impossible to decide until recently whether they referred to the same or to different species. To make matters even more complicated, Brèthes gave no type locality, but merely mentioned that the specimens described by him were sent by


ALTITUDE CONTOURS
Elevations of less than 500 meters
Elevations of 500 to 2000 meters
Elevations of more than 2000 meters
DISTRIBUTION IN COLOMBIA OF
HAEMAGOGUS ANASTASIONIS
HAEMAGOGUS ANDINUS
HAEMAGOGUS BOSHELLI
HAEMAGOGUS SPEGAZZINII FALCO
HAEMAGOGUS EQUINUS
HAEMAGOGUS LUCIFER
HAEMAGOGUS SPLENDENS
HAEMAGOGUS CHALCOSPILANS

FIGURE 1.

Dr. Carlos Spegazzini from the Province of Jujuy, Argentina.

In 1921 Dyar (12) decided that certain similar mosquitoes from the island of Trinidad constituted a different species, to which he gave the name *Haemagogus janthinomys*. On that occasion he designated certain figures in the monograph by Howard, Dyar, and Knab (13) as showing the characteristics of the terminalia and larvae of that new species. But in 1938, Shannon, Whitman, and Franca (2) reached the conclusion that the name *H. janthinomys* was a synonym of *H. capricornii* and that, for this reason, the latter name should supersede the former.

Finally Cerqueira (14), after a careful study of extensive material collected in Bolivia in 1942, decided that two species could be distinguished by certain small differences in the males and females secured in that country. To these he applied the names *H. capricornii* and *H. spegazzinii*. But at that time Cerqueira's conclusions were open to doubt, because neither he nor anyone else had seen males or larvae of *H. spegazzinii* from the type region in the Province of Jujuy, Argentina.

The closely related Colombian species, now designated as *H. spegazzinii falco*, which is abundant in the endemic zones of jungle yellow fever, has been referred to in recent publications both as *H. janthinomys* and as *H. capricornii*. We have taken it in the following 37 localities in this country, *Amazonas:*[3] Leticia; *Antioquia:* Casabe; *Bolívar:* Montería; *Boyacá:* Cuincha, Isabí, Muzo, Nunchía, Támara, Ten; *Caldas:* La Dorada, Victoria; *Caquetá:* Florencia; *Cundinamarca:* El Engaño, Malta, Medina, San Pedro de Jagua, Villeta, Volcanes; *Magdalena:* Chimichagua; *Meta:* Acacías, Chichimene, El Horizonte, La Chuchilla, Restrepo, Villavicencio; *Putumayo:* Puerto Asís; *Santander:* Bodega, Guamales, Landázuri, Pescadero, San Vicente de Chucurí, Tamborredondo; *Santander del Norte:* Tibú; *Vaupés:* Miraflores, Mitú, Montfort, Teresita.

Haemagogus chalcospilans Dyar, Insec. Inscit. Mens., IX, p. 110 (1921);

H. chalcospilans Dyar, Mosq. Amer., p. 139 (1928). *H. chalcospilans* occurs abundantly in certain places situated along the Pacific coast of the republics of Panama and Costa Rica, as well as on the Pearl Islands in the Gulf of Panama. In Colombia it has been taken at Turbo, Department of Antioquia, on the Gulf of Urabá. The larvae of that species are frequently found in rot holes in trees growing in extensive coastal mangrove swamps.

Haemagogus equinus Theobald, Entom., XXXVI, p. 282 (1903);

Cacomyia equina Theobald, Mon. Culic., IV, p. 554 (1907);

H. equinus Howard, Dyar, and Knab, Mosq. N. and C. Amer., IV, p. 871 (1917);

H. equinus Dyar, Mosq. Amer., p. 134 (1928);

H. equinus Edwards, Dipt. fam. Culic., p. 179 (1932);

H. equinus Lane, Cat. Mosq. Neotrop. São Paulo, p. 121 (1939). *Haemagogus equinus* was originally described by Theobald (15) from a single female taken near Kingston, Jamaica. Since no males have ever been caught in the type locality, there is some doubt as to whether Theobald's type is identical with the mainland species bearing that name. However, it is interesting to note that Theobald did observe the characteristic pale knee spot on the middle and hind legs. In Colombia we have secured specimens of *H. equinus* in the 11 localities, *Antioquia:*[3] Turbo; *Bolívar:* Mon-

[3] Departments, intendencias or comisarías are printed in italics; localities in Roman type.

tería; *Cundinamarca:* Malta, Utica, Villeta, Volcanes; *Magdalena:* Chimichagua; *Santander:* Bodega, Bucaramanga, Guamales, Tamborredondo.

Haemagogus lucifer Howard, Dyar and Knab, Mosq. N. and C. Amer., II, pl. 23, fig. 164 (1912);

H. lucifer Dyar, Insec. Inscit. Mens., IX, p. 107 (1921);

H. lucifer Dyar, Mosq. Amer., p. 138 (1928);

H. lucifer Edwards, Dipt. fam. Culic., p. 179 (1932);

H. lucifer Lane, Cat. Mosq. Neotrop. São Paulo, p. 119 (1939). This species is abundant in the Canal Zone, and Kumm captured large numbers of larvae at El Llano on the Bayano River, 50 miles east of the city of Panama. In the monograph by Howard, Dyar, and Knab (13), *H. lucifer* was confused with *H. splendens*, but 4 years later Dyar (12) separated them again. In Colombia *H. lucifer* has been obtained in localities in the valleys of the Magdalena and Sinú rivers as follows, *Antioquia:*[3] Casabe, Turbo; *Bolívar:* Montería; *Cundinamarca:* Córdoba, Malta, Volcanes; *Santander:* Bodega, Guamales, Pescadero, Tamborredondo.

Haemagogus splendens Williston, Trans. Ent. Soc. London, 1896, p. 271 (1896);

H. celeste Dyar and Núñez Tovar, Insec. Inscit. Mens., XIV, p. 152 (1926);

H. splendens Dyar, Mosq. Amer., p. 139 (1928);

H. celeste Dyar, Mosq. Amer., p. 141 (1928);

H. splendens Edwards, Dipt. fam. Culic., p. 179 (1932);

H. splendens Lane, Cat. Mosq. Neotrop, São Paulo, p. 120 (1939). The original description of *H. splendens* dates back to 1896 and was based on 8 females from the island of Saint Vincent, B. W. I. No males were secured until 1943, when Komp received several from the type area. These proved to be identical with *H. celeste*, which had been described in 1926 from Maracay, Venezuela, by Dyar and Núñez-Tovar (16). Thus the name *H. celeste* is a synonym of *H. splendens*. In Colombia, specimens of this species have been obtained both east and west of the Eastern Cordillera of the Andes. It is interesting that so far only two species of *Haemagogus* have been found in that huge tract of country that lies east of the Andes. Those two species are *H. spegazzinii falco* and *H. splendens*. The 6 Colombian records for *H. splendens* are as follows, *Arauca:*[3] Arauca, Arauquita, Rondón; *Atlántico:* Barranquilla; *Magdalena:* Chimichagua; *Santander del Norte:* Zulia.

Important differentiating characteristics

There has been considerable confusion during recent years in the literature dealing with *Haemagogus capricornii* and *Haemagogus spegazzinii*, because both Dyar (17) and Edwards (18) included those species among the synonyms of *Haemagogus equinus* Theobald. That error manifestly arose because neither Dyar nor Edwards had ever seen a male specimen of *H. capricornii* or *H. spegazzinii*. Males of *H. equinus* have palpi nearly as long as the proboscis, whereas the palpi in male specimens of *H. capricornii* from Brazil, and among examples of *H. spegazzinii* from Argentina and Colombia, are not more than one-eighth the length of the proboscis. Thus, neither *H. capricornii* Lutz nor *H. spegazzinii* Brèthes could possibly belong to the group or subgenus *Stegoconops*, which Edwards (18) restricted to those *Haemagogus* in which the palpi of the male were about two-thirds the length of the proboscis.

Furthermore, Edwards (18) pointed out that Dyar's separation of the species

into two subgenera on a basis of the presence or absence of toothed claws in the females was not valid. The females of at least 3 of the 10 species included by Dyar (18) in what he called the subgenus "*Haemagogus*" have toothed claws. Komp (19) also called attention to those discrepancies.

Among the 8 species that we have found to date in Colombia, there is only one with long palpi in the male, namely *Haemagogus equinus*. Similarly in Brazil, Cerqueira and Antunes (20) reported that but a single species among those known from that country had long male palpi. They gave to that species the name *Haemagogus tropicalis*.

The other 7 Colombian species fall conveniently into two major groups as shown below.

Group 2. Male antennae heavily plumose. Ninth tergite of male with setae arising from well-developed lobes. Postnotal setae absent. Tarsal claws of females toothed. Second marginal cell on wing shorter than its petiole. Comb scales of larva in a line.

Haemagogus anastasionis
Haemagogus andinus
Haemagogus spegazzinii falco.

Group 3. Male antennae sparsely plumose. Ninth tergite of male without setae and with atrophied lobes. Postnotal setae present. Tarsal claws of females simple. Second marginal cell on wing longer than its petiole. Comb scales of larva in a patch.

Haemagogus boshelli
Haemagogus chalcospilans
Haemagogus lucifer
Haemagogus splendens.

The relationship of the length of the petiole of the second vein to the length of the second marginal cell is an important character for differentiating the adults of the *Haemagogus* species known from Colombia. By the length of the petiole we mean the distance from that point on the second vein from which the third vein arises, to the fork of the second vein. The length of the second marginal cell is computed from the fork in the second vein to the wing margin. Careful measurements were made of the relative lengths of the petioles of the second vein and of the second marginal cells on 338 wings of *H. spegazzinii falco*, 39 wings of *H. equinus*, and 18 wings of *H. lucifer*. If the length of the petiole is considered as one, then the average proportionate length of the second marginal cell in the 3 species mentioned above is as follows:

Haemagogus spegazzinii falco	0.83
Haemagogus equinus	0.87
Haemagogus lucifer	1.68

This study showed that in *H. spegazzinii falco* and *H. equinus*, the petiole was longer than the second marginal cell, whereas in *H. lucifer* just the reverse was true.

The principal morphological characters found to be of value in differentiating adult males and females of the Colombian species of *Haemagogus* are brought out in table 2 and some of them are illustrated in plate II.

On the basis of the characters noted in table 2, it was possible to construct a key to separate most of the 8 species in their adult stages. We were unable, however, to find any reliable character for differentiating adult female *H. boshelli* from female *H. chalcospilans*. And it should be mentioned also with regard to *H. splendens* that we did encounter a few specimens of that species from the Comisaría of Arauca, which did not have dorsal white bands on all of the abdominal segments. Such specimens were indistinguishable from *H. lucifer*. While the golden yellow color of the coxae, trochanters, and underside of the femora is a good differentiating character

TABLE 2

Morphological characters useful for differentiating the adults of the 8 species of Haemagogus *known from Colombia*

Species of *Haemagogus*	Male antennae heavily plumose	Tarsal claws toothed in females	One or more large sterno-pleural setae present	Peticle of second vein longer than second marginal cell	Postnotal setae present	Scales on prothoracic lobes blue and white	Silvery white scales on tips of femora of middle and hind legs of females
H. anastasionis Dyar	x	x		x		x	
H. andinus Osorno	x	x	x	x			x
H. boshelli Osorno					x		
H. spegazzinii falco n. subsp.	x	x	x	x		x	
H. chalcospilans Dyar					x		
H. equinus Theobald	x	x	x	x		x	x
H. lucifer Howard, Dyar and Knab					x		
H. splendens Williston					x		

in *H. chalcospilans*, it is less reliable in *H. boshelli*. In summary, it should be pointed out that the following key is reasonably satisfactory except in the last two dichotomies.

terminalia have been summarized in table 3. Plate 3 was drawn from a preparation of the terminalia of a male *H. spegazzinii falco*, in which one side piece with its clasper and claspette had

Key to the Haemagogus *of Colombia: male and female adults*

1. Male antennae heavily plumose (plate II, figure 2); tarsal claws of females toothed on fore and middle legs (plate II, figure 6); postnotal setae absent; petiole of second vein longer than second marginal cell (plate II, figure 4).. 2
   Male antennae sparsely plumose (plate II, figure 1); tarsal claws of females simple (plate II, figure 5); postnotal setae present; petiole of second vein shorter than second marginal cell (plate II, figure 3)..... 5
2. One or more large sternopleural setae present..... 3
   Sternopleural setae absent..... *H. anastasionis*
3. Tips of mid and hind femora of females with white scales..... 4
   Tips of mid and hind femora of females not white-scaled..... *H. spegazzinii falco*
4. Male with long palpi; prothoracic lobes with white scales; dorsal abdominal scales dark blue in color..... *H. equinus*
   Male with short palpi; prothoracic lobes without white scales; dorsal abdominal scales light greenish blue in color..... *H. andinus*
5. Basal silvery-white bands on dorsum of all abdominal segments..... *H. splendens*
   Basal silvery-white bands on dorsum of last 3 or 4 abdominal segments only.. 6
6. Coxae, trochanters, and underside of femora golden yellow in color..... *H. boshelli*
   H. chalcospilans
   Coxae, trochanters, and underside of femora not golden yellow in color..... *H. lucifer*

The only really certain way of separating, one from another, all of the species of *Haemagogus* known from Colombia is by the male terminalia. The most valuable differential characters in the

been removed, while all the other organs were left in situ. This diagram shows beautifully the normal relationship of the various anatomical structures to each other, and it also brings out clearly the

TABLE 3

Morphological characters useful for separating the male terminalia of the 8 species of Haemagogus *known from Colombia*

Species of *Haemagogus*	Clasper cylindrical not broadened and flattened	Spine on clasper cylindrical not spatulate	Eighth tergite with broad fusiform scales instead of setae	Side piece with apical tuft of setae	Side piece with apical, middle and basal tufts of setae	Mesosome with spicules on the membranous part of the ventral surface	Ninth tergite with one or more setae present
H. anastasionis Dyar	x	x					x
H. andinus Osorno	x	x	x				x
H. boshelli Osorno				x	x		
H. spegazzinii falco n. subsp.	x	x	x			x	x
H. chalcospilans Dyar	x	x		x			
H. equinus Theobald	x	x	x				x
H. lucifer Howard, Dyar and Knab				x			
H. splendens Williston	x	x					

prominent beaklike terminal process on the mesosome, and how that process curves dorsally. It is also easy to see the group of spines on the ventral surface of the mesosome, which is a constant character among all the Colombian specimens of *H. spegazzinii falco* we have seen.

A key to the male terminalia has been drawn up from the principal differentiating characteristics shown in table 3. The morphology of the claspettes proved to be such a valuable feature for separating the 8 Colombian species from one another, that a special plate (plate IV) to emphasize those differences was prepared. The shape of the individual claspettes can be illustrated diagrammatically without difficulty, but it is exceedingly hard to describe them in words.

In the paper by Cerqueira (14) there are some beautiful drawings of the male terminalia of what he considered at that time to be specimens of *H. capricornii* and *H. spegazzinii*. The specimens of Cerqueira's supposed *H. spegazzinii* came from Bolivia, and the specimens of his *H. capricornii* from Afonso Arinos in the State of Rio de Janeiro, Brazil. In order to find out whether *H. spegazzinii* from the type region in Argentina was identical with Cerqueira's material from Bolivia, Boshell visited Ledesma in the Province of Jujuy in March, 1944. He secured numerous females in the forest near Ledesma, and reared males from eggs deposited by them.

The mesosomes of Boshell's Argentinian males are exactly like Cerqueira's drawings of material from Santa Cruz, Bolivia. In January, 1944, Boshell also obtained large numbers of female *Haemagogus* in the forest at Ribeirão da Fortuna, near Ilhéus in the State of Baía, Brazil. Males reared from eggs laid by these females from Ilhéus had mesosomes similar to Boshell's specimens from Ledesma (Argentina) and to Cerqueira's material from Santa Cruz (Bolivia). Figure 2 in plate V shows the appearance of the lateral aspect of a mesosome of one of Boshell's males from Ribeirão da Fortuna near Ilhéus. This figure should be compared with figure 13 in Cerqueira's paper (14).

some of Colombian specimens and their complete absence from Brazilian *H. capricornii*.

The Colombian species is morphologically much closer to *H. spegazzinii* than it is to *H. capricornii*, though differences do exist in the lateral aspects of the mesosomes. However, it is doubtful whether those characters are of sufficient importance to justify the creation of a new species. We suggest instead that the Colombian variety should be regarded merely as a subspecies of *H. spegazzinii*, which can be separated from the latter by an examination of the mesosome, when that organ is viewed from the side. In *H. spegazzinii* Brèthes from Argentina, Brazil, Bolivia, and Trinidad (B. W. I.), there is a short apical point on the mesosome, whereas the Colombian form, *H. spegazzinii* subspecies *falco*, has a mesosome with a long beak that is recurved dorsally (plate V, figures 1 and 2). We suggest that the type locality for *H. spegazzinii* subspecies *falco* should be the forest known as Volcanes in the valley of the Pitas River, municipality of Caparrapí, Department of Cundinamarca, Colombia. Specimens from this area have been deposited in the United States National Museum.

The name *H. janthinomys* becomes a synonym of *H. spegazzinii*, as material obtained from the type area of *spegazzinii*, near Ledesma, Argentina, is the same as that from the island of Trinidad, B. W. I., the type locality of *janthinomys*.

TABLE 4

Larval characters of 525 H. spegazzinii falco *from Amazonas, Boyacá, Caldas, Caquetá, Cundinamarca, Meta, Santander, and Vaupés, Republic of Colombia*

Morphological characters	Names of departments, intendencias or comisarías and number of specimens examined from each*							
	Amazonas	Boyacá	Caldas	Caquetá	Cundinamarca	Meta	Santander	Vaupés
	9	22	23	97	304	37	17	16
Upper posterior pair of dorsal head hairs	1	1	1 (1–2)	1	1 (1–2)	1	1	1
Lower anterior pair of dorsal head hairs	1	1	1	1	1	1	1	1
Number of hairs in ante-antennal hair tuft	3 (2–4)	3 (2–4)	2 (2–3)	3 (1–4)	2 (1–4)	3 (1–4)	2 (1–3)	3 (2–3)
Number of scales in comb	8 (6–10)	8 (6–10)	7 (4–10)	7 (3–10)	8 (3–12)	7 (4–10)	7 (4–8)	7 (5–8)
Number of free comb scales	0 (0–1)	1 (0–4)	0 (0–2)	1 (0–4)	1 (0–4)	0 (0–2)	2 (0–8)	1 (0–4)
Number of scales in pecten	11 (8–14)	10 (6–15)	11 (8–15)	10 (4–14)	11 (4–16)	11 (5–16)	9 (6–13)	9 (6–14)
Number of hairs in pecten tuft	2 (1–3)	2 (1–2)	2	2 (1–3)	2 (1–3)	2	2 (1–2)	2
Number of hairs in lateral tuft on anal segment	4 (2–5)	2 (2–3)	2 (1–2)	2 (1–4)	2 (1–3)	2 (2–3)	2 (1–2)	2

* The extremes in the number of elements observed in the specimens from each area examined are shown in parentheses; thus "(6–10)" indicates that the minimum was 6 and the maximum 10. The single number above the parentheses was the calculated average number.

A photomicrograph of the terminalia of the type of *janthinomys* is given in plate III, figure 18, of Cerqueira's paper (14).

It has been shown repeatedly that *H. spegazzinii falco* is a natural transmitter of jungle yellow fever in Colombia, and Cerqueira and Lane (21) concluded recently that both *H. capricornii* and *H. spegazzinii* are vectors in Brazil.

Because of the possibility that there might be more than one variety of *H. spegazzinii* in Colombia, we secured specimens from all over the country. So far the mesosomes from these different areas have all been alike. In addition, larvae were studied from 4 departments, two intendencias and two comisarías. The data presented in table 4 indicate that the larvae of *H. spegazzinii falco* from different parts of Colombia are very similar. Indeed the only larvae that showed any significant deviation from the remainder came from Amazonas. Larvae from Leticia on the Amazon River usually have about 4 hairs in the lateral tuft on the anal segment, whereas that tuft generally consists of two hairs only, among larvae from other parts of this Republic. But with the single exception of this slight difference in the lateral tuft on the anal segment, larvae from the Amazon are just like *H. spegazzinii falco* larvae from the rest of Colombia.

Plenty of larvae and larval skins of 7 of the 8 species known from this country were examined, and their more important differential characters have been summarized in table 5. Unfortunately, *H. chalcospilans* was secured too late in this study for us to be able to obtain an adequate number of associated larval skins of that species, in order to include it in the table or the following key.

TABLE 5

Larval characters of the Haemagogus *of Colombia* *

Morphological characters	*H. anastasionis*	*H. andinus*	*H. boshelli*	*H. spegazzinii falco*	*H. equinus*	*H. lucifer*	*H. splendens*
Number of larvae examined	44	38	72	525	64	34	26
Upper posterior pair of dorsal head hairs	1	2 (1–3)	1 (1–2)	1 (1–2)	1	1	1
Lower anterior pair of dorsal head hairs	1 (1–2)	1 (1–2)	2 (1–2)	1	1	2	2 (1–2)
Number of hairs in ante-antennal hair tuft	3 (2–4)	8 (4–10)	5 (3–7)	3 (1–4)	3 (2–4)	5 (4–7)	3 (2–5)
Number of scales in comb	8 (4–10)	10 (8–14)	34 (24–56)	7 (3–12)	8 (3–12)	24 (15–36)	18 (12–25)
Number of scales in pecten	15 (8–21)	17 (8–25)	14 (10–19)	10 (4–16)	12 (6–20)	13 (9–19)	16 (8–23)
Number of hairs in pecten tuft	3 (2–4)	3 (2–5)	4 (2–7)	2 (1–3)	2 (1–3)	3 (2–4)	3 (2–4)
Number of hairs in lateral tuft on anal segment	5 (3–8)	5 (2–8)	2 (1–2)	2 (1–5)	2 (1–3)	3 (1–8)	2 (1–2)
Length of siphon compared to its width	2:1	3:1	2:1	1.5:1	2:1	1.5:1	1.5:1

* See footnote to table 4.

Key to the Haemagogus *of Colombia: larvae*

1. Skin of larvae villose; comb scales arising from a chitinous plaque (plate VI, figures 1 and 3) ..... *H. spegazzinii falco*
   Skin of larvae glabrous; comb scales free and not arising from a chitinous plaque 2
2. From 3 to 14 comb scales arranged in a single row (plate VI, figure 4); lower (anterior) pair of dorsal head hairs single 3
   From 12 to 56 comb scales disposed in a patch or in several rows (plate VI, figure 2); lower (anterior) pair of dorsal head hairs usually double 5
3. Siphon 3 times as long as wide; ante-antennal hair tuft of 4 to 10 hairs, usually 8; upper (posterior) pair of dorsal head hairs frequently double.... *H. andinus*
   Siphon twice as long as wide; ante-antennal hair tuft of 2 to 4 hairs, usually 3; upper (posterior) dorsal head hairs always single 4
4. Number of hairs in lateral tuft on anal segment varying from 1 to 3 with an average of 2 ..... *H. equinus*
   Number of hairs in lateral tuft on anal segment varying from 3 to 8 with an average of 5 ..... *H. anastasionis*
5. Anal gills shorter than chitinous plate on anal segment; posterior edge of anal plate rugose with only a few minute spines ..... *H. boshelli*
   Anal gills longer than chitinous plate on anal segment; a number of prominent spines along the posterior edge of the anal plate 6
6. Number of hairs in ante-antennal tuft varying from 4 to 7 with an average of 5 *H. lucifer*
   Number of hairs in ante-antennal tuft varying from 2 to 5 with an average of 3 *H. splendens*

Summary

1. Eight species of *Haemagogus* were found in Colombia, 7 of them in the lowlands and one in the highlands.

2. The commonest and most widely distributed species was *Haemagogus spegazzinii falco*.

3. In South America there appear to be several species and subspecies of *Haemagogus* with hairy larvae, the males of which can be distinguished one from another by the morphology of the mesosome in its lateral aspect.

4. The name *Haemagogus spegazzinii* subspecies *falco* is proposed for the Colombian form, which has been incriminated repeatedly as a vector of jungle yellow fever.

5. Keys and diagrams are given for separating the larvae, adults and male terminalia of the *Haemagogus* of Colombia.

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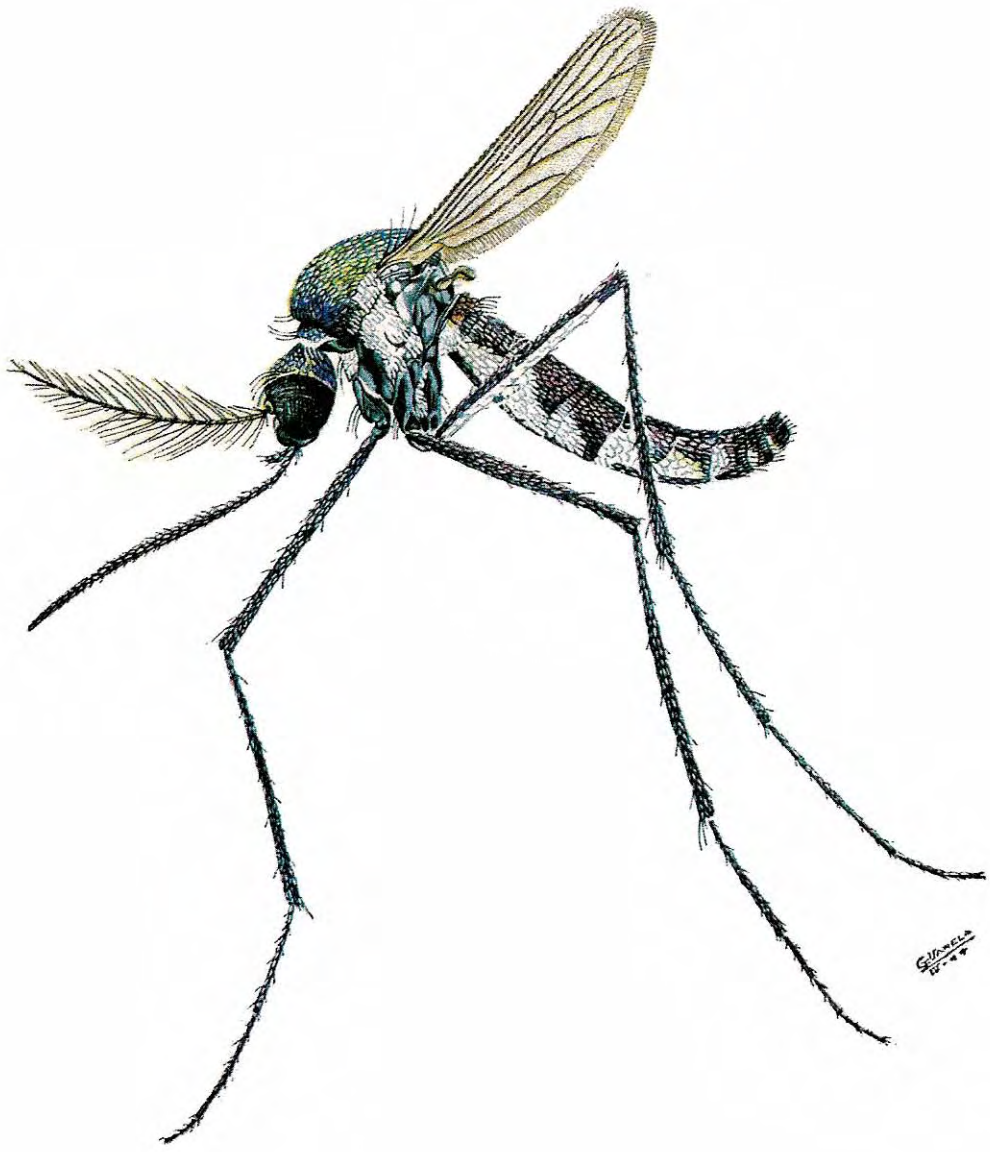
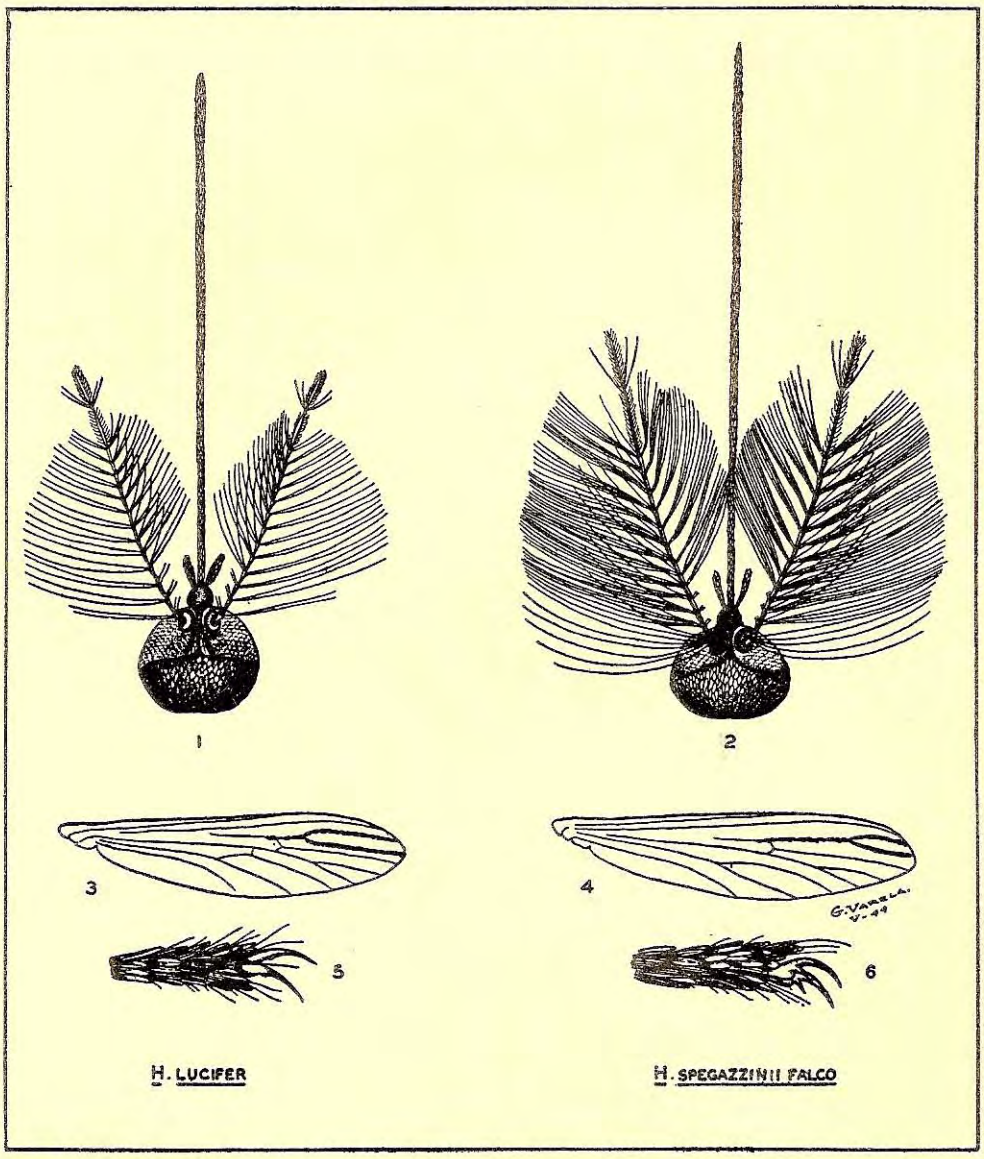


PLATE II

ADULT CHARACTERS



LATERAL VIEW OF TERMINALIA OF *HAEMAGOGUS SPEGAZZINII FALCO*

PLATE III

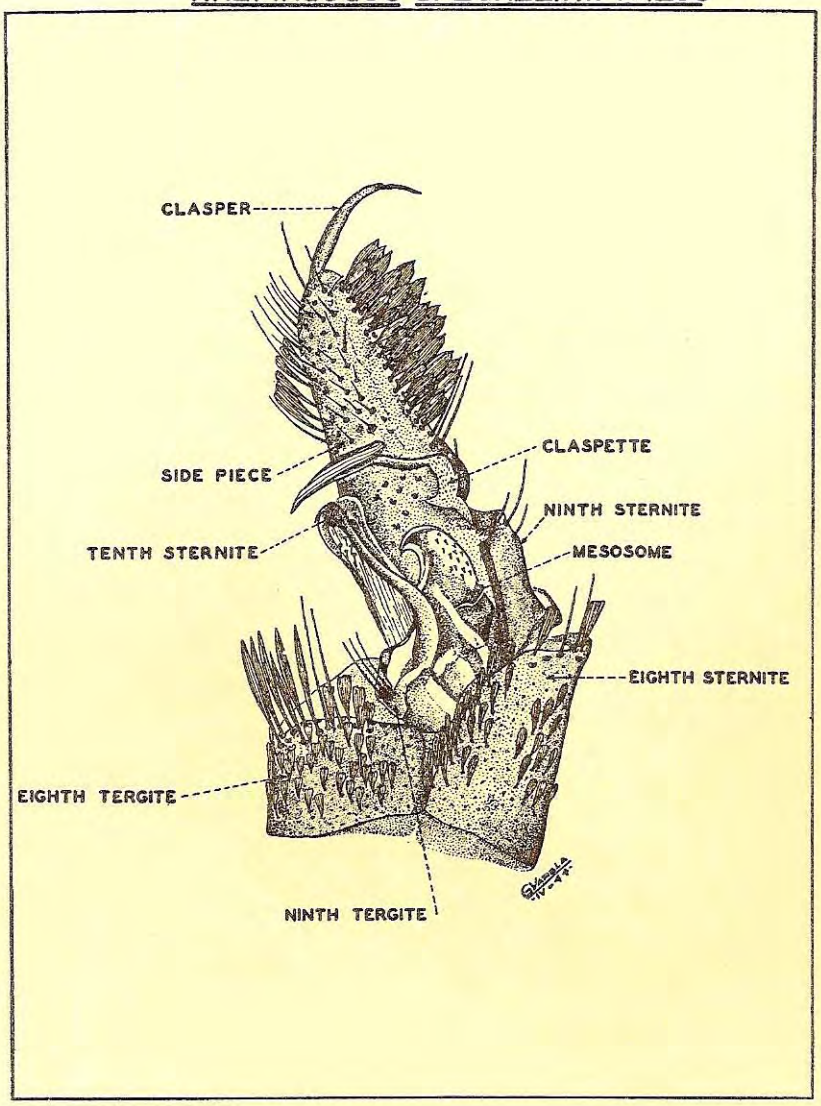


PLATE IV

CLASPETTES OF COLOMBIAN SPECIES OF *HAEMAGOGUS*

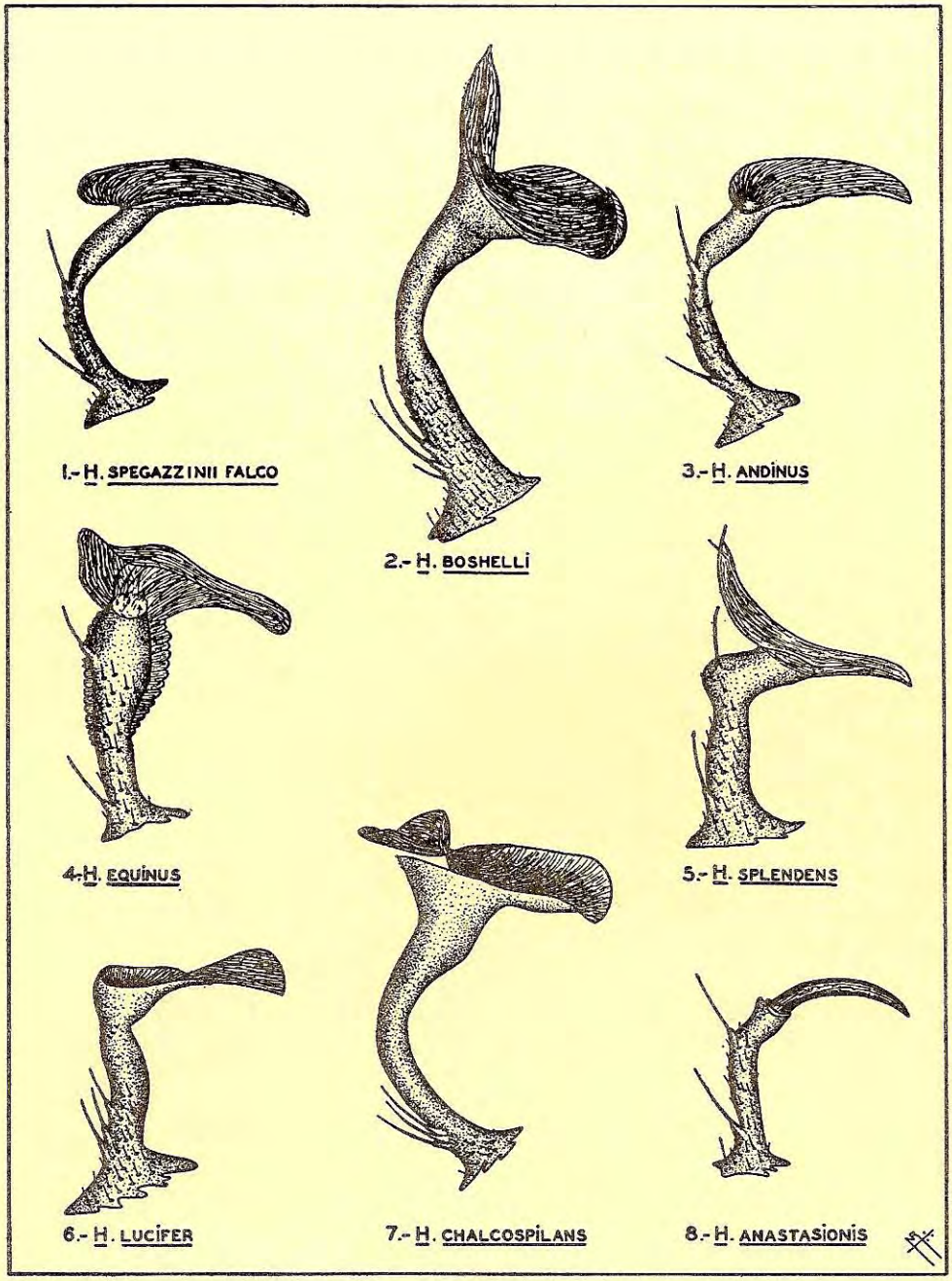


PLATE V

MESOSOMES OF REPRESENTATIVE *HAEMAGOGUS* SEEN FROM THE SIDE.

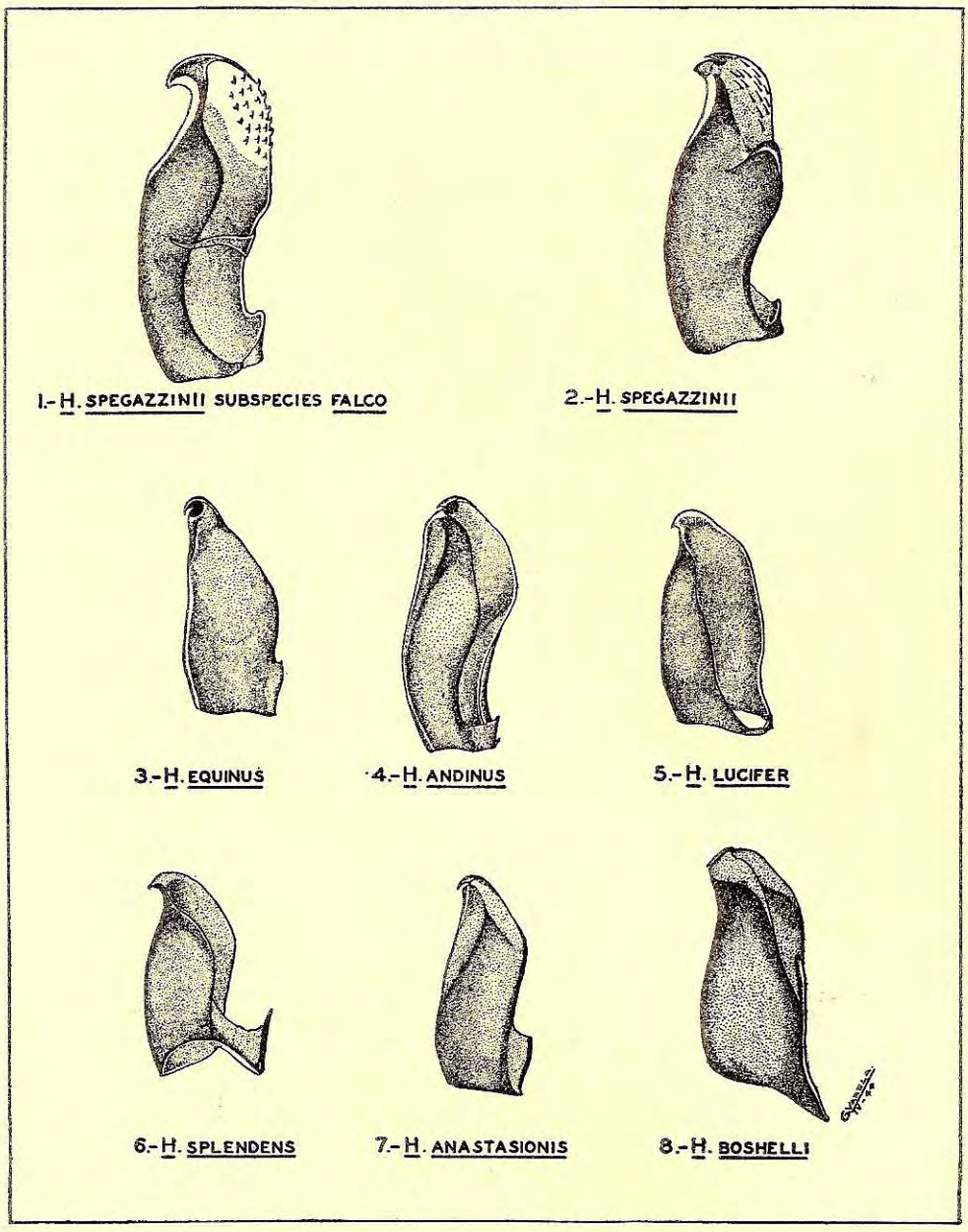
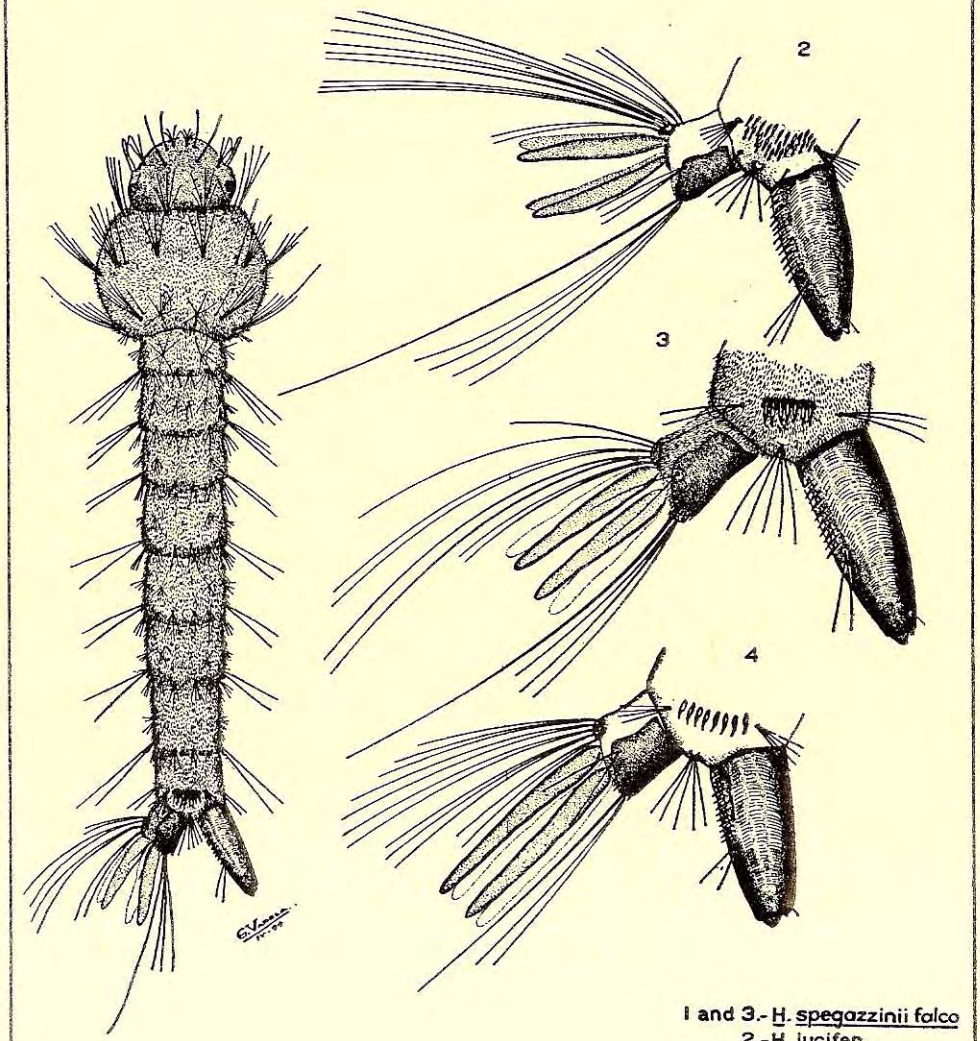


PLATE VI

LARVAL CHARACTERS



1 and 3.- H. spegazzinii falco
2.- H. lucifer
4.- H. equinus

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