site was present in small numbers, but it was not until May 25 that evidence was found of the advent of a new generation of the parasite. On this date several swollen bodies of lice were found and from two of these the parasites had already emerged. May 27 I was able to collect a considerable number of pupating parasites, and by the thirtieth, the dead, swollen bodies of the parasitized lice were very abundant on the leaves, stems and heads of both rye and oats. It was also noticeable that many of the large living aphides were of a very much darker color than normal and upon dissection these were invariably found to contain the nearly full grown larva of the parasite. It was also noted that these dark colored individuals were rarely surrounded with colonies of newly born aphides, as was the case with normal specimens, thus showing that reproduction had been stopped some time before the death of the louse, a fact having considerable bearing on the efficiency of the parasite, as previously pointed out by Professor Webster in his account of the *Lysiphlebus* parasite of *Toxoptera graminum*.

An attempt to determine the length of the life cycle of the parasite was unsuccessful, owing to the fact that it was carried out in an ordinary glass-covered insectary, the temperature of which proved to be too high for their development. Observations, however, warrant the belief that the normal development in June covers a period of from fourteen to sixteen days. The period from the death of the host until emergence of the parasite is usually about five days.

The parasites continued to increase in abundance until the grain was cut, by which time the majority of the aphides in the fields were parasitized. There can be but little doubt that had it not been for the presence of this parasite, the damage to the grain on the Experiment Station farm would have been severe in both seasons. As it was, little damage was done.

NOTES ON THE LIFE HISTORY OF THE TICK PARASITE *Hunterellus hookeri* Howard[1]

By H. P. Wood, *Bureau of Entomology*

Introduction

Only two hymenopterous parasites of the Ixodoidea or ticks have ever been discovered. About one of these (*Ixodiphagus texanus* How.) almost nothing is known. The other, belonging to the same tribe of encyrtine chalcidids, *Hunterellus hookeri* Howard, is of peculiar

[1] Published by permission of the Chief of the Bureau of Entomology.

interest. Though there are as yet some details lacking to a complete knowledge of the life history of this insect, we know its history in general. We submit this knowledge in the hope that we may soon be able to supply the remainder.

Hunterellus hookeri was first collected by the writer in the nymphs of *Rhipicephalus sanguineus* Latreille (=*texanus* Banks) on April 20, 1908 at Corpus Christi, Texas. Doctor L. O. Howard described the species in the *Canadian Entomologist* for July 1908 p. 239–241. Search made in 1909 by C. W. Howard in Portuguese East Africa resulted in his finding this same species attacking *Rhipicephalus sanguineus* nymphs at Lourenco Marques. On June 18, 1910, two nymphs of *Dermacentor parumapertus marginatus* were received at the Dallas laboratory which were taken on a jackrabbit (or a dog?) by Mr. McLure Lewis, a correspondent at Green Valley, California. When the nymphs were received at Dallas, one of them was found to be parasitized. The nymphs were placed on sand and on July 1st, thirteen parasites emerged from one of them. The other nymph molted to a male *Dermacentor parumapertus marginatus*. The nymph from which the parasites emerged was determined by Mr. N. Banks as the same species. The parasites were determined by Doctor Howard as *Hunterellus hookeri*.

Two hosts are known, *Rhipicephalus sanguineus* and *Dermacentor parumapertus marginatus*. A brief outline of the life history of these ticks is essential to an understanding of the life history of the parasite.

The two species may be grouped together for the purpose, as their life histories are nearly the same. The eggs, which are deposited on the ground, hatch and the larvæ come forth ready for a host. Upon finding a host the young ticks feed until replete with blood. They then drop to the ground, seek a crack or crevice for protection and there undergo the transformation to the nymphal stage. The nymph engorges to repletion, after which it drops to the ground to molt. While the nymph is engorging or after it has become engorged, parasitism takes place. Both male and female adults, like the other two stages, wait on grass for the appearance of a host. A host found, the adult ticks feed and mate.

It was first supposed that the insect was confined to a limited territory, but late collections indicate a wide range. To date, the species has been taken at Corpus Christi and Brownsville, Texas, also Green Valley, California in the United States, and from Monterey, Mexico[2] and from Lourenco Marques, Portuguese East Africa.

[2] November 25, 1909, Mr. F. C. Bishopp and Mr. E. A. Schwarz collected nymphs of *R. sanguineus* from dogs. Some of these were parasitized, but the parasites never matured and the determination is based on immature specimens.

Life History and Habits

In describing the life history of the parasite, we shall start with adults emerging from a small round opening at the posterior end of the nymph. (See Pl. 17, Fig. 5). The insects often encounter considerable difficulty in getting out through the small passage way. Should the nymph become somewhat dry, it occasionally happens that the parasites are unable to emerge. As soon as the male has extricated itself, it immediately seeks a female. Once free, the female awaits the male, meanwhile preening her antennae and wings with her forelegs. The male rapidly fertilizes the females, the sexual act requiring but a few seconds. As soon as she is fertilized the female starts off hastily in search of her victim. To the tick larva the parasite pays no attention, but attempted oviposition has been observed in both a male and unengorged female of *R. sanguineus*. All that the parasite requires is a nymph at least partially engorged. In nature both nymphs on the ground or on the host seem to be attacked. On the host animal the tick parasite is perfectly at home crawling through the hair as naturally as a flea. A nymph which has become quiescent before molting seems to be in no danger from the parasite. It appears to delight in motion on the part of its victim. When crawling about on the tick host, the parasite makes little use of its wings, but when free the insect moves about in short flights. Often the parasite will insert its ovipositor immediately after reaching the nymph, but sometimes it takes a few seconds of examination and at other times longer. After inserting its ovipositor, which remains inserted from about two to twenty seconds, the parasite usually leaves its host and seeks another victim. It may, however, wait and insert its ovipositor again, but never has been observed to oviposit more than twice in the same tick. Although feeding is not necessary before oviposition, this parasite has been seen to imbibe sweetened water when offered the chance.

In from eight to fifteen days in October the characteristic striped appearance (See Pl. 17, Fig. 12) of the parasitized nymph becomes evident. In about forty-four days during October and November, the parasites emerged as adults. The parasitic period within the nymphs is very nearly the same as the molting period of the nymphs.

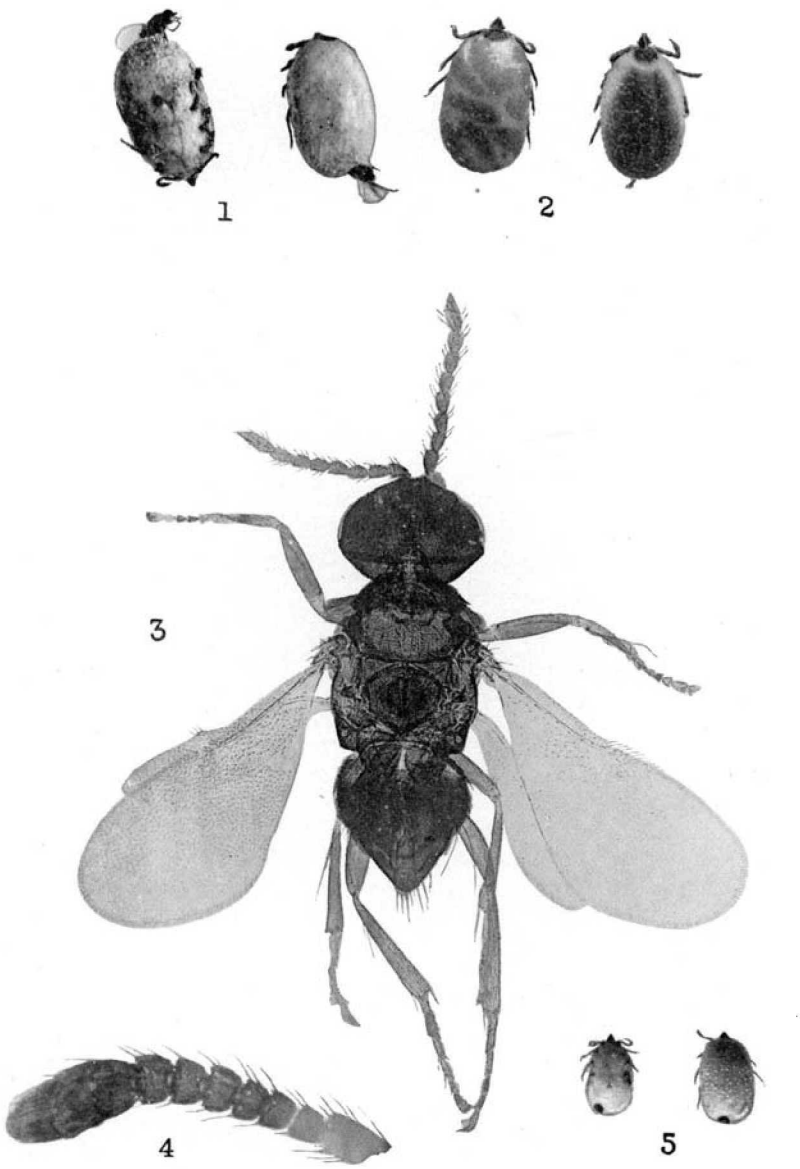
A study of the accompanying table (No. 1) will give some idea as to the number of parasites per tick, the proportion of sexes[3] and the time spent by the parasite within the nymph.

[3] The sexes are easily distinguished by the difference in the antennae. The segments of the antennae of the female are broader than long with the end segment club shape, while in the male the segments are longer than broad, the end segment being the same width as the others. Compare Pl. 17, Figs. 3 and 4.

RECORD OF PARASITES (*HUNTERELLUS HOOKERI*) REARED FROM *RHIPICEPHALUS SANGUINEUS*

Host collected	No. Nymphs	Days to emerge	Parasites emerged				Host collected	No. Nymphs	Days to emerge	Parasites emerged			
			♂	♀	?	Total				♂	♀	?	Total
1908							1908						
Apr. 20	1	32				10	May 28–29	1	24 or 25	2	4		6
" "	1	32				17	" "	1	24 or 25	2	8	2	12
" "	1	33				6	" "	1	24 or 25	1	7	2	10
" "	1	33	5	6		11	" "	1	24 or 25			4	4
" "	1	33				6	" "	1	24 or 25			5	5
May 28–29	1	22 or 23	1	5		6	" "	2	24 or 25	2	2	1	5
" "	1	22 or 23	1	4		5	" "	1	25 or 26	0	3		3
" "	1		1	3		4	" "	1	25 or 26	3	3	2	8
" "	1	22 or 23	1	8		9	" "	1	25 or 26	1	6		7
" "	1	23 or 24	1	4		5	" "	1	25 or 26	1	6		7
" "	1	23 or 24	0	6		6	" "	1	25 or 26	2	6		8
" "	1	23 or 24	1	4		5	" "	1	25 or 26	4	6	1	11
" "	3 (*a*)	20 or 24	3	10		13	" "	2	25 or 26	0	5		5
" "	3 (*b*)	21 or 24	2	8		10	" "	1	25 or 26	1	3		4
" "	3 (*c*)	22 or 23	3	10		13	Oct. 16, 1908	1	30				6
" "	1	24 or 25	1	5		6	" "	1	31				8
" "	1	24 or 25	0	3	1	4	" "	1	51				8
" "	1	24 or 25	2	4		6	Nov. 6, 1908		66				3
" "	1	24 or 25	2	2		4	" "		67				8
" "	1	24 or 25	0	4		4	Sept. 9–10, 1909	1	29 or 30				5
" "	1	24 or 25	2	6		8	" "	1	32 or 33				6
" "	1	24 or 25	3	6		9	" "	1	32 or 33				4
" "	1	24 or 25	4	6		10	" "	1	32 or 33				3
" "	1	24 or 25	2	3	1	6	" "	1	32 or 33				4
" "	1	24 or 25	2	11		13	" "	1	32 or 33				3
" "	1	24 or 25	2	11		13	" "	1	32 or 33				3
" "	1	24 or 25	1	5	1	7	" "	1	33 or 34				4
" "	1	24 or 25	3	3		6	Nov. 25, 1909	1	Removed				5
" "	1	24 or 25	1	5		6	" "	1					3
							June 11, 1910	1	20				13

(*a*) = 6 from one nymph.
(*b*) = 7 from one nymph.
(*c*) = 5 from one nymph.



Hunterellus hookeri Howard:—Fig. 1, Parasites emerging from nymphs of *Rhipicephalus sanguineus* Latr. x 6.3; Fig. 2, Nymphs of *R. sanguineus* showing characteristic appearance following parasitism, x 6.3; Fig. 3, *Hunterellus hookeri*, male, x 54; Fig. 4, antennæ of female of same, x 1450; Fig. 5, emergence orifices in nymphal ticks, x 3.6.

The percentage of parasitism varies considerably in the same locality. We have been able to secure at times an abundance of parasitized ticks at Corpus Christi, Texas, while at others, though it may have been very near the same season of the year, either no nymphs were found or the nymphs found were not parasitized.

The records in the table show the production of about one male to three females. As may be seen the proportion of males to females in a single nymph varies considerably, although it usually happens that there is an excess of females and in no case has the proportion of males exceeded that of females. The maximum number of parasites per tick was seventeen, the minimum three and the average eight. It took from twenty to sixty-seven, with an average of thirty-two days from the date of collection for the adults to emerge.

Description of Parasitized Nymph

For several days after being parasitized the nymph appears normal. The first indication of parasitism is swelling, soon followed by an irregular striped appearance (See Pl. 17, Fig. 2) caused by the larvæ of the parasite as seen through the nymphs' skin. This appearance gradually passes away as the body fluids are taken up by the parasite. Just before emergence, the front end of the body is black and the posterior part yellowish translucent. This is more pronounced in some cases than in others.

Artificial Parasitism

Early attempts to breed the parasites proved failures. Mr. W. A. Hooker's trials gave negative results, as did also the author's early tests. This was probably due to the extreme heat when the attempts were made. Our efforts finally proved successful and it was found very easy to breed the parasite, using *Rhipicephalus sanguineus* as a host. It si quite likely another generation might have been bred but for cold setting in.

Considerable difficulty was anticipated in breeding the parasite owing to its minuteness. The head and body length measures only about one millimeter. A large box was prepared in which the breeding was to be done. In actual practice, however, this box was found to be of no value. When the tick was attached to its host, it was necessary simply to allow a female parasite its freedom on the host. It would search out the nymphs. When the nymph was free, it was only necessary to put a glass over the parasite and nymph to prevent their escape.

The table below shows the results obtained in the breeding experiments:

TABLE II. RECORD OF RESULTS OF BREEDING OF *H. HOOKERI*

Parasitized	No. Nymphs	Date Emerged	Parasites emerged				Days to Emerge	Temperature (F.)		
			♂	♀	?	Total		Max.	Min.	Mean.
Oct. 12, 1909.....	1	Nov. 26	1		8	9	43	94	41	72.05
Oct. 13, 1909.....	1	Nov. 26	1		9	10	44	94	41	69.03
Oct. 14, 1909.....	1	Nov. 27				8	44	94	41	*

Besides those that emerged successfully there were five other nymphs that were parasitized at the same time, but which failed to produce adult parasites. When the nymphs were opened, one produced ten; one, thirteen; one, eight; and one, eleven adults; and the fifth nymph was found to contain four immature stages. An attempt was made to carry these parasites another generation, but without results, the failure due possibly to the lateness of the season. One tick which produced thirteen parasites appeared to be parasitized only about three times; in no case as many as thirteen times. This might suggest that the parasite deposited several eggs each time she inserted her ovipositor, or possibly some form of polyembryony.

Economic Importance

Several attempts have been made to cause the parasite to develop on hosts other than those on which it was collected, but thus far without positive results. It seems, however, since the parasite naturally breeds on at least two widely separated genera that further experiments should prove successful. It is true that the abundance of *Rhipicephalus sanguineus* varies greatly where the parasite is found but how much of this variation is due to the parasite cannot be determined without further study. In any case, *R. sanguineus* has always been found in sufficient numbers in south Texas to prove that the tick is able to thrive in spite of the parasite. The effect can be one of only partial control.

On November 14, 1908 a shipment of 200 nymphs, divided into two lots, one in a wooden box containing tissue paper, the other in a mailing tube containing green sawdust, were sent to Prof. C. P. Lounsbury at Cape Town, South Africa. Parasites emerged from each lot, but attempts to cause attack of the South African ticks were failures. Other lots of nymphs were collected in south Texas and shipped to Mr. C. W. Howard at Lourenco Marques, Portuguese East Africa and to Prof. P. Silvestri, Portici, Italy. In neither case were the parasites successfully reared.

* In refrigerator one day before emergence.

I wish to acknowledge the assistance in the work upon which this paper is based of Dr. L. O. Howard and Messrs. F. C. Bishopp and W. A. Hooker.

A NOTE ON XYLOCRABRO STIRPICOLA PACK

By A. B. Gahan

While records of the nesting habits of Crabronidæ are not wanting in entomological literature, the following observations are believed to be of sufficient interest for publication.

Early in March of the present year (1911) the Entomological Department of the Maryland Experiment Station received from a correspondent in Hagerstown a lot of twigs of *Catalpa bungei*, accompanied by a letter stating that a young tree was being badly injured by some insect boring in the twigs. Examination of the twigs revealed the fact that they were being utilized by some species of Crabronid as a nesting place. In some cases the stems had been hollowed out to a depth of twelve to fifteen inches, and had, of course, been killed for that distance. Some twigs contained as many as twenty-five or thirty of the larvae, each in its separate cell.

The larvæ at time of receipt were plump, pure white grubs with the abdominal spiracles quite prominent. Each was enveloped in a thin, pale, brownish cocoon. They were evidently just beginning to pupate, as the constriction between the abdomen and thorax was already appearing.

The cells containing the larvæ were separated by chewed up bits of the pith, and in the end of each cell was a mass of fragmentary remains of the insects which had served as the larval food. Examination of these fragments indicated that the principal part of the food had consisted of a small metallic blue-green Dipteron of the family Stratiomyidae. In some instances the remains of a grayish species, apparently of the same family, were found.

Adults were obtained from the twigs on May 8, 1911, and proved to be *Xylocrabro stirpicola* Packard. Professor Riley has recorded the finding of nests of this species in Osage Orange, and there are other records of its having been found in raspberry. The probable explanation for its choice of this catalpa as a nesting place and the accompanying injury, is to be found in the fact that the tree had evidently been pruned, leaving the soft pith exposed and furnishing an ideal and inviting place for the wasp to nest.