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(IN TWO PARTS)

PART I.

PART II.

THE UNIVERSITY OF KANSAS
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Studies on the Biology of the Reduviidæ of America North of Mexico.*

P. A. READIO, Department of Entomology.

CONTENTS.

* Submitted to the Department of Entomology and to the Faculty of the Graduate School of the University of Kansas in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

INTRODUCTION.

THE primary purpose of this paper is to present what is known at the present time concerning the life histories and habits of the Reduviidæ of North America north of Mexico. It seemed to the writer that the size, economic importance, and interesting habits of this family warranted the study of this rather neglected field. An attempt has been made to assemble the existing material on this subject, and to add to this as much as possible by original investigations. While this study is essentially a biological one, it seems practical, and almost essential, to include enough of the systematic side to enable one to determine our species. Consequently keys to the species and higher groups, as well as descriptions of most of the species, many of which have appeared formerly only in some language other than English, are included. Although this paper does not present any advances in the taxonomy of the family, it at least assembles the best that has been done previously in one compact work. Judging from the difficulties of the writer in determining many of the species with which he worked this part of the paper should be of value.

To the writer's knowledge, no previous work of a similar nature has appeared, and the work of collecting the existing literature on the biology of our species has been considerable. The original life history studies were made at Lawrence, Kan., and only species found in that vicinity were used in the work. Observations were made on twenty species for at least a part of their life histories, and for most of these the complete details of the life history have been worked out. Practically all of the commoner species occurring in the United States are included among those studied.

This study has been completed under the able direction of Dr. H. B. Hungerford, head of the Department of Entomology at the University of Kansas, to whom the writer wishes to acknowledge his indebtedness and express his gratitude. The other associates of the writer at the University of Kansas have also been most helpful. The writer wishes to thank and to express his sincere appreciation to Dr. P. B. Lawson for his help and criticism; to Mr. R. H. Beamer for assistance in collecting material; to Mrs. Lucy Readio for assistance in preparing the illustrations which accompany the paper; to Miss Kathleen Doering for advice in connection with, and assistance in preparing illustrations, and for assistance with rearing, without which several life-history records now complete would be incomplete; to Mr. Robert Guntert for taking over the rearing work for a period during the summer of 1925, and for many helpful suggestions in regard to breeding cages and food; to Mr. H. G. Barber, of Roselle, N. J., for the determination of material; and to all others who have aided in any way in making this paper more complete.

SIZE AND DISTRIBUTION OF FAMILY.

The family Reduviidæ is one of the larger and more important of the families of the order Hemiptera. The Lethierry and Severin (1896) catalogue listed 1,855 species as belonging to this family. Since that date the number has been increased to over three thousand.

An attempt has been made to determine the world distribution of the family by enumerating the species to be found in each faunal realm. The results of this study are shown in the appended table. Because of the difficulties of solving problems of synonymy these figures are not to be taken as absolutely accurate, but they do give the correct representation of the relative abundance of the different subfamilies in the divisions of the earth enumerated.

It will be noticed that the Nearctic realm, which practically coincides with the territory included in this work, has the poorest representation of the family, and that the Palæartic realm also has a rather small number of species represented within its limits. The Neotropical, Oriental and Ethiopian realms are relatively rich in species.

The great variety in structure in this family has necessitated its division into a rather large number of subfamilies, fifteen of these having been described. Of the fifteen, seven are to be found represented in all of the faunal realms. These are the Ploiariinæ, Saicinæ, Ectrichodiinæ, Stenopodinæ, Reduviinæ, Piratinæ and Harpactorinæ. Of the others, the Tribelocephalinæ, Holoptilinæ, Apiomerinæ and Salyavatinæ are widely spread but not yet reported from one or more faunal realms. The Hammacerinæ are found only in the Nearctic and Neotropical realms. The Bactrodinæ, with four species, the Vesciinæ, with two species, and the Chryxiinæ, with one species, are to be found only in the Neotropical realm. The subfamily Harpactorinæ is by far the largest and most important of the subfamilies, containing well over a thousand species. The subfamily Reduviinæ, with over six hundred species, is next in size and importance.

TABLE OF DISTRIBUTION OF REDUVIIDÆ BY SUBFAMILIES.

Subfamily	Nearctic.		Neotropical.		Palæarctic.		Ethiopian		Oriental.		Australian.		Total.	
	Genera.	Species	Genera	Species.	Genera	Species	Genera.	Species	Genera	Species.	Genera.	Species	Genera.	Species
Ploiariinæ	8	46	16	134	8	29	8	19	18	48	11	26	11	283
Bactrodinæ	0	0	1	4	0	0	0	0	0	0	0	0	1	4
Saicinæ	2	3	5	15	1	2	1	6	1	6	1	3	5	35
Tribelocephalinæ	0	0	1	1	2	2	2	12	4	15	1	3	6	33
Stenopodinæ	8	15	15	50	6	47	10	48	14	56	5	29	33	223
Salyavatinæ	0	0	1	1	0	0	3	17	5	21	0	0	7	39
Chryxiinæ	0	0	1	1	0	0	0	0	0	0	0	0	1	1
Holoptilinæ	0	0	0	0	4	7	1	8	3	20	4	13	10	48
Reduviinæ	4	16	14	170	8	57	34	182	36	192	11	33	87	639
Vesciinæ	0	0	1	2	0	0	0	0	0	0	0	0	1	2
Piratinæ	3	5	5	45	2	19	5	59	6	70	2	35	14	224
Ectrichodiinæ	2	3	9	14	7	16	22	127	21	109	5	11	18	317
Hammacerinæ	2	5	2	12	0	0	0	0	0	0	0	0	2	13
Apiomerinæ	1	9	11	68	0	0	3	7	3	15	0	0	17	91
Harpactorinæ	13	41	43	269	18	90	59	301	61	299	31	155	182	1,117
Totals	43	146	125	786	56	269	118	786	172	851	71	299	425	3,069

THE ECONOMIC IMPORTANCE OF THE REDUVIIDÆ.

Both beneficial and injurious forms are found in the family Reduviidæ. Because of the fact that they are chiefly predacious upon insects it might be thought that the family would be entirely beneficial, but the habit of occasionally using the poisonous bite in self-defense against a human being has given some assassin bugs a rather bad name. Let us consider the beneficial forms first.

BENEFICIAL REDUVIIDÆ.

Many reduviids exist on a diet a large proportion of which is made up of harmful insects, and of course should be considered to be distinctly friendly to man. One of the most important of these species is *Sinea diadema* (Fabricius), called by Ashmead the "crowned soldier bug." This species, as pointed out by the writer in a previous paper, is widely spread, numerous, common in fields where injurious insects are doing their work, and able to exist upon a wide variety of injurious insects. It has brought a great deal of attention to itself because of its beneficial habits. Ashmead (1895) found it to be common in cotton fields, and of great value in destroying cotton aphis, small caterpillars, including the cotton worm, and other injurious insects. Chittenden mentions it as a natural enemy of the Colorado potato beetle (1907) and of the striped cucumber beetle (1919). R. C. Smith (1924) reports it as one of the most important of the predacious enemies of the forage looper, *Cœnurgia erechtea* Cram. The writer has expressed a previous opinion that this species is generally beneficial, of outstanding importance as an enemy of no particular species, but nevertheless doing a vast amount of good in the wide range of its distribution.

Another species that has been mentioned quite often as a beneficial insect is the conspicuous wheel bug, *Arilus cristatus* (Linnæus). This insect is also of wide distribution and very numerous at times. Howard (1905) has reported it as a very beneficial insect in southern cities such as Baltimore and Washington, where it is important as a natural enemy of the numerous caterpillars which defoliate shade trees. Watson (1918) reports its presence in citrus groves, where it feeds on "orange dogs, tortricids and other caterpillars, as well as other bugs, including the pumpkin bug." Garman (1916) reports it as an important natural enemy of the locust borer, *Cyllene robiniæ*, since it consumes large numbers of adult beetles. The wheel bug has also been reported as a natural enemy of the fall webworm, *Hyphantrea cunea,* by Britton (1917); of the cabbage worm, *Pontia rapæ,* by Chittenden (1916); and of the southern corn rootworm, *Diabrottica 12-punctata,* by Chittenden (1905).

Morgan (1907) studied a third member of this family, *Apiomerus spissipes* (Say), with regard to its possibilities as a natural enemy of the cotton boll weevil, but found that the assassin bug was not important in that capacity.

Several insects of the genus *Zelus* have brought attention to themselves because of their beneficial habits. Kirkland (1896) found that *Zelus exsanguis* (Stal) was an important enemy of the Gipsy moth, *Porthetria dispar. Zelus renardii* Kolenati has been recorded as feeding on a variety of injurious insects. Morrill (1910) found that it was the only predacious hemipteron which attacked the conchuela, *Pentotoma ligata,* a stink bug which attacks cotton bolls, and that it was of some importance in this respect. Horton (1918*a*) found that young nymphs of *Zelus renardii* were common on orange trees in California and had been observed to feed upon the larvæ of the citrus thrips. He found that it was only when they were in their first and early second instars that they were valuable in this respect, however. He also (1918*b*) records this species as one of the natural enemies of the citrus mealy bug. A third species of the genus, *Zelus socius* Uhler, is a common and widely distributed insect, and is probably of beneficial habits. The writer has observed the first-mentioned species, *Zelus exsanguis,* attacking various defoliating caterpillars in Kansas.

A few other species have been reported as feeding on various injurious insects, but they may be considered as of less importance than the preceding. *Pselliopus cinctus* (Fabricius) has been reported as a natural enemy of the chinch bug by Webster, while Chittenden (1907) found the same insect to be one of those attacking the Colorado potato beetle.

Acholla multispinosa (De Geer) has been reported by Felt to be of beneficial habits, and the writer has observed the same insect in such large numbers on walnut trees in Kansas that it cannot but act as an insect police force to keep harmful insects from injuring the trees.

Caffrey and Barber (1919) record *Sinea spinipes* (Herrich-Schaeffer) as a natural enemy of the grain bug, *Chlorochroa sayi.* It is interesting to note the number of instances in which reduviids attack repulsive insects, such as stink bugs, which other predacious insects usually shun.

The masked bedbug hunter, *Reduvius personatus* (Linnæus), might be considered to be beneficial because of the fact that it dwells in houses and feeds on household pests, but because of its poisonous bite it is not to be desired as a housemate.

One other insect, of whose beneficial habits the writer finds no previous record, should be considered. This is the black kissing bug, *Melanolestes picipes* (Herrich-Schaeffer). This insect is well known as a fierce biter, but no reference has been made to its good qualities. A study of the feeding habits has shown that this species feeds to a very great extent upon June bugs, or May beetles, and their larvæ. As an adult it seems to feed almost exclusively on these insects, not attacking other insects that are found in company with them, such as meadow maggots and cutworms. Just how important a natural enemy of the economically injurious white grubs *Melanolestes* is has not been determined, but it seems probable that it is of considerable importance. To be sure, *Melanolestes* is not ordinarily found in the middle of cultivated fields where white grubs are feeding, but nevertheless the total number of white grubs must be greatly reduced by the feeding of such a common insect. The habit of this insect of coming to lights at night is probably for the purpose of catching adult June bugs for food, as well as for mating. It seems to the writer that the relation of this insect to the white grub is worthy of study.

To summarize, I might say that the family Reduviidæ is one of considerable beneficial effect, but that there are few instances where a particular harmful insect is entirely controlled by reduviids. However, the presence of a large number of *Sinea diadema* nymphs and adults in a field of alfalfa must reduce the insect injury to a very appreciable extent, and the presence of a large number of wheel bugs, or of any of the other tree-inhabiting species of Reduviidæ, in groves of trees must act as an important check to the injurious insects of that habitat. The factors which limit their importance are their low rate of reproduction, most having but a single and none more than two generations a year; and the unspecialized feeding habits, most of them feeding on a wide variety of insects, some of which may be beneficial.

INJURIOUS REDUVIIDÆ.

While it is true that at least a part of the diet of some Reduviidæ is made up of beneficial insects, their greatest injury to man consists of attacks upon his person. A number of the members of this family will, when handled, protect themselves by biting, and some few seem to have the well-defined habit of attacking human beings for the purpose of obtaining a meal of blood. One species, at least, has been proven to be the intermediate host of a trypanosome disease of human beings, and several others have been under suspicion as possible disease transmitters.

Reduvius personatus (Linnæus), the widely spread masked bedbug hunter, is a species which has caused much comment because of its painful biting. Because of the fact that it is a household species, and is attracted to lights at night, it comes into contact with human beings more often than do the other members of the family. Le Conte (1872) gives one of the earlier American accounts of this insect, and remarks upon the pain caused by its bite, which, he says, is almost equal to that of the bite of a snake, with swelling and irritation sometimes lasting for a week. He also says that in weak and irritable constitutions the bite may prove fatal. Howard (1899), in his discussion of the kissing-bug scare, discusses this insect as one of those responsible. There are numerous other references to the biting of this insect in American and European literature. There seems to be no doubt that in the case of this insect the natural food consists of other insects, and that the biting is the bug's attempt to protect itself.

In the same subfamily with the masked bedbug hunter are found the bugs of the genus *Triatoma,* a number of which are also implicated as severe biters. These insects are considered by Nieva (1914) to be inhabitants of the nests of certain mammals, such as wood rats and the armadillo, upon the blood of which they normally exist. He believes that some of the species, however, have acquired the habit of infesting human habitations, and substituting the blood of human beings for their normal diet. Several of the South American species are said to be common household pests, lurking in cracks of the walls during the day and crawling to the beds and sucking blood at night. It is interesting to note that in these species the biting of the insect and the extraction of blood cause no pain to the victim, which is quite unusual in this family. The most notorious of these species is *Triatoma megista* (Burmeister), the Barbeiro, an insect which not only sucks blood, but also acts as the intermediate host for a trypanosome disease organism. The disease produced is referred to as South American trypanosomiasis, Brazilian trypanosomaisis, or Chagas disease, is said to be more prevalent among children since they are more likely to be bitten by the bug, and to cause a high mortality. The chronic form of the disease is said to produce such symptoms as imperfections of the heart, motor paralysis, and mental weakness. The organism concerned is *Trypanosoma* (*Schizotrypanum*) *cruzi* Chagas. The trypanosomes are said to be injected into the blood of the human being with the saliva of the insect, and to be carried to the capillaries of the lungs, where they are said to become quiescent for a period and to multiply by schizogony, producing merozoites. These enter the circulation, lodge and grow in the red blood cell, which they destroy, and become free in the blood. When taken into the body of the bug it is said that the trypanosomes become pear-shaped, multiply by fission in the stomach, become Crithidiform, again multiply by fission in the intestine, acquire the undulating membrane, and eventually are found as trypanosomes in the body cavity and salivary glands, from which point they may be injected into a new human individual.

Among our own species of *Triatoma* we find several which have brought attention to themselves, not because of their activities in disease transmission, but because of their painful bites. *Triatoma sanguisuga* (Le Conte), popularly called the blood sucking cone-nose, Mexican bedbug, big bedbug, and several other local names, is the commonest of these. This species is often found in houses and frequently bites human beings, apparently for the purpose of obtaining blood as food. In fact, Morrill says that in many parts of Arizona this insect takes the place of the bedbug as a household pest. That its bite is severe is attested by many people. Le Conte (1855) reports, "This insect inflicts a most painful wound. It is remarkable, also, for sucking the blood of mammals, particularly of children. I have known its bite to be followed by very serious consequences, the patient not recovering from its effects for nearly a year." Morrill (1913) reports instances in which the bite of the bug produced "red blotches and welts all over the body and limbs." Marlatt (1902) considered that this insect normally fed on other insects, and that only a very few of the adults ever made their way into houses. This, however, is contrary to Nieva's opinion, which is that the members of this group feed normally on mammalian blood taken either from the mammalian host itself or from some ectoparasite such as the bedbug.

Another species of the genus which has made itself troublesome is *Triatoma protracta* (Uhler), a species reported from California, Utah and Mexico. This species is said to inhabit houses and barns, and is considered by some, as is the case in the preceding species, to be an enemy of the bedbug. It is said to attack sleeping individuals at night, as does the preceding species. The fact that Kofoid and McCulloch have recently shown that this insect harbors a trypanosome parasite which is closely related to the causative organism of Chagas disease indicates that there is a possibility of this insect, as well as some of our other cone-noses, playing some part in disease transmission. It is probable that all of our species of *Triatoma* will bite if carelessly handled, and possibly without provocation when in search of a meal, but the two species mentioned above have been mentioned most often in this connection.

Of our other species of Reduviidæ, it is those that are attracted to lights, or are occasionally found in houses, that are likely to be troublesome. Among the most important of these is *Melanolestes picipes* (Herrich-Schaeffer), the so-called "black kissing bug," or "black corsair." This insect is attracted to lights at night, and is so common that there are numerous reports of its biting. No authentic reports of biting unless handled have come to my attention, and it seems very unlikely that it ever seeks human blood, or bites without provocation. Howard (1899) discusses it as one of the insects responsible for the kissing-bug scare of 1899, and describes a number of interesting cases of bites from this insect. The writer has had the experience of having been bitten by this insect, and has observed the effects of the bite on several other people. In all cases there has been considerable pain, more than in the case of the average bee sting, swelling of the part bitten, which may last for several days, and soreness of the part bitten for from several days to over a week. In no case observed was there anything of a serious nature connected with the injury. However, the bite is really painful, and the insect quick to attack if molested. The variety *abdominalis* (Herrich-Schaeffer) of this species has habits essentially like those of typical *picipes*, and need not be discussed separately.

Two other accused species, in the same subfamily with the preceding, are *Rasahus biguttatus* (Say), the "two-spotted corsair," which is southern and southeastern in distribution, and *Rasahus* *thoracicus* Stal, sometimes considered a variety of the preceding, which is southwestern and western in distribution. It is claimed by Walsh and Riley (1869) that the former species is to be found frequently in houses in the Southern states, where it preys upon bedbugs. A number of instances of its biting human beings are on record. The second species is said to be a common insect in California, and is responsible for most of the so-called "spider bites" reported to physicians. The wound made by this insect is at times so severe that it has been suggested that the insect not only introduces its specific poison, but also certain putrefactive germs which may adhere to its beak. It is also true that the wound may become infected by other agencies, and thus be made more serious. The writer has been bitten several times by *biguttatus* while collecting in Kansas. In fact, it is very difficult not to be bitten when collecting this species on a hot day. The insect is very active, and when exposed in its hiding place under a rock will run swiftly or even fly in its attempts to escape. Forceps become useless in a case of this sort and the hands must be resorted to, especially if, as in the case of the writer, the specimens are desired alive for rearing purposes. The bite is very painful, about equal in severity to that of *Melanolestes picipes*, and is marked for several days afterwards by a small reddish spot at the point of insertion of the beak. It is thought that the two species of the genus *Rasahus* mentioned above are most likely to come into contact with human beings in the same manner as does *Melanolestes picipes*, by flying to the lights of houses at night.

The other species of the family which have been reported to injure are, in the opinion of the writer, not likely to attack any but those who molest them in their natural habitat in the fields and woods. Several of these are well known to collectors, however.

Arilus cristatus (Linnæus), the wheel bug, is one species which under ordinary conditions would have no desire to use its beak on anything but the insects which serve as its food, but will, when carelessly handled by collector or meddler, inflict a most painful wound. G. W. Barber (1919) reports a most painful experience with this insect, which, in this instance, produced a wound which was very painful for ten days, and demanded lancing for relief. A wound caused by this insect on the hand of a student was considerably worse than any that the writer had ever seen produced by *Melanolestes picipes* or *Rasahus biguttatus*. The large size of the bug and the probably correspondingly large size of the salivary glands account for this.

Only a few other species have been reported as biting. Morgan (1907) records an instance of a bite from *Apiomerus spissipes* (Say) which produced a wound more painful than he had ever experienced from any hymenopteron, tender to the touch for over two weeks. No other records of the bite of this insect have come to our attention, but the writer has observed, when handling this insect with forceps, its apparent willingness to bite, indicated by prodding the forceps with its beak.

The writer has been bitten on several occasions by the nymphs of *Acholla multispinosa* (De Geer). In one case the insect fell onto the body when a walnut tree was being swept, and, as far as he knows, was not squeezed or molested in any other way, apparently biting for the purpose of feeding. This can hardly be the usual habit of the species. Possibly the insect bites through the instinct to feed on whatever is presented to it, as *Lygus pratensis* (Linnæus) and *Empoasca mali* (Le Baron) will bite occasionally. In this case the bite, even though made by a third instar nymph, was rather sharp and lasting. It was about equal in intensity to the bite of *Stomoxys calcitrans*, the stable fly, but lasted much longer, the place being marked by slight soreness the following day. A slight swelling was produced in the region of the bite, and the point of insertion of the stylets was marked by a red dot. It is extremely doubtful, however, if this species will ever make a nuisance of itself by biting.

It might be well to sum up the evidence in regard to the habits of the Reduviidæ as inflicters of wounds in human beings. For the United States there are no records of any of the members of the subfamilies Ploiariinæ, Saicinæ, Stenopodinæ, Ectrichodiinæ, or Hammacerinæ biting. Hoffmann, (1925) has, however, recorded *Stenopoda cinerea* Laporte as biting, in Cuba. In the subfamily Reduviinæ are three important species, *Reduvius personatus, Triatoma sanguisuga,* and *Triatoma protracta,* and it is probable that all of the members of this subfamily will bite if roughly handled, and some may actually seek human blood as food. None of our species have been proven to transmit human disease organisms. In the subfamily Piratinæ, our common species, those belonging to the genera *Melanolestes* and *Rasahus*, are well known as fierce biters, and it is probable that all of the members of that subfamily will bite upon provocation, though there is no evidence to indicate that any of them ever seek human blood. In the subfamily Apiomerinæ there is record of one species, *Apiomerus spissipes*, biting, and it is probable that other members of that subfamily will bite if carelessly handled. Finally, in the subfamily Harpactorinæ, we have one very severe biter, *Arilus cristatus*. The other members of the subfamily, if they bite at all, are probably not important in this respect.

The question is naturally raised as to whether any assassin bug, if improperly handled, or molested, will not bite in self-defense. The writer's experience indicates that some species not only will not attack human beings, but cannot be made to bite by any amount of tormenting. *Sinea diadema* (Fabricius) has been handled freely, and not only handled but deliberately squeezed, and a finger, the back of the hand, and the soft skin between the fingers presented to it, but it has never bitten under such circumstances. *Zelus exsanguis* (Stal) has been subjected to the same torments with the same results. It is probable that in all cases the function of the poisonous saliva is to kill the prey, rather than to defend against enemies.

BIOLOGY OF THE FAMILY IN GENERAL.

HABITAT.

The Reduviidæ are entirely terrestrial insects, living, however, in a wide variety of situations.

A large number of the species of this family are ground dwellers, living either on the surface of the ground, under protecting rocks, logs and leaves, or clinging to the undersides of logs and rocks in very close proximity to the ground. To the former group belong the members of the subfamilies Piratinæ, Saicinæ, some of the Reduviinæ, and possibly the nymphs of the Apiomerinæ. The Stenopodinæ, while always resting very close to the ground, are usually found clinging to the under side of a rock, board, or log. Some of the Ploiariinæ may also be found in such situations, very near the ground, but usually supported on grass stems, bits of boards, and leaves.

The greater number of the members of the family dwell on various parts of plants. Some may live on the leaves, twigs, or stems of woodland trees. Others are not so desirous of shade and live on the borders of woodlands, while still others are sun lovers and may be found in open fields. The members of the subfamily Harpactorinæ, and the adults, at least, of the Apiomerinæ, are to be found in such places. The members of the subfamily Hammacerinæ are recorded as occurring under the bark of dead trees.

At least one species of the family is truly domestic in habits, living in the dusty corners of human habitations. This is the widely spread *Reduvius personatus* (Linnæus). Some of the members of the genus *Triatoma* seem to have acquired domestic habits. Others of the family, such as *Melanolestes picipes* (Herrich-Schaeffer) and *Rasahus biguttatus* (Say), have been mentioned as possible household species, but are instead normally out-of-door species which are occasionally attracted to houses by lights.

Still others, such as *Emesaya brevipennis* (Say) of the subfamily Ploiariinæ, inhabit sheds and outhouses not occupied by human beings. The insect mentioned may be found in such places resting either on the rafters of the roof or on the spiders' webs so likely to be found in such places.

The last group to be mentioned are those that are to be found in the nests of mammals, such as *Triatoma geniculata* (Latreille), which occurs in the nests of the armadillo, *Dasypus novemcinctus* Linnæus, and *Triatoma neotomæ* Nieva, which has been found only in the nests of wood rats of the genus *Neotoma*.

Usually the insect will be found in the same situation for the whole of its life cycle, though there are some exceptions to this. For instance, *Zelus exsanguis* (Stal) spends its egg, nymphal and adult life on the leaves of trees, leaving them only at the approach of winter to find a protected place for hibernation among the leaves on the ground. In the case of one species, however, *Apiomerus spissipes* (Say), the writer has found the nymphs under rocks on the surface of the ground, and the adults on the leaves and flowers of plants.

FOOD.

The great majority of the members of the family Reduviidæ feed upon other insects. It is probable that insects of all orders are accepted as food by the various species. In most cases there is probably a rather wide range of insects possible as food for each individual species, though in some cases there are evidences of rather narrow limits in the insects serving as food for certain of the bugs. The adults of *Melanolestes picipes* (Herrich-Schaeffer), for instance, seem to feed almost exclusively upon June bugs, or May beetles, of the family Scarabæidæ. It is natural that individual species should feed on those insects most common in the environment which they occupy.

Not all of the Reduviidæ feed on insects, however. Those belonging to the genus *Triatoma* are considered by Nieva, who is the authority on their biology, to be normally hæmatophagous, feeding on mammalian blood at first hand, in most cases, though sometimes obtaining their food from other blood-sucking insects such as bedbugs.

Some reports have been made of certain Reduviidæ feeding on carrion and upon excrement. It is reported by Mr. J. B. Lembert that the common Pacific Coast species of *Triatoma*, probably *protracta* (Uhler), is attracted by carrion. It is doubtful if this habit is of very widespread occurrence in the family.

Mrs. E. S. Haworth, a public-school teacher of Great Bend, Kan., has reported that she has fed young nymphs of the wheel bug, *Arilus cristatus* (Linn.), on finely chopped pieces of meat. The writer has attempted to feed nymphs of *Reduvius personatus* (Linn.) with small bits of meat, and has observed change in size which must have been due to feeding on the juices of the meat, although none of the insects were actually observed feeding on the meat. It is probable, too, that any meat feeding which members of this family may do is not general, important, nor natural.

Several references have been found to some of the members of this family feeding on plant juices. I quote one of the more detailed of these, a statement by Mr. R. M. Dixon, of Bombay, India, appearing in Distant's discussion of the Reduviidæ in Fauna of British India. "They feed chiefly on the mucilaginous juices of plants. The sharp needle-like rostrum of the insects seems to fulfill a very important bionomic function. It generally pierces the inner bark of a plant and discharges into the wound an acrid poisonous fluid, which rarifies the mucilaginous sap and helps the setæ to suck the juice with ease and convenience, evidently doing no harm to the plant, but, on the contrary, promoting the exudation of the valuable sap. Hence there is reason to believe that the gums, resins, and other resinous vegetable products of commercial value depend largely on the punctures made by the reduviids. The blood-sucking propensities of some of the species are, I believe, due to a habit acquired probably for some purpose of self-defense."

The above-quoted opinion is not held by hemipterists acquainted with this family. The strong and stout beak, the raptorial front legs, and quickness of movement of the insects in question indicate predaceous rather than phytophagous feeding habits. Spinose front legs might be explained if we considered them to be adaptions for catching and holding prey, but not if we considered them as aids in self-defense.

The writer has observed that several of the species will imbibe water at times. *Melanolestes picipes* (Herrich-Schaeffer) is very eager to drink if it has been kept for a time in a cage containing rather dry earth.

In summing up the discussion of the food of this family we will say that as far as authentic accounts are concerned the members of the family are for the most part predacious, feeding on other insects, and that some of the insects represented are hæmatophagous, living in the nests of mammals and feeding on their blood.

FEEDING HABITS.

The method of obtaining food varies considerably in the family. In general it may be said that the insects possess a strong, short, curved beak, and front, sometimes front and middle, legs fitted for grasping and holding prey. By far the commonest method of obtaining prey is that followed by the members of the subfamilies Harpactorinæ and Apiomerinæ. These insects take their position in a situation likely to be frequented by other insects, such as in a flower head, on a leaf, or on the twig or branch of a tree. The usual method of procedure is to wait for the approach of an insect to the vicinity, and then to maneuver in such a way that the insect will approach within grasping distance, or to stalk the insect slowly and cautiously. At the final moment of attack, the insect is grasped by the front legs and pierced by the stylets of the beak at the same instant. The poisonous saliva of the reduviid is then injected into the prey until it stops all struggles, and then feeding may proceed at the pleasure of the assailant. Usually the front legs are not used to hold the insect after the struggles are over, but the prey is held dangling from the tip of the beak, evidently held by the barbs of the mandibles. Kershaw and Muir believe that at the moment of the insertion of the stylets, the sides of the labium, at its apex, contract, and hold the stylets firmly so that they may be inserted through the exoskeleton of the prey. In most cases the beak is applied, and the entrance made, in the softer, membranous portions of the exoskeleton, at the juncture of two sclerites. During the period of feeding the hold of the assailant, and the point of insertion of the stylets are changed with the assistance of the legs. Feeding is continued until the liquid portions of the body are exhausted, and then the carcass is dropped.

Not all of the members of the family obtain their food in this manner, however. The members of the subfamily Piratinæ are chasers and pouncers. They have both of the anterior pairs of legs equipped with soft, spongy pads covered with short, thickly set hairs, the function of which seems to be to hold onto the smooth bodies of other insects. Instead of actually grasping their prey, and lifting it from its feet, as do the preceding, they are content to pounce upon it, insert their beak, and rely upon their legs to keep the prey from pulling away from them. After the prey has been killed, it is fed upon in the position in which it was killed, its body resting upon the ground.

Several of the Ploiariinæ have been recorded as frequenting spider webs for the purpose of feeding upon small insects caught in them, as they undoubtedly do. The writer has proven to his own satisfaction, however, that *Emesaya brevipennis* (Say), the commonest of these insects, is not dependent upon the insects trapped in spider webs for food, since it is quite capable of catching its own prey with its very efficient, mantis-like front legs.

The method of attack of the common household species, *Reduvius personatus* (Linnæus), as described by De Geer, is quoted elsewhere. Those species which feed on mammalian blood have no use for grasping front legs. The method of feeding by one of these insects is described by Darwin as follows:

"At night I experienced an attack (for it deserves no less a name) of the Benchuca, a species of *Reduvius*, the great black bug of the Pampas. It is most disgusting to feel soft, wingless insects about an inch long crawling over one's body. Before sucking they are quite thin, but afterwards they become round and bloated with blood, and in this stage are easily crushed. One which I caught at Iquique (for they are found in Chile and Peru) was very empty. When placed on a table, and though surrounded by people, if a finger was presented, the bold insect would immediately protrude its sucker, make a charge, and, if allowed, draw blood. No pain was caused by the wound. It was curious to watch its body during the act of sucking, as in less than ten minutes it changed from being as flat as a wafer to globular form."

SEASONAL LIFE HISTORY.

There is no uniformity in the type of seasonal life history to be found in this family. Even members of the same subfamily vary in this respect.

The winter may be passed in the egg, nymphal or adult stage. The following table will show the hibernating stage of the species with which the writer has worked, or concerning which the necessary data exist:

Hibernating in egg stage.	Hibernating as nymphs.	Hibernating as adults.
Emesaya brevipennis.	*Oncocephalus geniculatus.*	*Oncerotrachelus acuminatus.*
Acholla multispinosa.	*Narvesus carolinensis.*	*Triatoma sanguisuga.*
Arilus cristatus.	*Reduvius personatus.*	*Melanolestes picipes.*
	Triatoma sanguisuga.	*Hammacerus purcis.*
	Rasahus biguttatus.	*Pselliopus cinctus.*
	Hammacerus purcis.	*Pselliopus barberi.*
	Apiomerus spissipes.	*Sinea diadema.*
	Zelus exsanguis.	*Sinea spinipes.*

It will be observed that two species in the above table are listed as hibernating both as nymphs and adults, as records indicate. In the case of those hibernating as nymphs, it is usually the older nymphs, of the fourth and fifth instars, that pass the winter, though in some cases younger nymphs have been found in winter quarters. It is possible that these do not survive the winter. The place of hibernation varies. A number of species, *Zelus exsanguis* among them, may be found in leaves and other rubbish on forest floors, in company with ladybird beetles, lacewing flies, stink bugs, and other insects which hibernate in such places. Nymphs and adults of ground inhabiting forms may be found in their normal habitat under rocks and logs, usually in somewhat better protected situations than in summer, however. One ground-inhabiting species, *Melanolestes picipes* (Herrich-Schaeffer), has been found too often by the writer in hibernation in the wood of old stumps to be considered as normally hibernating in any other place. The eggs of those species which hibernate in that stage may be found during the winter on the twigs of trees in the case of *Acholla multispinosa* (De Geer), on the trunks and larger branches of trees in the case of *Arilus cristatus* (Linnæus), and on the rafters and roofs of sheds and outhouses in the case of *Emesaya brevipennis* (Say).

The time of oviposition is, of course, dependent upon the stage in which the winter is passed. *Melanolestes picipes* (Herrich-Schaeffer) deposits its eggs quite early in the spring, as it winters as an adult. Those species which winter as nymphs usually become mature in early summer, and deposit their eggs then, as does *Rasahus biguttatus* (Say). Those which winter in the egg stage naturally deposit their eggs in the fall, *Arilus cristatus* (Linnæus) depositing its eggs in September and October.

The usual number of nymphal instars is five, as is to be expected in the Hemiptera. One of the members of the family, however, *Melanolestes picipes* (Herrich-Schaeffer), when reared by the writer, passed through only four nymphal instars.

In most cases there is a single generation a year. Among the insects that the writer has reared there is a single exception, *Sinea diadema* (Fabricius). This insect passes through two generations a season, as the writer has proven by collecting nymphs in June, carrying these through to the adult stage, obtaining eggs from them, and then rearing the resulting offspring through to the adult stage again. While it is possible that other species will be shown to have more than one generation a year when further study is given, it is not likely that very many will be found to have more than the one generation. The writer has seen no indications of any species requiring more than a year to complete its development.

HABITS OF ADULTS.

Feeding, mating and oviposition are the chief activities of the adult insects. The feeding habits have already been discussed.

There are certain features of the act of mating that seem to be uniform throughout the family. It is usual for the male to approach from behind, sometimes rapidly, as in the case of *Melanolestes picipes* (Herrich-Schaeffer), and some times very slowly and clumsily, as in the case of *Emesaya brevipennis* (Say). The male mounts, holding to the female by his legs, and usually supporting himself further by applying the tip of the rostrum at the juncture of the head and thorax. During this time the head of the female will be seen to be bobbing up and down, and a careful ear will detect a faint chirping which results from the rubbing of the tip of the beak on the ridged groove of the prosternum. Whether this is a protest or an invitation, it is impossible to say, although the apparent attempts to escape seem to indicate that it may be a protest. The male extends the tip of the abdomen, with the copulatory organs extended, along the under side of the female abdomen until the complimentary organs of the female are met and union accomplished. Copulation may last for several hours. The position assumed by the male of the different species may vary somewhat. It has been noticed, for instance, that the male of *Pselliopus barberi* Davis rests the tarsi of the front legs on the head of the female directly behind the bases of the antennæ; that the male of *Apiomerus spissipes* (Say), when once having united in copulation with the female, lets go his hold with the two anterior pairs of legs, remaining attached only by the hind pair of legs and the sexual organs themselves; and in one case it was observed that the male of *Emesa brevipennis* (Say) had grasped the female around the head, pressing her rostrum close to the underside of her head.

The reactions of adults when captured vary. Some will immediately protrude the beak and bite if any suitable part of the body is offered. *Melanolestes picipes* and *Rasahus biguttatus* are very fierce fighters, and will bite readily, or if held with forceps, will probe the forceps with their beak. Others will threaten with the rostrum, but, either from inability to pierce the skin, which seems unlikely, or disinclination, will not bite. Others seem to be obsessed only with the desire to get away, and make no attempt to bite. Some of the species, when approached or threatened, may draw the legs and antennæ close to the body, let go their hold, and roll to the ground. This is the method of escape adopted by many beetles, such as the weevils. The nymphs of *Zelus exsanguis* in particular have been observed to have this habit. With them, however, the curled-up condition does not last very long, for they soon stretch out their legs and walk away.

A careful study of any of these insects will repay one in the discovery of interesting habits of minor importance. For instance, it has been observed that adults of *Pselliopus barberi* Davis clean their antennæ by pulling them through a slit made by placing the front tarsi together in front of the body.

HABITS OF NYMPHS.

The feeding habits of the nymphs are in general similar to those of the adults in each case. Usually the habitat of the two will be found to be the same, and the same structural adaptations for catching prey will be found in each.

Several nymphs have the habit of disguising themselves by covering the body with various substances. The masked bedbug hunter, *Reduvius personatus* (Linnæus), is the best known of these. This insect lives in houses and has the body covered with dust and lint, which conceal its form and color. The disguising material is held in place by sticky hairs which cover the body of the nymph. Some authors consider that the function of the disguise is to enable the insect to waylay its prey without giving warning of its true nature. Others insist that, since the insect is nocturnal in habits, this cannot be the true function of the disguise, which must be considered as a protection from its own enemies.

A few of our outdoor species may sometimes be taken with bits of leaves attached to the surface of the body. *Sinea diadema* nymphs are sometimes found in such a condition. The nymphs of the ground-inhabiting species, *Oncocephalus geniculatus* (Stal), have been taken by the writer when bearing incrustations of dirt on the surface of the body. E. A. Butler described the nymph of an Indian species which bore a variety of small objects on its back.

EGGS AND OVIPOSITION.

Because of the lack of uniformity in the habitat of the members of this family, we find a corresponding variation in the place and manner of oviposition. In general it may be said that the eggs are usually found in the same situations as are the adults and nymphs. Thus *Arlius cristatus* (Linnæus) deposits its eggs upon the trunks and larger branches of trees; *Acholla multispinosa* (De Geer) places its eggs on twigs; *Zelus exsanguis* (Stal) on the leaves themselves; *Sinea diadema* (Fabricius) on the leaves and stems of lower plants to be found in open fields; *Melanolestes picipes* (Herrich-Schaeffer), and several others, in the ground; *Emesaya brevipennis* (Say) attached to the rafters and roofing boards of outhouses; and *Reduvius personatus* (Linnæus) in dusty out-of-the-way corners in houses.

Some species lay their eggs singly, and these may or may not be attached to some support. In the case of *Reduvius personatus*, for instance, the eggs are placed in dusty corners without any sign of attachment or arrangement. Others which deposit their eggs singly may place them in the ground, as does *Melanolestes picipes* (Herrich-Schaeffer). In this case the egg is inserted into the ground for the greater part of its length, the top alone extruding. We would expect to find the eggs of all members of the subfamilies Piratinæ and Stenopodinæ deposited in this manner, since they are ground-inhabiting forms. Others may attach a single egg to a plant stem or leaf as does *Pselliopus cinctus* (Fabricius); or to a rafter, as does *Emesaya brevipennis* (Say). Many of the Harpactorinæ and Apiomerinæ deposit their eggs in definite groups or masses of different types of arrangement. *Sinea diadema* (Fabricius) and *Sinea spinipes* (Herrich-Schaeffer) lay their eggs in elongate masses, each the width of two eggs only, attached to a supporting leaf or stem by a cement. *Zelus socius* Uhler also lays its eggs in elongate masses, but these are the width of three or four eggs. Other species deposit their eggs in more compact masses. *Pselliopus barberi* (Davis) deposits a rather small angular mass. *Zelus exsanguis* (Stal) produces a very compact angular mass of forty to fifty eggs, attached to the leaf on which it rests, and almost entirely surrounded by a large amount of cement. *Arilus cristatus* (Linnæus) produces one of the largest and most conspicuous egg masses of the family. This is usually six-sided and contains from forty-two eggs, the minimum recorded by Girault, to one hundred eighty-two eggs, the maximum recorded by G. W. Barber. It can be seen from the examples given that there is no uniformity in the grouping and arrangement of the eggs in this family.

The structure of the individual eggs is rather uniform throughout the family. The egg is in most cases cylindrical, or elongate-ovate, slightly curved in some cases. One end bears a distinct cap. The eggs are very often ornamented by extensions of the chorion around the region of the cap, or by ornamentations of the cap itself. These ornamentations may consist of elongate spine-like processes, as in *Melanolestes picipes* (Herrich-Schaeffer); reticulated membranous structures as in *Sinea diadema* (Fabricius); rod-shaped structures, as in *Pselliopus cinctus* (Fabricius); filamentous appendages, as in *Arilus cristatus* (Linnæus), or other structures. It has been noticed several times that the eggs have the appearance of small flowers. The writer, in a previous paper (1926), has made a comparative study of the eggs of the different subfamilies and genera, and has found that in most cases the eggs of the species of one subfamily resemble one another more closely than they do those of other subfamilies, and that generic resemblance is also shown. Descriptions of the eggs of the individual species studied are given elsewhere.

The period of incubation varies for each species. It may be from nine or ten days to nearly a month for those species which deposit their eggs in the spring and summer, and, of course, all winter for those which deposit their eggs in the fall.

The hatching process has been witnessed for several species, but not for all. In hatching the cap of the egg is gradually lifted by the pressure of the young inside. The insect gradually works its way out of the egg, enveloped at first in a membrane which binds the appendages close to the body. Eventually the body, which is usually bent double in the egg, is straightened out, the legs, antennæ, and beak freed from the enveloping membrane by repeated and successive pulls, and finally the adomen removed from the interior of the egg and the retaining membrane. Fabre gives an account of the hatching process of *Reduvius personatus* (Linnæus) which is quoted later.

SOUND PRODUCTION.

One of the structural characteristics peculiar to the Reduviidæ is the possession of a transversely ridged longitudinal groove on the prosternum. It has been observed by several writers that this groove is important in sound production, receiving the tip of the rostrum which rubs back and forth over the ridges, thus making a chirping sound.

The first observation of this phenomenon was made by Ray, and published in his "Historia Insectorum" in 1710. Several other observers of sound production in the Reduviidæ did not understand the method of sound production as accurately as did Ray. Fabricius, Frisch and Goreau had an incorrect idea of the act. Landios, in 1874, gave the correct explanation of the phenomenon, and Handlirsch, in 1900, gave a detailed description of the sound-producing organs and a figure of those of *Coranus subapterus*. He found that the groove in the prosternum bore about 170 chitinous ridges and that these were separated by intervals of 0.005 mm. Handlirsch examined ninety genera of the family, including members of the subfamilies Emesinæ, Saicinæ, Tribelocephalinæ, Phimophorinæ, Stenopodinæ, Salyavatinæ, Holoptilinæ, Acanthaspidinæ, Piratinæ, Ectrichodiinæ, Hammacerinæ, Apiomerinæ, and Harpactorinæ, and found that without exception they possessed the longitudinal groove in the prosternum. He also states that the groove is lacking in the Henicocephalidæ and Nabidæ, but present in the Phymatidæ. E. A. Butler states that the prosternal furrow in *Reduvius personatus* (Linnæus) bears upwards of 220 transverse lines, 0.009 mm. apart. He describes the prosternal furrow in *Ploiariala vagabunda* (Linnæus) as follows:

> "The furrow in the prosternum in which the tip of the rostrum travels is very deep, and is crossed by four slightly curved ridges placed at nearly equal intervals, and the whole area, including the ridges, is covered with fine parallel transverse striæ. It can scarcely be doubted that this structure, identical in principle with those in *Reduvius* and *Coranus*, which are known to have stridulation for their function, is also stridulatory, but I don't know that anyone has yet heard any sound produced by this particular insect."

The writer has found the ridged groove present in all the American species which he has studied, and has found that the sound-producing apparatus is functional in all those which he has reared. In *Emesaya brevipennis* (Say) the sound produced is very faint indeed, but can be heard. The immature forms, even down to the first instar nymphs, possess the structure. In some cases the young nymph can be seen to be nodding its head up and down, rubbing the tip of the beak back and forth in the groove, with no sound appreciable by the human ear produced. In such cases it is probable that the sound is produced, but is too faint, or too high pitched, for detection.

As regards the function of the sound, two views have been expressed. Landois believed that because of the fact that the species which he studied, *Reduvius personatus* (Linnæus), lived in houses, and was active only at night, that the sound was necessary for the attraction of the sexes one to the other, and that without it the existence of the species would be threatened. Handlirsch believed that it was a threat for the defense of the insect, arguing that not all of the members of the family live in houses; that in the cases where sexual attraction is the function of the sound produced, as in the crickets, locusts and cicadas, only one sex is capable of producing the sound, while in this case both sexes are equipped equally; that in the cases he had observed, the sound was produced only at times when the insects were threatened. The writer agrees with Handlirsh that the sound is for the purpose of warning, or frightening away enemies, rather than for sexual attraction. The fact that the nymphs are capable of producing sound argues against the latter theory. It has been observed by the writer that during the preliminaries of copulation, and sometimes during the act of copulation, the female insect will stridulate. In this case, however, it seems to be a protest, and does not occur until she has been grasped by the male.

POLYMORPHISM.

In this family, as in several others of the Hemiptera, occur some instances of polymorphism of adults. The females of *Melanolestes picipes* (Herrich-Schaeffer), as the species is now considered to include *abdominalis*, may have long wings which extend to the tip of the abdomen, or very much shortened wings which extend only to the base of the third abdominal segment. In several species of the Ploiariinæ, *Metapterus fraternus*, for example, the wings may be fully developed, or vestigeal. *Fitchia aptera* Stal may appear in either a completely winged or a wingless form. Uhler states that the northern form of *Rhiginia cruciata* (Say) has shorter wings than does the southern form. The female *Oncocephalus apiculatus* Reuter has short wings, the length of those of *Melanolestes picipes.*

Very little has been done to clear up the questions which such a condition suggests: In how many cases is the short-winged or apterous condition confined to one sex and in how many appearing in either sex; just what effect environment has upon the development of wings; whether the long- or short-winged condition is inherited; whether the short-winged or apterous species are not, after all, distinct species in some cases?

The writer can make a start at settling the question in one species, but has had no experience with the others. In *Melanolestes picipes* the males are all long-winged, and the females may be either long- or short-winged. The species also presents color differences. The males may or may not have the abdomen marked with red, particularly along the connexiva; the short-winged females also may or may not show the red color; the long-winged females do not ever show the color, as far as the writer's observations go. The attempt was made to rear the offspring of short-winged black, short-winged reddish, and long-winged females to see if the characters of the parents were perpetuated in the offspring. The first observation worthy of mention that was made was that the first instar nymphs of the short-winged adults, both entirely black and reddish, had a yellow prothorax, while those of the long-winged forms had a black prothorax. There were found to be no variations to this. Unfortunately only a very few adults resulted from the rearings, seven from the short-winged forms, and three from the long-winged forms. Of the seven reared from the short-winged forms three were short-winged females and four long-winged males, all without traces of red. Of the three reared from the long-winged females, one long-winged female was obtained and two long-winged males, also without any trace of red. The results of these rearings are too meager to be of any practical value, but they indicate the possibility, at least, that in this case the long- and short-winged females may represent two distinct species, the males of which will have to be separated by some other characters.

In regard to the other species mentioned, the writer has no more than a guess concerning the true condition of affairs. Careful rearings would, however, settle these uncertain points.

DORSAL STINK GLANDS OF THE NYMPHS.

In common with most terrestrial Hemiptera, the nymphs of the Reduviidæ are provided with stink glands opening on the dorsal surface of the abdomen. Gulde, who made a careful study of the morphology of these organs, as well as a comparative study of their differences in the various families of Hemiptera, found that the gland itself is a sack-like structure lying under the dorsal surface of the abdomen, its open end directed backward, and its closed end forward. This sack is lined with a chitinous intima, behind which is a layer of cylindrical cells which secrete the odiferous liquid. These are found only on the ventral side of the sack, normal epithelial cells taking their place on the dorsal side. The gland has a single duct which leads to the cephalic margin of the segment to which it is attached, and opens in a transverse cleft. Usually a projection of the dorsal plate of the preceding segment extends over the central portion of this cleft so that two small pores alone are left open. Muscles serve for opening and closing the gland and for the emptying of its contents.

Gulde found these glands present in all the Geocorcorisæ except the Hydrometridæ (Limnobattidæ). He found that the typical arrangement consisted of three glands, their openings located on the anterior margins of the fourth, fifth and sixth abdominal segments, and that this arrangement was to be found in the nymphs of Pentatomidæ, Lygæidæ, Pyrrhocoridæ, Aradidæ, Reduviidæ, Nabidæ and Cimicidæ. He found that the first gland was lacking, there being but two, opening in the fifth and sixth segments in the Coreidæ, Berytidæ, (Neididæ), Phymatidæ, and some Lygæidæ, and that in the family Tingididæ there were only two gland openings, this time located in the fourth and fifth segments. The Saldidæ and Capsidæ were found to have a single gland opening at the anterior margin of the fourth abdominal segment.

In speaking of the dorsal glands of the Reduviidæ he considers them to be typical, each showing two pores in most cases. He states, and gives *Harpactor iracundus* and *Coranus subapterus* as examples, that the pores of the first gland are more widely separated than are those of the other two pairs of glands. In *Reduvius personatus* he states that he finds the three glands, but that the pores are united in this case to form a single circular opening, and that only the opening of the anterior gland is distinct, the others being very difficult to see.

In working on the immature stages of the members of this family the writer has made some observations on the presence of the glands in question. The members of the subfamilies Piratinæ, Hammacerinæ, Apiomerinæ, and Harpactorinæ which have been studied have shown the glands to be present as stated above. In the only two representative of the family Ploiariinæ studied, *Emesaya brevipennis* and *Metapterus fraternus*, no traces of glands were found, and it is probable that they do not exist in this subfamily. In the subfamily Reduviinæ the nymphs of *Reduvius personatus* and of a species of *Triatoma* have been studied, and nothing comparable to the glands found in other divisions of the family is present. This is contrary to what has been reported by Gulde, and is rather surprising, since the odor of *Reduvius personatus*, at least, has been remarked upon several times as being stronger than that of the bedbug, *Cimex lectularius*. Nymphs of the subfamily Stenopodinæ, including those of *Pygolampis pectoralis*, *Narvesus carolinensis*, and *Oncocephalus geniculatus* show the presence of only two glands, these located at the anterior margins of abdominal segments four and five. Material of the other subfamilies is not available at the present time.

The appearance of the gland openings varies considerably. It is usual for the pores to be located in chitinized plates, these sometimes of the color of the surrounding surface, sometimes of a different color. In some cases the plates bear spines which appear to guard the pores.

The function of the odoriferous secretion produced is, of course, to warn the enemies of the insect. Just how much a predacious insect needs this protection, and just how much the glands have degenerated in predacious bugs, has not been determined. There is a possibility of the odor warning prey as well as enemies, which of course would be disadvantageous to the possessor of the odor.

KEY TO SUBFAMILIES OF REDUVIIDÆ OF AMERICA NORTH OF MEXICO.

1. Anterior coxæ elongate, at least four times as long as thick, PLOIARIINÆ, p. 32
   Anterior coxæ never more than two or three times as long as wide...... 2
2. Ocelli present in winged individuals.............................. 3
   Ocelli absent .... SAICINÆ, p. 75
3. Hemelytra without a quadrangular or discoidal aërole at proximal angle of anal aërole of membrane.................................. 4
   Hemelytra with a quadrangular or discoidal aërole at proximal angle of anal aërole of membrane (Pl. XX, Fig. 6)........................ 7
4. Ocelli not farther cephalad than the caudal margin of the eyes; segment 2 of antennæ simple.. 5
   Ocelli cephalad of hind margin of eyes; segment 1 of antennæ stout, 2 made up of many small segments (Pl. X, Fig. 4), HAMMACERINÆ, p. 146
5. Pronotum constricted caudad of middle...............PIRATINÆ, p. 126
   Pronotum constricted in middle or cephalad of middle................ 6
6. Apex of scutellum narrow, without spines or with a single tooth, REDUVIINÆ, p. 102
   Apex of scutellum broad with two or three spines or teeth, ECTRICHODIINÆ, p. 143

7. Anal aërole of the membrane not extending as far proximad as the costal aërole; basal segment of antennæ thickened, porrect; other segments slender, folding back underneath head and segment one, STENOPODINÆ, p. 79
   Anal aërole of membrane extending farther proximad than costal aërole (Pl. XX, Fig. 6) 8
8. Ocelli farther apart than the eyes..... APIOMERINÆ, p. 151
   Ocelli not so far apart as the eyes..... HARPACTORINÆ, p. 167

DISCUSSION OF INDIVIDUAL SPECIES.

SUBFAMILY PLOIARIINÆ.

The members of this subfamily are characterized by the absence of ocelli, the presence of anteriorly opening coxal cavities, and of very elongate front coxæ. McAtee and Malloch (1925) have recently revised the American forms of this subfamily, and their work is followed exactly for the systematic treatment of this group.

WORLD DISTRIBUTION OF SUBFAMILY.

This subfamily is a large and widely distributed one, being found in all the faunal realms, on all the major land divisions. It is composed of about 220 species, distributed as follows: Nearctic, 43 species; Neotropical, 134 species; Palæarctic, 29 species; Ethiopian, 19 species; Oriental, 48 species; Australian, 26 species. The apparent predominence of species to be found on the American continents may be due in part to the thoroughness of the recent revision of McAtee and Malloch (1925). It is not likely that the members of the subfamily of other regions have been studied with equal thoroughness.

CLASSIFICATION OF SUBFAMILY.

The genera of this subfamily represented in North America north of Mexico may be separated by the following key, which has been adapted from the key given by McAtee and Malloch to all American genera:

1. Fore tarsi distinctly segmented, sometimes heavily chitinized and the segments subfused, but the dividing sutures always visible under a high-power lens; claws of fore tarsus consisting of an equal-sized pair except in some species of *Ploiaria*..... 2
   Fore tarsi without distinguishable segmentation under the highest-power lens (even when cleared) consisting of but one heavily chitinized segment, with an unequal pair of claws, a single claw, or without distinct claws 7
2. Ventral spines on fore femur commencing at or very close to base; fore tibia very distinctly over half as long as fore femur..... 3
   Ventral spines on fore femur commencing at or very close to middle; fore tibia not over half as long as fore femur..... 6

3. Forewing with a closed subtriangular cell at basal extremity of large discal cell, which does not touch margin of wing at any part (Pl. XXI, Fig. 3); adults always winged; prothorax always with a deep constriction and distinctly bilobate, often penduncuIate,
Stenolemus Signoret, p. 44

Forewing lacking a closed subtriangular cell at basal extremity of the large discal cell (Pl. II, Fig. 3); adults sometimes apterous; prothorax neither pedunculate nor lobate, never more than slightly constricted, 4

4. Pronotum not extending over mesonotum even in winged forms; fore tarsus long, heavily chitinized, glossy and bare above, the three segments fused so closely that the oblique sutures are visible only under a very high power lens; adults often apterous, *Ploiaria* Scopoli, p. 49

Pronotum extending over mesonotum to base of wings; adults never winged; fore tarsus short, not heavily chitinized nor glossy and bare above, the segmentation distinct 5

5. Prothorax slightly constricted near anterior margin; mesonotum, metanotum, and basal abdominal tergite each with a long, erect median spine; fore tarsi two-segmented...............*Empicoris* Wolff, p. 33

Prothorax slightly constricted at or near the middle; mesonotum without a spine; fore tarsi three-segmented...*Luteviopsis* Champion, p. 48

6. Fore tibia almost half as long as fore femur; basal ventral spine of fore femur not longer than the longest of the others; fore tarsus with the segments well defined, not heavily chitinized, hairy above; mesonotum highly glossy............................*Gardena* Dohrn, p. 55

Fore tibia not nearly half as long as fore femur; basal ventral spine of fore femur very distinctly longer than the longest of the others; fore tarsus with the segments poorly defined, heavily chitinized, bare above; mesothorax sericeous.....*Emesaya* McAtee and Malloch, p. 57

7. Fore tarsus with two longitudinal series of angularly deflected spines which under high power appear like elongate knifelike teeth on its ventral edge; head with a more or less pronounced spine or tubercle between bases of antennæ, labrum closely adherent to base of rostrum, not projecting spinelike; adult never winged,
Ghilianella Spinola, p. 73

Fore tarsus with two series of decumbent setulose hairs on its ventral surface; adults sometimes winged; head normally with two stout tubercles or spines, one between bases of antennæ and the other (labrum) above base of proboscis; pronotum in winged form overlapping mesonotum to base of wings.........*Metapterus* Costa, p. 67

Genus EMPICORIS.

This genus was originally described by Wolff (1811). McAtee and Malloch describe the genus as follows:

"All species known to us have the legs and antennæ as well as the beak with blackish spots or annuli, and the wings are invariably dark spotted. The head and thorax have silvery hairs, usually arranged in distinct lines, some of these being almost invariably evident on pleura and pectus. The pronotum is more or less distinctly vittate, at least behind the constriction, but there are some differences in this respect which are used in defining a few of the species; the carina on side of pronotum is nearly always pale. The abdomen usually is dark, with the spiracles and spots on connexivum pale, the venter finely pubescent, with more or less of the median line, and sometimes spots about bases of certain longer hairs, bare.

"The radial vein runs to beyond the middle of the fore wing, ending in the costa, the apical portion of it being what we have called the stigma which offers some good distinguishing characters for the species, both in its shape and color. The pronotum is divided into two parts by a broad constriction, the anterior part being about half as long as the posterior, but there are no species known to us in which the pronotum is at all pedicillate. All species have the mesonotum and metanotum, and usually the basal abdominal tergite with a slender thorn on the middle of the hind margin; the presence or absence of a process on middle of hind margin of the pronotum is a specific character. The spines or bristles on fore femora are sometimes difficult to see even with a high-power lens."

DISTRIBUTION OF GENUS.

This is a genus composed of 24 described species, distributed as follows: Nearctic, 13 species; Neotropical, 6 species; Palæarctic, 10 species; Oriental, 1 species; Australian, 3 species.

CLASSIFICATION OF GENUS.

A key to the species of this genus which have been taken in the United States, adapted from that of McAtee and Malloch, is given:

1. Pronotum with the lateral carinæ distinguishable only at anterior and posterior extremities, obsolete in middle; eighth sternite in male with a large rounded central incision in posterior margin, *rubromaculatus* (Blackburn), p. 35

   Pronotum with the lateral carinæ complete, pale colored on their entire length; eighth sternite in male produced in middle of hind margin 2

2. Pronotum with two dorsal linear yellowish carinæ similar to the lateral carinæ, extending the entire length of dorsum, *barberi* (McAtee and Malloch), p. 38

   Pronotum without sharp dorsal carinæ, with two slight rounded longitudinal elevations 3

3. Hind wings conspicuously spotted with black apically, or fuscous with white reticulations 4

   Hind wings not spotted apically or very faintly so at extreme tip...... 5

4. Pronotum with a conspicuous tubercle on middle of hind margin; anterior extremity of lateral carina of pronotum with a small capitate process which projects nearly at right angles to pronotum, *errabundus* (Say), p. 43

   Pronotum without a median tubercle on hind margin; lateral carina of pronotum with at most a slight process at anterior extremity which is not capitate nor at right angles to pronotum, *reticulatus* McAtee and Malloch, p. 39

5. Both veins closing discal cell of hemelytra at apex nearly straight (Pl. XXI, Fig. 2); posterior lobe of pronotum not narrowed in front, a little broader than long...... *orthoneuron* McAtee and Malloch, p. 37

   At least the vein closing posterior half of apex of discal cell conspicuously bent or angulated; posterior lobe of pronotum as long or longer than broad, narrowed anteriorly, the sides not straight...... 6

6. The large fuscous spots on forewings irrorated with minute clear dots; one or two of the spines at base of ventral series on fore femur

about as long as the femoral diameter and quite stout; fore coxæ stouter than usual, not longer than distance from coxal cavity to upper margin of pronotum.............. *parshleyi* (Bergroth), p. 40

The large fuscous spots on forewings not irrorated; fore femoral spines not nearly as long as the femoral diameter; fore coxæ longer than the distance from coxal cavity to upper margin of pronotum anteriorly 7

7. Pronotum with a distinguishable tubercle on middle of hind margin... 8

Pronotum without a distinguishable tubercle on middle of hind margin, 10

8. Tubercle on middle of hind margin of pronotum very small, the linear white vittæ distinct in front of constriction, almost straight, disk almost bare .... *subparallelus* McAtee and Malloch, p. 39

Tubercle on middle of hind margin of pronotum large................. 9

9. Pronotum with two conspicuously curved linear pilose white vittæ which are distinct in front of constriction; bases of fore wings white .... *nudus* McAtee and Malloch, p. 40

Pronotum with two moderately broad whitish vittæ which do not extend in front of constriction nor to hind margin, the disk with rather conspicuous white decumbent hairs, *armatus* (Champion), p. 39

10. Front lobe of pronotum with two raised curved white lines in addition to the lateral carinæ; hind lobe of pronotum, costal margin of elytra and front legs with numerous very fine erect hairs in addition to the usual pile; mesonotal spine brown, horizontal... *palmensis* Blatchley, p. 44

Front lobe of pronotum without curved white elevated lines; hind lobe of pronotum and costal margin of elytra without erect hairs........ 11

11. Stigma linear, entirely black, forming a conspicuous costal streak centered on vein closing costal half of discal cell, the latter much longer than that closing the other half; cross veins in middle of hind wing forming a straight line....... *winnemana* McAtee and Malloch, p. 38

Stigma widened beyond vein closing costal half of discal cell, the latter not longer than that closing other half; cross veins in middle of hind wing forming an angulate line 12

12. Stigma with two or three blackish spots beyond the cross-vein; male hypopygial claspers knobbed, the knob concave at the tip, *culiciformis* (De Geer), p. 41

Stigma without dark spots beyond the cross-vein; claspers not knobbed. *vagabundus* (Linnæus), p. 36

Empicoris rubromaculatus (Blackburn).

Blackburn, Proc. Linn. Soc. New South Wales, ser. 2, III:349; 1889. *Ploiariodes rubromaculatus.*

Other characteristics of this species mentioned by McAtee and Malloch are as follows:

"In some cases the anterior rudiment of the lateral carina is dark in color and therefore inconspicuous. The fore femur is about as long as the pronotum and the apical antennal segment is not over one-third as long as the third segment. This species has no round bare spots at bases of the longer hairs on venter as in *errabundus* and some others."

Ploiariodes euryale Kirkaldy, *Ploiariodes californica* Banks and *Ploiariola froggatti* Horvath are considered as synonymous with this species.

Biology. A brief note of possible interest concerning this species is contributed by Downes (1924):

"This (*'Ploiariola californica'*) was abundant in an old henhouse in Victoria among the cobwebs. One specimen was taken in flight at Neatings, B. C."

From this note we might judge that the species has habits similar to those of *Emesaya brevipennis* (Say). Blatchley records collecting it from dead willow branches, and from Spanish moss and dead leaves of cabbage palmetto.

Localities. Hawaii, California, Mississippi, Florida, Indiana, Virginia, British Columbia, Porto Rico, Brazil.

Empicoris vagabundus (Linnæus).

Linnæus, Syst. Naturæ, ed. 10:540; 1758. *Cimex vagabundus.*

Two varieties of this species may be keyed out as follows:

1. Antennæ and fore femora with very short hairs, those on the former very little longer than the segmental diameter; general color usually somewhat fuscous .... *vagabundus* (Linnæus).
   Antennæ and fore femora with very long hairs; those on the former about four times as long as the diameter of the segments; general color usually whitish .... *pilosus* (Fieber).

Ploiariola canadensis Parshley is considered to be synonymous with the former variety, and *Ploiariodes hirtipes* Banks with the latter.

Biology. Brief notes on the habits of the two varieties of this species are given by Downes. The former (1921) is as follows:

"This species (*Ploiariola canadensis*), described in my previous report, has been found again by Downes in moderate numbers, in company with *P. hirtipes.* The latter was numerous this year on the under side of a rail on the shady side of a close board fence which separates my garden from the adjoining lot. Here they were found in all stages living among the cobwebs and apparently getting their living from the insects caught in them, though I never actually found one feeding." (Parshley, 1921.)

Downes (1924) reports again on these two varieties:

"This (*Ploiariola vagabunda* var. *pilosa*) was originally recorded as *P. canadensis,* but Mr. McAtee informs me that it is identified with the first-named European species. I have taken it on trees in the city of Vancouver and in Stanley Park, and in Victoria on the shady side of board fences in company with *P. hirtipes,* but not as commonly as the latter."

Butler (1923) gives a more complete account of the habits of the insect:

"*Ova.* Not described.

"*Larva.* Last instar, 5½ mm. Elongate, similar in form to adult; head and pronotum whitish, a narrow dark streak running from eyes along sides of head and pronotum; wing-pads with white margins, the rest thickly covered with black dots, of which the two central ones are larger and more distinct on the rows at the margins of the segments; whole surface with long, scattered, curved hairs; legs and antennæ barred as in adult, but with bars on antennæ smaller, and therefore the white interspaces larger; hairs on legs and antennæ curved, and much longer than in adult; tarsi two-segmented; rostrum very stout.

"*Life Cycle.* The imago is found from July to October, and there is a record for March. Both Morely and I have taken the insects *in cop.* in August. But Morely also took a nymph in his garden on *Geum urbanum*, August 15, 1913, which changed to the adult on the 18th, and I have also taken the nymph in August on a spruce fir. These two specimens imply an oviposition period not later than June.

"*Habitat, etc.* The form of the anterior legs and of the rostrum is sufficient to indicate that the insect is predacious, and Fallen says it has been found sucking *Culices.* Forel also saw it on windows attacking small flies, and Schiodte saw numbers on the trunks of trees pursuing small Lepidoptera. It appears to hunt its prey mainly on trees; thus it has been taken on firs, both Scotch and spruce, yew, ivy, oak, hazel, holly, apple trees, elder, and furze (Masan), and *Sparticum junceum* (Ferrari). I have also taken considerable numbers upon palings. Duda reports finding it in Bohemia on *Picea excelsa* in July and August, always in company with *Atractotomus parvulus* Reut., and Champion beat it from a stack of cut pine branches. Fieber says it occurs in galls made by Aphides on *Ulmus campestris,* on walls in the passages of damp houses, and on damp boards in swimming baths. Marshall has recorded it from houses in Britain. It is commonly taken by sweeping.

"According to De Geer it flies easily and takes wing with promptitude. Burmeister states that the larva covers itself with particles of dust and lives on prey."

Localities. The variety *vagabundus* has been taken in America from British Columbia and Washington, D. C.; the variety *pilosus* has been taken in America from Wisconsin, Pennsylvania, Massachusetts, Vermont, Michigan, and British Columbia. Europe.

Empicoris orthoneuron McAtee and Malloch.

(Pl. XXI, Fig. 2.)

McAtee and Malloch, Proc. U. S. Nat. Mus., LXVII:18; 1925.

"*Male.* Similar to *errabundus* in color, except that the type shows no distinct spotting at the apices of the hind wings, but these wings in this specimen are in poor condition and it is not possible to be absolutely sure of this character. The venation of apex of the discal cell is as in *reticulatus,* but the minute honeycomb of lines is absent, the stigma is narrower, fuscous, and there is a more conspicuous blackish mark on middle of veins closing discal cell and the base of the vein that emanates from them. The apical sternite is triangular."

Length, 4 mm.

Locality. California.

Empicoris barberi (McAtee and Malloch).

McAtee and Malloch, American Museum Novitates, No. 75, May 11, 1823, pp. 7-8 *Ploiariodes.*

"*Male.* Head with white pruinosity in front of eyes and a white line from base of each antenna, which connects with another that runs diagonally from lower hind margin of eye to upper occiput; faint lines of pruinosity on lower sides of pronotum in front and on pleura, and posterior and lateral margins, and lateral and dorsal carinæ of pronotum white. Abdominal spiracles white; venter mottled, each sternite with a large round bare spot on each side on hind margin. Antennæ and legs with narrow annulations, a subapical one on each femur and on first segment of antenna broader. Dark areas on fore wings profusely areolate with minute pale dots; apices of hind wings fuscous with white reticulations.

"Pronotum without median tubercle on hind margin; submedian dorsal carinæ as sharp as the lateral ones, but little curved; mesonotal and metanotal thorns absent in type, the one at base of abdomen distinct. Apical abdominal sternite not deeply excavated at tip. Fore femur with very weak ventral spinules. Stigma normal, cross-vein closing apex of discal cell on its anterior half straight, the other one curved.

"Length (without wings), 3 mm."

Localities. Florida, Porto Rico.

Biology. Blatchley records capturing a specimen from dead leaves of cabbage palmetto.

Empicoris winnemana McAtee and Malloch.

McAtee and Malloch, Proc. U. S. Nat. Mus., LXVII:19; 1925.

"*Male.* This species differs from all the others in having the legs and antennæ almost entirely brownish fuscous, with but faint annuli except at extreme apices of segments, the fore and middle alone showing distinguishable annuli. The pronotum is always uniformly brownish and the thoracic spines are stramineous. The wings are as in *errabundus,* but the linear stigma is entirely black as far before as beyond the cross-vein.

"Antennæ with short pubescence, apical segment over one-third as long as the subapical. Lateral carina of pronotum not sharp. Apical abdominal tergite subtriangular, hypopygial claspers slender, tapered at apices. Fore femur over twice as long as coxa, rather densely short-haired ventrally, the spines minute. Cross-veins in middle of hind wing forming a straight line.

"*Female.* Similar to male, the abdomen broader.

"Length, 4.5 mm."

Localities. Maryland, Virginia.

Empicoris reticulatus McAtee and Malloch.

McAtee and Malloch, Proc. U. S. Nat. Mus., LXVII:20; 1925.

"*Male and Female.* Similar to *errabundus* in color, the spots at apices of hind wings very distinct. Differs as indicated in the key, the reticulation or honeycombing of forewings only visible under a very high power. The apical abdominal sternite of male is similar to that of *orthoneuron* and quite different from that of *errabundus*. As in *errebundus* and *orthoneuron* the cross-veins in middle of hind wings are angulated and the apices of forewings are notched where the vein joins the margin. Apical antennal segment nearly half as long as preapical. Base of abdomen with a much shorter dorsal thorn than in *errabundus*.

"Length, 5-6 mm."

Biology. A specimen of this species is reported by its authors as having been found on imported orchids from Barrios, Guatemala.

Localities. Mississippi, Maryland, Virginia, Massachusetts, Mexico, Guatemala.

Empicoris armatus (Champion).

Champion, Biol. Centr. Am., Heter., II:165; 1898. *Ploiariodes armata.*

The following description is that given by McAtee and Malloch:

"Head with white decumbent hairs which form three curved longitudinal lines on each side, one from lower posterior angles of eye, one from just above middle of eye and a third from upper posterior angle of eye, the latter curved inward at middle. Pronotum with two whitish submedian vittæ which do not reach anterior or posterior margins, the space between them yellowish, laterad of these and across their posterior extremities dark brown, hind margin of pronotum narrowly pale yellowish in middle, broadly so on each posterior lateral angle, dorsum with rather dense decumbent white hairs; mesonotal spine dark brown, pale at tip; metanotal spine whitish; basal abdominal spine dark brown. Abdomen brown, venter unspotted, spiracles and a connexival streak in front of them on each segment, whitish. Wing spots not irrorate; stigma from cross-vein to near tip filled with two contiguous brown or fuscous spots.

"Lateral pronotal carina complete, without anterior process; on hind margin of pronotum situated a stout, conspicuous, median process. Fore coxa slender, almost as long as pronotum and half as long as femur. Vein closing posterior half of discal cell much curved. Apical antennal segment fully one-third as long as preapical."

Localities. Florida, Canal Zone, Guatemala, Porto Rico, Jamaica.

Empicoris subparallelus McAtee and Malloch.

McAtee and Malloch, Proc. U. S. Nat. Mus., LXVII:21; 1925.

"*Male.* Similar to *nudus* in color and structure, differing as stated in the key. The black spots on antennæ are much smaller than in *nudus*, and especially apically, the last two segments in *nudus* being almost entirely fuscous whereas in *subparallelus* they are largely white, the apical segment having a small black spot at base and a larger one near apex.

"Length, 4.5 mm."

Localities. Texas, Cuba.

Empicoris nudus McAtee and Malloch.

McAtee and Malloch, Proc. U. S. Nat. Mus., LXVII:22; 1925.

"*Female.* Head marked as in *armatus;* the white lines are not composed of moderately long decumbent hairs, but of microscopic pile or pruinescence, and the two lines on dorsum are regularly arcuate, the anterior and posterior extremities being incurved. The dorsum of pronotum is chocolate brown on disk between the white lines, the latter are very slender, converge from anterior margin to constriction, and then arcuately diverge, ending a short distance from hind margin of pronotum; laterad of the white lines the posterior half of pronotum is paler brown; there is a slender white Y-shaped mark extending from constriction over humerous on each side, a white line along the hind margin, and the lateral carinæ are white. In other respects as in *armatus.*

"Pronotum almost nude, processes and spines as in *armatus.* Fore coxa stouter than in that species, distinctly shorter than pronotum, and half as long as femur; stigmatal spot farther from apex. Apical antennal segment fully half as long as preapical.

"Length, 4.5 mm."

Locality. Paradise Key, Florida.

Empicoris parshleyi (Bergroth).

Bergroth, Not. Ent., II:50-51, 79; 1922.

The following description is that given by McAtee and Malloch:

"Color decidedly more brownish than in *errabundus.* Dorsum of pronotum behind suture pale yellow brown, but little darker than the lateral carinæ; thoracic spines pale. Venter of abdomen pale brown, spotted. Most of the fuscous spots on wings and especially those in discal cell with minute, clear dots in them; apices of hind wings not spotted. Legs and antennæ ringed and spotted with fuscous.

"Pronotum with lateral carina, which has a small process at anterior extremity, and with a poorly developed but distinguishable median process on hind margin. Fore legs short and stout, the femur not longer than the pronotum, the coxa about half as long as the femur and not longer than distance from coxal cavity to upper anterior margin of pronotum. Stigma normal, rather broadly rounded at apex; discal cell produced at apex, both veins closing cell curved. Apical antennal segment fully half as long as preapical.

"Length, 5-6 mm."

Localities. Virginia, Maryland, New Hampshire, Massachusetts.

Empicoris culiciformis (De Geer).

De Geer, Mem. Hist. Ins., III:323-8, pl. 17, figs. 1-8; 1773. *Cimex culiciformis.*

The structural features of this insect are discussed by McAtee and Malloch:

"We have before us several European specimens of this species, including one male. A number of North American specimens, comprising males also, agree in every particular with those from Europe so that we have been compelled to accept the American species as *culiciformis.* In color it agrees very closely with *errabundus,* but is distinguished structurally as indicated in the key, and also by the lateral carina of the pronotum lacking the anterior process. The apical sternite in male is more broadly rounded at apex than in *errabundus,* and the hypopygial claspers are knobbed at apex. No other species so far as we know has this last structural peculiarity. The wings are as in *errabundus,* but the hind pair are not spotted apically. Apical antennal segment about half as long as preapical. One or two of the basal ventral spines of fore femur quite prominent.

"Length, 4-4.5 mm."

Biology. American accounts of the habits of this species are apparently lacking, but I find an excellent account of the biology of the insect given by E. A. Butler (1923), whom I quote:

"*Ova.* Undescribed.

"*Larvæ.* According to Burmeister, the larva covers itself with dust.

"*Life Cycle.* The imago has been taken throughout the year except in February and November, so that it no doubt occurs all the year round. This is probably connected with the fact that it is less dependent upon trees than the preceding species (*vagabundus*), and hence seasonal changes do not affect it so much.

"*Habitat, etc.* This species occurs in thatch, whether of houses or ricks, and also in faggots. J. Edwards records a few examples crawling on the walls of a countinghouse in Norwich, and Fieber mentions that it occurs in arbours. The following interesting account of its habits and feeding is by H. J. Charbonnier: 'On December 18 a specimen of this curious insect walked across my study table; it looked like a gnat, but on closer examination I saw that what looked like three pairs of legs were in reality two pairs of legs and a pair of slender and elbowed antennæ; there was something in front of the head that looked like a pair of spider's falces, and presently these were straightened out and revealed a stout pair of legs that were held in front between the antennæ. When the surface was somewhat difficult, these were used for walking, and then the insect looked precisely as though it had four pairs of legs; it afterwards held up the front pair, Mantis fashion, in front of the head. From its rapacious look and gnatlike appearance I thought it would probably feed on insects. On the 31st, having obtained a *Culex*, I put it in the box. *Ploiariola* walked round several times, but returned to the gnat and felt it over very carefully with its antennæ; after two or three minutes it made a sudden spring forward and seized the gnat's abdomen between its anterior femora and tibiæ, inserting its rostrum between the segments; after sucking for five minutes it shifted its hold, grasping the base of the leg; the gnat offered no resistance, and seemed indeed not to feel the touch of those slender, hairlike limbs, its own being comparatively quite clumsy. After being sucked for another five minutes the gnat collapsed, drawing its legs together and falling to the bottom of the box. Altogether *Ploiariola* sucked its victim for about forty minutes. January 5 put another *Culex* in the box; *Ploiariola* attacked it like the first one, but sprang upon its back, and having seized the base of each wing, inserted its rostrum in the gnat's neck, and raising itself on its legs, fairly lifted the insect off its feet. January 15, tried *Ploiariola* with a *Phora,* which was treated like *Culex.* March 2 tried *Ploiariola* with a *Calliphora,* first alive and then dead, but it remained untouched. March 4 tried to tempt *Ploiariola* with a *Sciara,* but in vain. March 13 tried again with a *Sciara;* after much hesitation, and much feeling with its antennæ it seized it and inserted its rostrum, but instantly withdrew it, and would not make a second trial; *Sciara* is evidently distasteful to it. The front femora of *Ploiariola culiciformis* have at the back a double row of sharp spines; the anterior tibiæ shut down tightly between them.'

"The arrangement of the striæ in the prosternal furrow is very similar to that in *P. vagabunda,* but it is more difficult to see. Here again there are no records that any sound may be heard to proceed from the insect. Of course it is conceivable that the sounds may be too high-pitched for the human ear to distinguish.

"I can find no reference of its occurrence on trees, except that Reuter, quoting from Reiber and Puton, gives 'quelquefois sur les arbres verts.' "

American records concurring with, or disagreeing with, the above accounts are apparently lacking. We can, however, assume that the species would have the same habits in one country as in the other, and these accounts are valuable not only in giving us an idea of the habits of this particular species, but also in showing us what we may expect to find from some of our closely related species.

W. E. China reports oviposition of this insect on August 30, and hatching of the eggs the same fall. He describes and figures the egg. His description is quoted:

"Shining black, elongated, more or less cylindrical with the base hemispherically rounded, and the apex truncate. The greatest diameter is in the middle, and the truncate end is narrower than the rounded base. The apical quarter of the egg is distinctly bent to one side so that, seen from two viewpoints, one side is convex and the other concave. The truncate micropylar end is sunk a little below the circular margin of the shell, and consists of a grayish-white finely reticulated cap with its center conically elevated. The reticulations which comprise a network of elevated ridges on the surface of the micropylar cap are rather coarse around the circumference, but become finer towards the center, until, on the slopes of the conical process, they are almost obsolete. Around but just below the apical margin of the shell on a level with the circumference of the cap are 15 or 16 very minute micropylar processes similar to those found in Pentatomid eggs. On the lateral surfaces of the shell are several longitudinal narrow ridges of dried gumlike substance formed during oviposition.

"Length 0.785 mm., widest diameter 0.315 mm., diameter of micropylar cap 0.157 mm."

Localities. Massachusetts, Pennsylvania, Maryland, District of Columbia, Virginia, West Virginia, Oregon, Europe.

Empicoris errabundus (Say).

Say, Heter. N. Harm., 34; 1832. Fitch Rep., 803. Compl. Wr., I:359. *Ploiaria errabunda.*

The following descriptive notes on this species are given by McAtee and Malloch:

"In addition to the characters mentioned in the key, this species has the venter with dense appressed white pile except on numerous small round areas at bases of the longer hairs which give it under a moderate magnification the appearance of being spotted. The fore coxa is nearly as long as the pronotum, the cross-veins in the hind wing form an angulated line, both the veins closing the discal cell are curved so that the apex of the cell is drawn out into a rather long point, the stigma is spotted beyond the cross-vein, and the eighth sternite in the male has an obtusely pointed terminal process. The apical antennal segment is one-third as long as preapical.

"Length, 4-4.5 mm."

Biology. This is the most common and widely distributed representative of the genus in the United States. We would expect that at least some of the general features of its life history would be known, but a study of the literature shows an almost total lack of such information. Uhler (1884) says the following in regard to it:

"Its delicacy and small size have caused it to be a rare species in collections, but it is no doubt common enough upon the leaves and branches of *Cornus florida*, where we have found it during the month of June."

McAtee and Malloch record the capture of a female by H. S. Barber at Cropley, Maryland, on April 27, 1910, which laid eggs soon after capture. This capture and egg-laying record would indicate that the insect spent the winter as an adult or advanced nymph. Another record indicates that this species has been collected at light.

Provancher (1888) gives the following discussion concerning the eggs of this insect:

"This insect, taken at Trois-Rivières and sent alive in a small box, deposited its eggs during the trip. These eggs, ten in number, were in the shape of kidneys, concave on their lower surface, and bearing four or five white lines on the upper surface; one of the extremities ended in a little cap preceded by a slight construction, and bearing at its extremity a projection in the form of a crown which is supported by braces in the form of squares. They are fixed to the support not by an extremity, but by the dorsal surface, that is to say the pedicle is prolonged on the cardboard and remains attached there in the form of a very delicate line, bearing each egg attached by its middle by its dorsal surface. From their external appearance, they might easily be taken for umbelliferous grains, or the anthers of certain flowers. It is only after having submitted them to a microscope that we were able to convince ourselves that they were animal, and not vegetable productions."

Localities. Maine, Massachusetts, New York, Pennsylvania, Maryland, Virginia, West Virginia, Georgia, Michigan, Ontario, Kansas, Texas, Mexico.

Empicoris palmensis Blatchley.

Blatchley, Heterop. of Eastern N. A., p. 522; 1926.

The original description of this insect follows:

"Elongate, slender. Head and front lobe of pronotum dull yellow blotched with fuscous; hind lobe of pronotum a uniform dull yellow; meso- and metanota brownish-yellow, their spines dark brown; elytra dull yellow, the costal margin of each with a small fuscous submarginal blotch in front of middle and another at apical fourth; first and second joints of antennæ each with about nine pale rings alternating with nine narrower brownish ones; beak yellow, the second joint with two fuscous rings, the third with base tinged with fuscous; front legs yellow, the coxæ each with two brownish dots on outer side, the femora with four narrow rings and apical fifth brownish, tibiæ with two brownish rings on basal half and a wider one at apical third; middle and hind legs yellow, alternated with narrow brownish rings; under surface pale brown, the margins yellowish. Joint 2 of antennæ one-fifth shorter than 1, 3 one-half the length of 2, twice as long as 4. Both head and eyes small for the genus. Hind lobe of pronotum subquadrate, the usual obtuse discal ridges scarcely evident. Spine of mesonotum almost horizontal, of metanotum suberect. Elytra surpassing abdomen by one-fifth their length, their tips narrowly rounded. Spines of front femora very short and wholly pale, almost invisible. Length, 4.2-4.7 mm."

Biology. Blatchley reports taking specimens of this insect from the dead leaves of a cabbage palmetto.

Locality. Florida.

Genus STENOLEMUS.

This genus, originally described by Signoret (1858), is characterized by McAtee and Malloch as follows:

"In species of this genus the labrum is closely adherent to base of rostrum and there is no spine between bases of antennæ; the apices of the latter are more or less enlarged, ending in an acute process which may be more or less curved or angled. The prothorax is very variable in structure, but is always carried backward over mesonotum to the bases of wings, and is very noticeably constricted near middle, or pedicellate; there are great differences in the length of the pedicel connecting the anterior and posterior lobes. Some species have merely a constriction while others have a long pedicel. This difference is, however, not coördinated with any other outstanding structural character except in the case of *arizonensis* which has the venation of the fore wing different from that of the other species; we consider this species entitled to subgeneric rank. The mesonotum and metanotum each have a long spine on middle of hind margin. Fore femur spinose from base, fore tarsus not heavily chitinized, short and straight, with two distinct segments, hairy above and below; claws equal.

"With the exception of *S. arizonensis* members of this genus are whitish to stramineous with brown to black markings of variable extent; their usual pale coloration and the abundance of long hairs on most parts of the body give them a habitus quite distinct among American genera. While the extent to which dark markings prevail is variable, the pattern is nearly the same throughout all of the subgenus *Stenolemus*. The principal features of these markings are the following: Bands differing in number, width and intensity, and sometimes in character of pubescence, and even of the supporting integument, on antennæ and legs; two longitudinal vittæ on top of anterior lobe of head; a band on each side of head from neck toward eyes dividing so as to leave the tubercles and a spot behind each eye pale; on prothorax a stripe nearly percurrent on lower surface, embracing most of pedicel, and sending a tongue posteriorly along side of posterior lobe, and anteriorly a band above front coxa, and a broad vitta each side of the median line on the dorsum, these latter vittæ interrupted by one or two pale stripes on outer side near base; mesothorax and metathorax largely dark, with pale edgings, and abdomen the same, more or less marked with pale. In most cases we have figured the fore wings in order to give a clearer idea of their markings."

DISTRIBUTION OF GENUS.

This genus is composed of 21 described species, distributed as follows: Nearctic, 5 species; Neotropical, 7 species; Palæarctic, 2 species; Ethiopian, 1 species; Oriental, 4 species; Australian, 3 species.

CLASSIFICATION OF GENUS.

The species of this genus which occur within our limits may be separated as follows:

1. A distinct vein emitted from costal margin of basal discal cell of fore wing (Subgenus *Stenolemus*) (Pl. XXI, Fig. 1)...................... 2

   No vein emitted from costal margin of basal discal cell of fore wing; basal stout spine on postero-ventral surface of fore femur directed downward, not angling towards base of femur; prothorax hardly pedunculate, anterior lobe gradually narrowed posteriorly, posterior lobe without tubercles on posterior margin; dorsum of head without postsutural tubercles (Subgenus *Stenolemoides*)...*arizonensis* Banks, p. 46

2. Basal spine of fore femur directed straight downward, not angling towards base of femur; prothorax deeply constricted but not pedunculate, anterior lobe quadrate, posterior lobe with four distinct tubercles near hind margin; subapical antennal segment longer than apical; fore tibia stout, barely longer than fore coxa and hardly as long as head and the anterior lobe of prothorax combined; mesothoracic and metathoracic spines short and stout, tapered apically,
   pristinus McAtee and Malloch, p. 46

Basal spine of fore femur angling towards base of femur................ 3

3. Prothorax not distinctly pedunculate, anterior lobe tapered posteriorly, tubercules on posterior lobe nearly obsolete; subapical antennal segment less than half as long as apical; fore tibia slender, about twice as long as fore coxa and as long as head and thorax combined; mesothoracic and metathoracic spines long and slender, *pallidipennis* McAtee and Malloch, p. 47

Prothorax pedunculate, the peduncle sharply differentiated from the anterior and posterior swollen lobes and about as long as or longer than the former; posterior lobe with four tubercles near hind margin...... 4

4. Posterior discal cell of fore wing bisected longitudinally by a distinct vein; mesothoracic and metathoracic spines not thickened near apices ....*hirtipes* McAtee and Malloch, p. 48

Posterior discal cell of fore wing not bisected by a distinct vein; mesothoracic and metathoracic spines more or less swollen near apices; tubercles on hind lobe of head prominent, acute, *spiniger* McAtee and Malloch, p. 48

Stenolemus arizonensis (Banks).

(Pl. XXI, Fig. 3.)

Banks, Psyche, XVI:45; 1909. *Luteva arizonensis.*

Described by McAtee and Malloch as follows:

"A pale brownish-yellow species, without distinct markings on fore wings. Basal two antennal segments with a few whitish annuli. Anterior third or more of posterior lobe of pronotum whitish, posterior margin subfuscous. Anterior femora and tibiæ faintly whitish annulate, mid and hind femora and tibiæ faintly whitish annulate, mid and hind femora each with six whitish annuli. Most of the veins of fore wings paler than the membrane.

"Head about as wide as long on dorsum, eyes large, the posterior lobe slightly bulbous above and neither tuberculate nor sulcate. Anterior lobe of prothorax about 1.5 as long as wide, much tapered posteriorly, barely half as wide at posterior as at anterior margin, dorsum arched, posterior lobe slightly widened posteriorly, a little longer than anterior lobe, with a broad shallow median depression, posterior width less than greatest length, no tubercles near posterior margin. Legs less elongate than usual in the genus.

"Length, 8-9 mm."

Localities. Arizona, Nevada, California.

Stenolemus pristinus McAtee and Malloch.

McAtee and Malloch, Proc. U. S. Nat. Mus., LXVII:29; 1925.

"*Female.* Head, anterior lobe of prothorax, and abdomen conspicuously marked and clouded with brownish fuscous and the fore wings almost entirely of that color, with the veins, some reticulating lines, and a few dots, whitish. The antennal, and femoral, and tibial annuli of mid and hind legs are very pale brown and, with the exception of the preapical one on each femur, inconspicuous; front coxa with 2, and front femora and tibiæ with 4 rather conspicuous brown bands.

"Head rather broader than long, eyes large, covering much more than half the entire length of side of head, transverse suture on dorsum not very deep, posterior lobe with two small but sharp processes on dorsum anteriorly; antennæ much stouter than usual, with long hairs, third segment fully as long as fourth. Anterior lobe of prothorax subquadrate, not tapered, separated from posterior lobe by a deep constriction, posterior lobe widened from anterior to posterior margin, with four distinct but not very large tubercles near posterior margin; mesothoracic and metathoracic spines comparatively short and stout. Spines on fore legs much shorter than in any of the other species, the basal one not bent towards base of femur. Abdomen elongate ovate, third, fourth, and fifth tergites each with an angular projection near posterior lateral angles; venter without submedian spines, spiracles elevated. Posterior discal cell of fore wing with a longitudinal vein bisecting it, vein emitted by basal discal cell not as close to base as in next species, the cell acute at base.

"Length, 7.5 mm."

Biology. Blatchley reports beating these from dense hammocks along the margins of tide-water lagoons.

Locality. Key West, Fla.

Stenolemus pallidipennis McAtee and Malloch.

(Pl. XXI, Fig. 1.)

McAtee and Malloch, Proc. U. S. Nat. Mus., LXVII:30; 1925.

"*Male.* Much paler than the other species of the genus, the general color stramineous, the femoral annuli very indistinct, and the wing markings pale fuscous.

"Head as broad as long, arched above, the posterior lobe slightly tumid on each side of median line anteriorly; basal antennal segment and base of second segment above very long-haired, third segment not one-third as long as fourth. Anterior lobe of prothorax not longer than its greatest width, anterior lateral angles tumid, narrowed posteriorly, and separated from posterior lobe by a deep constriction, posteriorly gradually widened from anterior to posterior margin, about 1.5 times as long as anterior lobe and as long as wide, the four tubercles before hind margin barely evident; mesothoracic and metathoracic spines slender, curved, the pointed processes directed forward. Venter lacking submedian processes, the spiracles slightly elevated and situated very close to lateral margins; hypopygium not large, almost covered on dorsum by the broadly rounded posterior projections of the apical tergite, claspers small, slender, curved. Venter and all femora and tibiæ with very long, fine hairs; fore femur with the postero-ventral spines longer and more widely spaced than usual, four or five of them conspicuously longer than the others, the basal one directed somewhat toward the base of femur.

"Length, 8.5 mm."

Locality. Santa Rita Mountains, Arizona.

Stenolemus hirtipes McAtee and Malloch.

McAtee and Malloch, Proc. U. S. Nat. Mus., LXVII:32; 1925.

"*Female.* Similar to *schwarzi* in color, rather pale, with the fore wings differently marked, and the antennal, femoral and tibial annuli much paler.

"In addition to the structural characters mentioned in the key the following are the principal characters possessed by this species: Head as broad as long, bituberculate on dorsum or posterior lobe anteriorly; basal antennal segment and base of second above very long-haired, third segment about three-fifths as long as fourth. Anterior lobe of prothorax as long as peduncle, posterior lobe not abruptly widened, the tubercles large and rather sharp; mesothoracic and metathoracic spines erect and slender. Fore femur with only two of the postero-ventral spines conspicuously longer and stouter than the others; all legs, the prothorax, and venter densely and rather long-haired.

"Length, 9-10 mm."

Biology. Blatchley reports taking a specimen from buttonwood, *Conocarpus erecta L.*

Localities. Mississippi, Florida, South Carolina.

Stenolemus spiniger McAtee and Malloch.

McAtee and Malloch, Proc. U. S. Nat. Mus., LXVII:33; 1925.

"*Male and female.* Similar to *hirtipes* in color, but rather variable in intensity and form of markings.

"Besides the characters mentioned in the key, the peduncle of the prothorax is slightly longer than the anterior lobe (on dorsum) and distinctly tapered anteriorly, not equally thick the whole length as in *hirtipes;* the vein emitted by basal discal cell is longer and nearer base of cell than in that species, and there are three or four outstanding stout spines on the postero-ventral surface of fore femur.

"Length, 10-12 mm."

Localities. Texas, Mexico, Guatemala.

Genus LUTEVIOPSIS.

This genus was described originally by Champion (1898). It may be recognized from the characters given in the key.

DISTRIBUTION OF GENUS.

Three species have been described for this genus, all of which are probably typically Neotropical in distribution. Of these one has been recorded from our limits.

Luteviopsis longimanus Champion.

Champion, Biol. Centr. Am., Heter., II:166, pl. 10, fig. 10; 1898.

McAtee and Malloch describe the single species of this genus taken from within our limits as follows:

"*Female.* Reddish testaceous, shining, without distinct markings, the venter of the abdomen darkest, and the wings unmarked. Head over 1.5 times as long as wide, much tapered anteriorly, convex above, anterior lobe with a deep, short, central longitudinal cavity at posterior margin, the posterior lobe not sulcate. Anterior lobe of prothorax fully twice as long as its greatest width, gradually tapered from anterior to posterior margin, subopaque, with a slight linear sulcus posteriorly, posterior lobe subquadrate, about two-thirds as long as anterior, slightly elevated on each lateral angle and in center posteriorly. Abdominal spiracles slightly raised, no protuberances on tergites, the apical sternite convex at apex; seventh and eighth tergites polished, moderately convex apically, the former three times as long as the latter. Fore legs rather slender, coxa about five-sixths as long as tibia, the latter slightly curved.

"Length, 10 mm."

Localities. Florida, Mexico.

Genus PLOIARIA.

This genus was originally described by Scopoli (1786). McAtee and Malloch discuss its characteristics as follows:

"This genus shows in the structure of the fore tarsi an approach to the form of those of *Barce*, but in the armature of the fore femora there is a stronger resemblance to *Emesa* and its allies. In the winged forms of this genus the pronotum does not extend over dorsum of mesonotum except at the extreme anterior margin. The venation of the fore wing is characteristic and in the hind wing there is immediately behind the cross-vein a distinct thickening of the membrane and a slightly denser appearance similar to that of the costa extending almost across the field of the wing which is not found in any other genus in the subfamily so far as we know. That we have here a group of closely allied species well regarded as belonging to a single genus is evident from the intergradation observable in what have been considered diagnostic characters."

DISTRIBUTION OF GENUS.

This genus is composed of nearly forty described species, distributed as follows: Nearctic, 10 species; Neotropical, 14 species; Palæarctic, 7 species; Oriental, 3 species; Australian, 3 species.

CLASSIFICATION OF GENUS.

The species of this genus which occur within our limits may be separated as follows:

1. Fore trochanters with one or more spines (sometimes merely bristles), usually set on raised bases (the body of trochanter itself often acutely produced), never with numerous setæ; fore femur with 4 to 7 stout spines which are always set on more or less distinctly enlarged and elevated bases, standing in line with or almost in line with a larger number of much smaller spines or bristles on the posteroventral surface, the longer spines sometimes with an outward curvature; apical antennal segment longer than subapical, never shorter than it; length of fore coxa variable in relation to length of fore tibia (subgenus *Ploiaria*) 2

   Fore trochanters nearly bare or with few to numerous fine hairs, one or two of which are sometimes bristle-like; fore femur with the spines or bristles on the posteroventral surface more uniform in length, the larger bristles lacking enlarged elevated bases, and almost straight; apical antennal segment shorter than subapical, equal to it only in *setulifera*; fore coxa invariably longer than fore tibia (subgenus *Lutevа*) .... *setulifera* McAtee and Malloch, p. 51

2. Posterior lobe of head with a prominent median backwardly projecting spine 3

   Posterior lobe of head lacking spine 4

3. Last tergite of male with a slender, obtuse, strap-shaped process extending back over hypopygium and closely adherent to it (Pl. XXI, Fig. 4); median process of seventh tergite of female extending distinctly farther caudad than the acute lateral angles, *denticauda* McAtee and Malloch, p. 54

   Last tergite of male with a shorter, pointed process (Pl. XXI, Fig. 5); hind margin of hypopygium sinuate; median process of seventh tergite of female extending but little farther caudad than the rounded lateral angles .... *hirticornis* (Banks), p. 55

4. Posterior lobe of head with an erect spinelet at margin of eye on each side behind constriction .... *reticulata* (Baker), p. 53

   Posterior lobe of head not so armed 5

5. Fore coxa shorter than fore tibia; wings entirely absent, *aptera* McAtee and Malloch, p. 55

   Fore coxa as long as, or longer than fore tibia; wings or wing pads present 6

6. Fore coxa nearly twice as long as fore tibia; anterior lobe of head with a short, deep sulcus posteriorly; spines on fore femur distinctly longer than the femoral diameter 7

   Fore coxa but little longer than fore tibia; anterior lobe of head without sulcus 8

7. Mesonotum rather depressed, with a broad elliptical sulcus extending nearly its entire length; only soft hairs between the strong posteroventral spines on fore femur; thorax pale above; legs not banded; length 4 mm.; discal cell of fore wing with inner apical part angulate, *uniseriata* McAtee and Malloch, p. 52

   Mesonotum well arched both transversely and longitudinally, without median depression; legs banded; short spines between the strong posteroventral spines on fore femur; larger species, darker colored; inner apical part of discal cell of fore wings rounded, *similis* McAtee and Malloch, p. 53

8. Distance between eyes on dorsum of head greater than the width of one eye; antennæ short hispid or microscopically hispid 9

   Distance between eyes on dorsum of head not greater than width of one eye; basal two antennal segments distinctly hairy, the hairs longer than the diameter of the segments, *pilicornis* McAtee and Malloch, p. 52

9. Fore tarsus fully two-thirds as long as fore tibia; hind border of male hypopygium with slight indentation medially, *carolina* (Herrich-Schaeffer), p. 51

Fore tarsus not two-thirds as long as fore tibia; hind border of male hypopygium with no median indentation... *floridana* (Bergroth), p. 52

Ploiaria setulifera McAtee and Malloch.

McAtee and Malloch, Proc. U. S. Nat. Mus., LXVII:55; 1925.

"*Female.* A pale yellowish brown species without conspicuous markings, the apices of hind and mid femora whitish. Fore wings with a few brown markings consisting of poorly defined spots or streaks, the most noticeable situated in middle of discal cell and just behind discal cell on inner side of wing.

"Head similar to that of *pilicornis;* pronotum almost uniform in width to near posterior margin, where it is slightly flared, microscopically granulose and not sulcate; mesonotum with a very shallow, broad, central sulcus. Fore coxa about 1.5 as long as pronotum; fore trochanter with some fine hairs and one or two distinct, but short bristles; fore femur as in preceding two species (*brunnea* and *sciaria*); fore tibia half as long as femur, with a ventral series of decumbent setulæ, which are directed apicad, very minute at base and becoming gradually longer apically; fore tarsus over three-fourths as long as tibia, extending almost to base of femur.

"Length, 8 mm."

Biology. McAtee and Malloch describe what is probably the nymph of this species as follows:

"There are also three nymphs from the same localities which agree in most respects with the foregoing description. The wing pads are present, there are only two segments in the tarsi, and the armature of the fore legs is relatively stronger (especially in the bristling of the trochanter), more noticeably so in the younger specimens."

Blatchley reports taking this insect from dead leaves of cabbage palmetto and of royal palm, and from Spanish moss.

Locality. Florida.

Ploiaria carolina (Herrich-Schaeffer).

Herrich-Schaeffer, Wanz. Ins., IX:8, fig. 936; 1853. *Emesodema carolina.*

McAtee and Malloch describe this species as follows:

"A dark-brown species with a pale dorsocentral line on head and thorax, the fore femora with fairly prominent pale annuli and the apices of mid and hind femora yellowish. The wings are brown and faintly marbled with darker brown, not distinctly reticulated with fine brown lines as in some species; a darker spot in discal cell.

"In the nymph there is a rather noticeable central elevation on anterior margin of posterior lobe of head, but in the mature specimens this is almost or entirely absent. The apterous forms have the pronotum tapered posteriorly and almost without a constriction before the hind margin on top, the sides somewhat flared; in the winged forms the hind margin is noticeably flared dorsally also. Male hypopygium with slight indentation in middle of hind margin. Fore femur stout, with 6 or 7 long posteroventral spines, the longest fully as long as the femoral diameter, the apical one well beyond middle of femur; fore tibia without readily distinguishable setulæ, but somewhat densely haired.

"Length, 4.5-5.5 mm."

Biology. The only reference to the immature stages of this insect is that given in the above description. Blatchley reports taking the insect from flowers of Compositæ, and from beneath bark of a pine log.

Localities. Georgia, North Carolina, Florida.

Ploiaria floridana (Bergroth).

Bergroth, Konowia, I:218-219; 1922. *Lutera floridana.*

The following descriptive notes, taken from McAtee and Malloch, will supplement the key:

"*Male.* Very similar to the preceding species, differing as stated in the key. The pronotum is without the slight dorsomedian sulcus of *carolina*, the eyes in the winged form are larger, and the longest spines on the posteroventral surface of fore femur are not as long as the femoral diameter; fore tibia not so much expanded distally; central spine on posterior border of hypopygium apparently simple instead of paired. The fore wing has the venation as in *denticauda.*

"Length, 6 mm."

Locality. Florida.

Ploiaria pilicornis McAtee and Malloch.

McAtee and Malloch, Proc. U. S. Nat. Mus., LXVII:61; 1925.

"*Male.* Similar to *bispina* in color, but the fore femur has a faint subapical fuscous annulus.

"The head is slightly broader than in *bispina*, the pronotum is not sulcate and is more constricted before the hind margin, the fore femora are stouter, the short spines are less numerous, the long spines are longer, the longest fully as long as the femoral diameter, and the apical one is at one-third the length of femur from apex. Hind border of hypopygium slightly concave.

"Length, 5.5 mm."

Locality. Higley, Ariz.

Ploiaria uniseriata McAtee and Malloch.

McAtee and Malloch, Proc. U. S. Nat. Mus., LXVII:61; 1925.

"*Male.* Brownish fuscous, dorsum of mesonotum yellowish-testaceous, antennæ and legs brown, not noticeably annulated. Wings with dusky reticulation and a more prominent spot in discal cell and in area of wing just posterior to it on inner side.

"Eyes large, as high as head and nearly half its length, width of one above equal to space between them; posterior margin of anterior lobe of head and anterior margin of posterior lobe each with a short deep sulcus in the center, on each side of which the surface is slightly tumid; antennæ long-haired. Pronotum not much tapered, very slightly flared posteriorly; mesonotum gradually widened posteriorly, with a shallow median dorsal sulcus; mesonotum ending in a rounded knob; metanotum with the margin raised and three discal carinæ.

"Fore coxæ slender, about 1.25 as long as pronotum; trochanter with one long curved spine and one or two shorter bristles; femur curved, a little thicker than the coxa, posteroventral series of spines consisting of about six, their bases slightly swollen, the longest more than twice as long as the femoral diameter, the spines bent outward; ventral surface fine-haired, with a series of short erect setulæ on median third; anteroventral spines much shorter than posteroventral, about seven in number, inwardly curved, a wider space in the series near base for the reception of the tarsus; fore tibia two-thirds as long as coxa, with fine setulæ along anteroventral surface which are about as long as tibial diameter; tarsus about as long as tibia, basal segment with microscopic setulæ posteriorly. Transverse vein at one-third the distance from tip of wing to apex of discal cell, the latter narrowed anteriorly. Hypopygium rather long, black and polished medianly, claspers long and slender, much curved and tapered on apical half; apical tergite convex posteriorly.

"*Female.* Similar to male in armature of the fore legs. The eyes are much smaller; there are only small wing pads present; the abdomen is much more robust and there are small but distinct processes on middle of hind margins of tergites; seventh tergite horizontal, with a short, triangular, median process, the margin concave, then angled each side of it; eighth tergite deflexed, narrowed toward apex, which is transverse.

"Length, male, 4 mm.; nymph, 3.5 mm."

Locality. Brownsville, Tex.

Ploiaria similis McAtee and Malloch.

McAtee and Malloch, Proc. U. S. Nat. Mus., LXVII:62; 1925.

"*Male.* Similar to the preceding species in color and structure, differing as stated in the key, and in size.

"Length, 8 mm."

Locality. Brownsville, Tex.

Ploiaria reticulata (Baker).

Baker, Pomona Jl. Ent., II:225-6; 1910. *Ploiariopsis reticulata.*

Description given by McAtee and Malloch:

"*Male.* Head and thorax testaceous yellow, mottled with fuscous. Antennæ stramineous, basal segment fuscous at base and apex and with a rather broad subapical and a narrow apical whitish annulus; beak annulate. Mesonotum with two linear submedian brown vittæ, laterad of these the disk is grayish, each lateral margin broadly brown. Abdomen black, faintly speckled with yellowish, spiracles white. Legs stramineous, fore pair mottled with blackish and rather imperfectly annulate, mid and hind femora with faint brownish dots on basal half and each with three broad brown annuli on apical half. Fore wings with brownish fuscous markings, forming reticulations on the greater part of the disk, the most distinct marks being two long blackish streaks, one in apical half of discal cell and the other beyond that cell and behind the longitudinal vein but distinctly clear of it, the hind margin of the vein narrowly brown.

"Head about as broad as long, with a small, sharp spike at eye margin just behind transverse dorsal constriction, and a small round protuberance behind eye on each side of head; antennæ long-haired, third segment fully as long as fourth. Pronotum slightly flared posteriorly. Hypopygium with a bifid process projecting upward inside of hind border, the claspers not very long, curved, tapered at apices.

"Fore trochanters produced into an acute process below which is armed with two or three spines. Fore wing with discal cell subequal in length to longitudinal vein beyond it, the transverse apical vein faint, situated at nearly three-fourths the distance from apex of discal cell to apex of wing, the longitudinal vein bent down apically.

"Length, 9 mm."

Biology. The author of this species reports that it is common at Claremont, California.

Locality. California.

Ploiaria denticauda McAtee and Malloch.

(Pl. XXI, Fig. 4.)

McAtee and Malloch, Proc. U. S. Nat. Mus., LXVII:63; 1925.

"*Male.* This species is colored like *granulata*, but the femoral and tibial annulation is much less distinct.

"In addition to the characters mentioned in the key it differs from *granulata* as follows: The fore coxæ, fore femora, and the pronotum are not granulose and haired as in that species, the posteroventral spines on fore femur are in an almost regular series, the bases of the longer spines are pale, but little differentiated from the spines and both combined are but little longer than the femoral diameter; the fore tibia has the series of setulæ on posteroventral surface very weak and short and that of basal half of anteroventral surface practically absent; the fore tarsi are as long as tibiæ. The male hypopygium with hind margin sinuate, the tergites are not produced on sides and the processes on the middle of hind margins of tergites except the last one are very small. The series of males contains winged and subapterous specimens.

"*Female.* Similar to male, but the apical tergites are as described in key, and the antennæ are very short hispid instead of long-haired.

"Length, 5-5.5 mm."

Localities. Arizona, California.

Ploiaria hirticornis (Banks).

(Pl. XXI, Fig. 5.)

Banks, Psyche, XVI:44; 1909. *Ploiariopsis hirticornis.*

Described as follows by McAtee and Malloch:

"This species closely resembles the last in structure of the fore legs, but the coxæ are more slender and nearly twice as long as the tibiæ, the fore tarsi are as long as the tibiæ, the elevated bases of the long spines of posteroventral series are about as in the last species, white, and the spines are blackish; the pronotum is longer and narrower than in *granulosa*, the abdomen has no lateral projections on tergites and the dorsal tubercles are small anteriorly, increasing in size posteriorly; the seventh tergite of the female has the lateral angles slightly produced and a longer central process; all our specimens have minute wing pads except one male paratype which is fully winged; the wings are rather closely reticulated with fuscous, the heaviest markings being in discal cell and along hind side of vein emanating from it.

"Length, 5-6 mm."

Biology. "An immature female from Shreveport, La., has the abdomen inflated, especially posteriorly, median tubercles on all tergites, that on five most prominent; eighth tergite concave apically, without process."

Blatchley reports taking specimens from beneath a board, and from dead leaves of cabbage palmetto.

Localities. District of Columbia, North Carolina, Louisiana, Florida.

Ploiaria aptera McAtee and Malloch.

McAtee and Malloch, Proc. U. S. Nat. Mus., LXVII:66; 1925.

"*Female.* Much paler than *marginata*, the dorsum of thorax little darker than the venter.

"Head as in the preceding species, but the eyes comparatively larger and the subapical antennal segment appreciably longer than the apical. Fore coxæ, femora and tibiæ similar in lengths to those of *marginata*, the posteroventral long and short spines between each pair of the long spines and none opposite their bases; there is an isolated spine near base on anteroventral surface, the anteroventral series of setulæ on apical half of tibia is stronger than in *marginata*. Abdomen ovate, distorted in type, but evidently lacking well-developed median processes on hind margins of tergites.

"Length, 5.5 mm."

Locality. Galiuro mountains, Arizona.

Genus GARDENA.

This genus was described originally by Dohrn (1860). It is characterized by McAtee and Malloch as follows:

"Characters common to all American species besides those mentioned in the generic key are: head lacking spines, prothorax (measurements taken on dorsum) twice or more than twice as long as meso- and meta-thoraces taken together (even in wingless forms); the anterior division of prothorax is trumpet-shaped with a low tubercle each side in front and expands posteriorly in the winged forms into a capacious, inverted, scoop-shaped, highly polished portion which completely covers the mesothorax, hind margin usually somewhat concave with a slight median swelling, but there are notable departures from this character in some species; mesopleura and mesosternum lightly polished, either subnude or with a bare stripe in front of coxa; hind margins of sternites 2-6 in both sexes more or less emarginate medianly and arcuate laterally, most pronounced so on 6; sixth sternite in males visible from above, forming apparently an almost complete body ring; in most species it is overlaid dorsally by a flaplike process of sixth tergite; the ninth sternite also is largely exposed dorsally, where it is divided by a broad V-shaped cleft open posteriorly; the surface of the hypopygial segments is polished; all of the legs and the antennæ exceed the body in length; antennæ of males with abundant long hairs decreasing in length and erectness distally, especially from middle of second segment; fore tibia haired.

"Coloration in the genus is very uniform, the species being chiefly castaneous, darkest on front legs, prothorax, and genitalia; the mid and hind trochanters and knees are stramineous, the pale base of tibia being more or less interrupted by fuscous; the tegmina and wings in most cases are dusky hyaline, whitish at base."

DISTRIBUTION OF GENUS.

This genus is composed of 17 described species, distributed as follows: Nearctic, 2 species; Neotropical, 10 species; Palæarctic, 1 species; Oriental, 4 species.

Gardena messelina McAtee and Malloch.

McAtee and Malloch, Proc. U. S. Nat. Mus., LXVII:72; 1925.

"*Female.* Front femora each with a faint subapical band; mid femora and tibiæ each with two pale bands. Seventh tergite very slightly convex on hind margin, eighth moderately long, semi-elliptical; ninth very convex transversely, somewhat constricted near middle of exposed portion, rounded apically. Sixth tergite with a deep emargination posteriorly, involving the entire hind border; seventh sternite long, with a short, median triangular process posteriorly, sides of hind margin slightly concave; eighth sternite broadly exposed on sides, profoundly emarginate in middle.

"Length, 17 mm."

Locality. Victoria, Tex.

Gardena poppæa McAtee and Malloch.

McAtee and Malloch, Proc. U. S. Nat. Mus., LXVII:74; 1925.

"*Male.* Posterior margin of hypopygium with two teeth, the superoposterior angles considerably elevated, portion of this sternite visible from above as long as seventh tergite including process, the latter barely lapping base of V-shaped cleft of hypopygium, its length compared to entire tergite as 3 is to 8; claspers retracted, their form unknown.

"Length, 20 mm."

Locality. Victoria, Tex.

Genus EMESAYA.

The authors of this genus, McAtee and Malloch, discuss it as follows:

"For *Emesa* of authors not of Laporte who named *E. mantis* Fabricius as type. Since this species belongs to the genus subsequently called *Westermannias* the latter name therefore falls into synonymy, and the insects formerly known as *Emesa* are left without a distinctive name.

"Characters of the genus besides those mentioned in the key to genera are: Mid and hind legs and antennæ longer than body; head without frontal spine, the transverse sulcus convex posteriorly, its ends in front of eyes, its middle course between them; prothorax in unwinged forms somewhat shorter than meso- and meta-thoraces together, in winged forms decidedly longer, expanded posteriorly and entirely covering dorsum of mesothorax, its hind margin more or less concave medianly; wings extending only to about middle of abdomen; sutures between tergites difficult to distinguish, those seen are straight; sixth tergite of male ending in a long apically rounded flap covering hypopygium; sutures between sternites convex anteriorly, that between 5 and 6 most so; hypopygium of male long, somewhat compressed, hind margin with median process; in females the seventh tergite is approximately semicircular in outline, the eighth is oblong, somewhat tapering apically, with the apex variously modified, yielding the most valuable characters for the separation of species; the connexivum is more elevated in females than in males. Structure of fore tibia and tarsus and venation of wings as given.

"Coloration of genus is simple, the general tone varying from stramineous to reddish (erythrization being especially characteristic of maturity); the whole head and body has a fine short sericeous pubescence, bare spots and lines in which account for most of the apparent markings, as a line over anterior half of pronotum and head, forked in front of transverse construction, a straight line under each eye, cirrhose maculations on pronotum, and dotting over both upper and lower surfaces of abdomen; the mesosternum and mesopleura are entirely sericeous, not glossy as in *Gardena*. The front legs are entirely dark-spotted and the spines dark-tipped; at least the knees (femoratibial joints) of mid and hind legs are pale, often there is another distinct pale band each side of this joint. When the antennæ are not pale entirely the first segment is pale apically. The wings vary from stramineous to fuscous-hyaline, often paler at base."

DISTRIBUTION OF GENUS.

Ten species have been described for this genus, all American. Seven of these are represented in the Neotropical region, and five within our limits.

CLASSIFICATION OF GENUS.

The species found within our limits may be separated as follows:

MALES.

1. Hind margin of hypopygium nearly straight across, bearing on its inner side a process which extends upward and forward between (and usually concealed by) apices of claspers..........*brevipennis* (Say), p. 59

Hind margin of hypopygium produced, in the plane of its outer surface, into a process which is not concealed between apices of claspers, *incisa* McAtee and Malloch, p. 58

FEMALES.

1. Seventh tergite with a pair of divergent carinæ bounding disk, within and distinct from the ridges which divide the upper surface from the down-folded lateral portions of the tergite........................ 2
   Seventh tergite without such carinæ................................. 3
2. Fore femur about 7.5 mm. long; fore coxa hardly twice as long as head, *brevicoxa* (Banks), p. 58
   Fore femur about 9 mm. long; fore coxa fully twice as long as head, *banksi* McAtee and Malloch, p. 58
3. Hind margin of eighth tergite between the processes decidedly concave, the emargination broadly U-shaped; seventh and eighth tergites with a median longitudinal bare and slightly elevated tergite subangulate posteriorly......................*lineata* McAtee and Malloch, p. 67
   Hind margin of eighth tergite between the processes nearly straight, the emargination nearly rectangular; seventh and eighth tergites lacking such a line; side of eighth tergite not at all angulate posteriorly, *brevipennis* (Say), p. 59

Emesaya brevicoxa (Banks).

Banks, Psyche, XVI:48; 1909. *Emesa brevicoxa.*

McAtee and Malloch give the following notes on this species:

"The carinæ of seventh tergite, not mentioned in original description, are very distinctive, grouping the species with the new form *banksi* described below. The coloration is scarcely different from that of *E. brevipennis;* however, it was noted that the mid and hind tibiæ are entirely pale except for a subbasal dusky band on each. Approximate measurements are: Length of head and body together 29 mm.; of fore coxa, 5 mm.; of fore femur 7.5 mm."

Locality. California.

Emesaya banksi McAtee and Malloch.

McAtee and Malloch, Proc. U. S. Nat. Mus., LXVII:77; 1925.

"Agrees with *E. brevicoxa* Banks in carination of seventh tergite but differs in measurements of front legs as indicated in key. The posterior lateral angles of eighth tergite are less produced than in *E. brevicoxa* and much less than in average specimens of *E. brevipennis* Say. General color pale reddish-brown, short gray pubescence abundant; leg bands only faintly indicated.

"Length about 29 mm."

Localities. Texas, California.

Emesaya incisa McAtee and Malloch.

McAtee and Malloch, Proc. U. S. Nat. Mus. LXVII:78; 1925.

"Somewhat smaller than *E. brevipennis*, and most of the species are paler than the average color in the genus, this being especially true of the legs and antennæ; the dark annuli therefore unusually prominent.

"*Male.* Ground color stramineous, broad vittæ on sides of head and posterior lobe of pronotum (sometimes whole of this expansion), dorsum of abdomen more or less, leg bands and dots fuscous. Genitalia as described in key.

"Length, 24-27 mm."

Localities. California, Arizona, Mexico.

Emesaya brevipennis (Say).

McAtee and Malloch divide this species into three subspecies as follows:

1. Processes of eighth tergite shorter and more rounded as seen from above; disk of tergite stramineous, with more copius and longer pubescence, giving it a sericeous appearance........................*occidentalis.*
   Processes of eighth tergite longer, more slender and pointed; disk of tergite darker, pubescence shorter and sparser...................... 2
2. Pale annuli on mid and hind legs tending to obsolescence, especially in the males, often the knees only pale........................*australis.*
   Full complement of pale leg markings usually evident in both sexes, *brevipennis.*

Emesaya brevipennis brevipennis (Say).

(Pl. 1.)

"In general color this subspecies varies from rubiginous to fuscous with the pale leg markings distinct; nymphs and teneral specimens redder or darker. Genitalia as described in key.

"Length, 28-36 millimeters."

Biology. Because of the commonness of this species, there have been numerous observations made on its habits, more, in fact, than in the case of any other member of this subfamily. Accompanying the original description, we find the following observation by Say (1828):

"This is a very common insect, and is often found even in the city of Philadelphia. It inhabits outhouses, where it may be observed generally motionless on the walls. When disturbed, it moves its body up and down on its legs, and at the same time advances slowly forward."

Uhler (1884) discusses its life and habits rather fully. Part of this discussion I quote:

"When lodged on the twig of a tree or bush it has a curious habit of swinging backwards and forwards like some of the long-legged spiders, such as *Phalangium.* . . . In Maryland its principal home is in the young pine trees, where it may be seen with its two fore feet placed close together and stretched out in front, as is the common habit of our common phasmid, *Diapheromera femorata.* Occasionally it leaves the trees and takes shelter in sheds, outhouses, and barns, where it may be seen overhead swinging by its long legs from a rafter or the lining of the roof. The immature form may be found roaming over the trees during early summer, but by the middle of August it acquires the organs of flight and becomes a fully developed insect. We do not yet know where it deposits its eggs; but from analogy we are led to believe that these are glued to the twigs of bushes and trees, just as is the case with many others of the great group to which this species belongs. The fore legs are most formidable instruments in catching and securing the insects upon which it feeds; the long fore coxæ project far in front of the head, and furnish a swinging joint for the spined femora, which can be thrown forward like a flail, while at the same time the sharp tibiæ are shut back against the acute spines, and the victim is thus irretrievably transfixed."

The eggs, which at the time that Uhler wrote had not been found, were first mentioned by Dr. Hagen, who stated that the eggs were of an elongated, conical form. Weed (1899) concluded that Uhler's suspicion that the eggs were glued to the twigs of trees and bushes was probably correct, since specimens which he had in captivity deposited eggs on the sides of the breeding cage, gluing them to the wood. Weed described and figured the egg.

Champion (1899) described and figured a nymph of this species.

Wickham (1909 and 1910) made some valuable contributions to our knowledge of the life of this insect. His observations were made on a colony in a shed in his yard. Observations on the flight, feeding habits, copulation and oviposition of this species are particularly valuable. I quote parts of his account:

"Unless disturbed, the bugs were not seen to move much during the middle of the day, but towards the end of the afternoon would come out and fly slowly and awkwardly through the lane between the trees, their long legs and slender bodies retarding aërial progress despite the swift beat of the little wings. With the sun glinting against the coating of dust particles they made a curious and interesting sight—like nothing else that I have ever seen.

"I was very anxious to see something of their feeding habits, since the published statements are somewhat vague or even contradictory. I did at last find one at rest upon a screen door, sucking a gnat about the size of the common mosquito of these parts, and it is probable that in general only small or fragile insects are attacked. Some of the numerous captive *Emesæ* were seen to take the juices from the bodies of dead flies and spiders with which they had been provided, but they were not seen to catch nor kill any of the living specimens of these insects which were put in with them. Eventually they fed upon their own kind. Every morning I would find one or two dead bugs in the cage, one frequently serving as food to a living individual which was extracting the fluids by means of its short, sharp beak. I saw no evidence of attack. It may be that those dying of age or weakness were simply utilized as food by their survivors. Occasionally I saw free specimens of *Emesa* at rest in spiders' webs, not entangled but ready to move when disturbed; still I never saw any evidence of the spiders being attacked nor of other insects being taken from the webs. Twice, however, I noticed remains of *Emesa* in webs, one of which belonged to *Agalena*. The bugs had apparently been sucked dry, one of them chewed as well, the fragments being held together with bits of silk. Living specimens were seen out of doors as late as October 5, up to which date we had no heavy frosts.

"The copulating habits of these beasts seem to be undescribed. Just before eight o'clock on the morning of September 18 I found a pair of them on the kitchen screen. Union had already been effected when I came on the scene and lasted only about five minutes afterwards. In the meantime I had made some notes and a sketch which will give some idea of the curious pose assumed by the male. He stands upon his hind legs, some little distance behind the female, who is in her resting position, his middle legs cling by their tarsal claws of the hind legs of the female, which are grasped a little below the knee. The male abdomen is bent downwards at a sharp angle with the exterior part of the body, the tip overlapping the apex of the female abdomen on the left side. The front legs in both sexes, are extended forwards, those of the male having the tibia folded back on the femur while in the female it is open. The female started to walk away, but the male was equal to the emergency, being able to accompany her and yet to hold his position by tiptoeing on his hind feet and releasing the hind legs of the female alternately or both at once as she moved."

McAtee (1911) reports the feeding of this insect on *Anopheles* mosquitoes on the window screens of a house in Big Lake, Ark.

Howes (1919) discusses this insect at some detail, and makes several statements contrary to those of Wickham. One of these is that the wings of the species are now degenerate, "scarcely capable of easing her fall when dropped from one's hand." In regard to feeding habits, Howes says that flies and bees form the insect's chief article of diet. He considers it the normal thing for this insect to take up its abode in an abandoned spider's web, and there to subsist on insects that become entangled in the web, and describes a "stampede" of a large number of thread-legged bugs racing slowly towards an unfortunate insect caught in a spider's web. Wickham's opinion that only very small, fragile insects may serve for food is not shared by Howes, who says:

"Flies, bugs, and even bees hold no terrors for this insect, who is immune from their bites and stings. From their position in the creature's outstretched arms they can reach no vital spots. A wildly darting sting, a poisoned fang or a tireless set of muscles are of no avail, and the thread-leg feeds at leisure."

Howes' excellent photographs which accompany his paper are a valuable part of his contribution. His photographs of the molting and of the oviposition of this insect are particularly good.

McAtee and Malloch (1925) figure and describe the egg and describe a six-millimeter nymph, instar undetermined; they also include a note on the number of eggs laid.

The writer wishes to summarize the above information, to call attention to doubtful points, and to add what he can to what is already known.

Habitat. There is no uniformity of opinion in regard to the normal habitat of this insect. Weed speaks of finding it only out of doors on the trunks of trees; Howes considers it to be typically a shed and outhouse inhabiting species, and Uhler mentions having found it in both situations. The colony upon which the present writer made his observations was located in a carriage shed at Lake View, Kansas, although there are specimens in his collection taken from trunks of trees in Kansas. Probably Wickham's explanation of the habit of flight will solve the problem. He states that during the greater part of the day the adults are inactive, but that late in the afternoon they leave their protecting shed, and fly among trees. This, however, would not account for Uhler's finding the immature forms "roaming over the trees in early summer." The writer's opinion is that this is not typically an out-of-doors species, but lives for the most part in sheds, outhouses, and deserted houses and barns.

Several writers report finding the insect associated with spiders' webs, and Howes considers that insects caught in abandoned spider webs constitute its main food supply. In regard to whether the insect is dependent upon food caught in the spider web, the writer is uncertain, but he is certain that the insect hangs from abandoned webs as well as from rafters, and that it can make its way over a web without any embarrassing entanglements.

Food. Weed records *Emesaya* feeding on a small moth, possibly *Spilosoma virginica.* Wickham observed one feeding on a gnat and concluded that they fed only on very small and fragile insects. Howes says that flies and small bees form their chief articles of diet, and says that *Emesaya* is immune to their bites and stings. Wickham, in addition to his other observations, reports that they are cannibalistic. Records of the writer report the feeding on a small moth, undertermined, and a small spider, also undetermined. Unconfined individuals have been observed feeding, in one case on a small dipterous insect, undetermined, and in another case on the biting house fly, or stable fly, *Stomoxys calcitrans.* In addition the insects have been reared successfully on a diet of the house fly, *Musca domestica*, and have been observed to feed on this insect very commonly. In addition, instances of cannibalism, previously reported by Wickham, have been observed. In one case a female adult which had recently molted was attacked and sucked dry by a male with which she had been confined. Several other cases, which could not be explained by any known weakness of the victims, also occurred.

Seasonal Life History. This insect hibernates in the egg stage. The eggs hatch in late spring, May in Kansas, and the greater part of the summer is spent as a nymph, the insect becoming adult in late August or early September, and living until the cold weather of late October or early November. The eggs are deposited during the warm days of September and October. Such a life history allows only a single generation a year, and no evidence contrary to this has been found.

Eggs. (Pl. I, Fig. 7.) The eggs have been observed and described by several writers, including Hagen, Weed, Wickham, Howes and McAtee and Malloch. I quote the description given by the last-mentioned writers:

"The eggs of this species are about 2 millimeters in length, long-elliptical in outline, the opercle with a large central, truncately conical tubercle, the periphery of which is more or less eroded at the base; the main body of the egg is black in ground color, somewhat compressed and with longitudinal rows of membranous, saw-toothed-shaped exfoliations, the bases of which are almost continuous; these lines of projections are arranged more or less in concentric ellipses on the flat side of the egg."

These eggs are laid singly, attached to the bark of trees, particularly evergreens (Weed), or to rafters (Howes). The writer has collected eggs which were attached to rafters of a shed, and has also found them attached to a spider's thread. There is also a specimen of a female in my collection with two eggs of her species attached to her hind tibia, probably attached there by another individual after she had died. Each egg is attached along one side near the base, held in place by a cement. The egg is inclined and forms an angle with the surface upon which it rests.

The number of eggs deposited by a single female was reported by Wickham to be nineteen, these being deposited over a period of three or four days. McAtee and Malloch report having obtained twenty eggs from a female between the dates of October 6 and 11.

The details of the act of oviposition have not been reported upon, though Howes gives a very good photograph of the insect showing the position of the body during the act.

Mating. The act of copulation of this insect has been described by Wickham, whose description is quoted above. Apparently he saw but a single pair mating, and did not witness the act from the beginning. The writer has had the opportunity to witness mating several times. Previous to the actual coupling, the male approaches the female, not necessarily from behind, but soon maneuvers into a position directly behind her. During this time his abdomen is bent at the point of its juncture with the thorax so that it extends forward under the thorax. He now attempts to mate with the female, advancing forward and usually resting his middle legs on her body and legs; however, not necessarily on the tibia of her hind leg just beneath the knee joint, as is described by Wickham. Connection is established by the bent abdomen of the male with its copulatory organs extruded and bent upwards first coming in contact with the under side of the female abdomen, and then sliding backwards until the opening of the genital organs is reached. During the preliminary part, and for a while afterwards, the head of the female can be seen to be bobbing up and down, and a good ear can detect a very faint stridulatory note, which is undoubtedly produced by the rubbing of the tip of the beak in the ridged groove on the prosternum. The female attempts to avoid copulation. In one case a female was seen to grasp the tibia of the middle leg of a male with which she was at the time coupled, and apparently to insert her mouth parts in it. However, the male successfully completed copulation and continued to live. In another case a male was observed to have grasped the female with which he was mating around the head, holding her beak firmly to the under side of her head. Copulation lasted varying lengths of time, from ten minutes in some cases to several hours in others, and the same pair was observed to mate several times.

Natural Enemies. Wickham mentions finding remains of this species in spider webs, one of which belonged to *Agalena*, and assumed that they had served as food for spiders. The writer has also found individuals entangled in webs. No actual observations of spiders feeding on these insects have been recorded, however.

A small hymenopterous parasite was observed making its way out of the egg of this insect by the writer, and careful collecting produced several other eggs which showed emergence holes of parasites. The parasite makes its way out through the side of the egg, rather than through the top by pushing the cap off, as does the host insect.

DESCRIPTION OF INSTARS.

First Instar. (Pl. I, Fig. 1.) Length of body, 5.3 mm. to 6.5 mm.; length of front femur, 1.3 mm.; length of first antennal segment, 2.9 mm.

General color dirty whitish with fuscous markings along lateral margins of head and thoracic segments; eyes red; location of abdominal spiracles marked by fuscous spots; apices of femora and bases of tibiæ of mid and hind legs banded with alternate dark and light; front legs fuscous with whitish markings; spines of femur white, tipped with black; first antennal segment fuscous with whitish apex; second and third segments also with light apices.

General shape extremely elongate, with thread-like legs and antennæ as is the case in all nymphal instars and adult; head about twice as long as wide, slightly swollen behind the eyes; first antennal segment longest, second nearly as long, third very short, and fourth nearly half as long as second and sharply pointed; rostrum slender, the tip fitted into groove on under side of prothorax; front legs raptorial, with elongate coxæ, femora with two rows of ventral spines, occupying about three-fourths of the basal length, the basal spine the longest, tibia not more than half the length of the femur.

Second Instar. (Pl. 1, Fig. 2.) Length of body, 10 mm.; length of front femur, 2.1 mm.; length of first antennal segment, 3.3 mm.

General color whitish with fuscous vittæ on lateral margins of head, thorax and abdomen, also dorsal dark spots on abdomen; eyes red; a faint, often interrupted, median red line running caudad from epicraneal suture to caudal limit of thorax, barely visible in some individuals; markings of legs and antennæ as in previous instar; proportionally longer and more slender than preceding; spines on fore femur more numerous; wing pads not visible in this instar.

Third Instar. (Pl. I, Fig. 3.) Length of body, 16.5 mm.; length of front femur, 3.2 mm.; length of first antennal segment, 6 mm.

Color as in preceding with increase of dark markings on upper surface of body; similar to preceding in structure with proportional increase in size. Wing pads present, mesothoracic pads arise on dorsum opposite most caudal point in attachment of second pair of legs, about .15 mm. long; metathoracic pads arise at a point about three-fifths the distance from the attachment of the middle legs to the attachment of hind legs, less than one-half as long as mesothoracic pads.

Fourth Instar. (Pl. I, Fig. 4.) Length of body, 26 mm.; length of front femur, 5.3 mm.; length of first antennal segment, 9.2 mm.

Color much as in preceding with an increase in number of dark markings on upper surface of thorax and abdomen. Similar in structure and proportions to preceding; wing pads larger, first pair now a little over a millimeter in length and extended over bases of hind pair, these extended about .7 mm. beyond apices of first pair; both long and slender with pointed apices.

Fifth Instar. (Pl. I, Fig. 5.) Length of body, 34 mm.; length of front femur, 6.5 mm.; length of first antennal segment, 12.5 mm.

General color whitish, marked with numerous fuscous vittæ; upper surface of head marked with fuscous; eyes red; a median reddish line from epicraneal suture to the base of head and continued on thorax; antennal segments somewhat fuscous, whitish at apex of each except last segment; prothorax with slender median reddish line; middle region of disk white, margined with fuscous; mesothoracic pads whitish with longitudinal fuscous vittæ; abdominal segments darker than head and thorax, marked with numerous longitudinal vittæ, spiracles black; front legs whitish, marked with fuscous; spines of fore femora white, tipped with black; middle and hind legs light, each femur bearing two dark bands and each tibia one dark band.

General shape very narrow and elongate as in other nymphal instars and adult. Structural features as in other nymphal instars; wing pads now increased in size; those of mesothorax extended over those of metathorax for entire length; both extended as far as attachment of hind legs.

Localities. Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Maryland, North Carolina, Florida, Indiana, Illinois, Iowa, Texas, Kansas.

Emesaya brevipennis australis McAtee and Malloch.

"From the Gulf states southward to Panama occurs what seems to be a geographical race characterized by a strong tendency, which is almost universal among the males, to lack all pale-leg markings except at the knees. We have not been able to correlate this character with any structural differences, whether of gentalia or otherwise, although it is noticeable that in this form the processes of the eighth tergite often are shorter than in northern specimens."

Distribution. Texas, Georgia, Florida, Panama, Guatemala, Costa Rica.

Emesaya brevipennis occidentalis McAtee and Malloch.

"The general color is rufo-stramineous with all markings, whether darker or paler, much less noticeable than in *E. brevipennis.*

"Length, 31-34 mm."

Localities. California, Lower California.

Emesaya lineata McAtee and Malloch.

McAtee and Malloch, Proc. U. S. Nat. Mus., LXVII:81; 1925.

"*Female.* Knees of posterior two pairs of legs pale, the middle legs with, the hind legs without, a faint subbasal pale annulus on femur; legs in general pale, head and body dark reddish-brown.

"Length, 31 mm."

Locality. Crescent City, Fla.

Genus METAPTERUS.

This genus was originally described by Costa (1860). Recently the American members of this genus, which had been previously placed in the genus *Barce*, were identified as belonging to this genus by McAtee and Malloch (1925).

DISTRIBUTION OF GENUS.

The genus is composed of eight described species, seven of which are Nearctic in distribution, and one Palæarctic.

CLASSIFICATION OF GENUS.

The species of this genus which occur within our limits may be separated by the following key, that prepared by McAtee and Malloch.

MALES.

1. Basal spine of posteroventral series on fore femur less than its own length from base of femur; apical outline of hypopygium from side irregular ....*aberrans* McAtee and Malloch, p. 68

   Basal spine of posteroventral series on fore femur more than its own length from base of femur; apical outline of hypopygium from side usually regularly rounded 2

2. Head with a pale yellowish stripe along venter which is of about equal width on its entire length, filling the interocular space, and without a dark spot on each side behind eye; upper margin of hypopygium with a squarish backwardly curved process which is more or less emarginate at tip, no erect spine within the upper margin of hypopygium.. 3

   Head with a pale yellowish stripe along venter which is narrower than interocular space or has a distinct dark spot on each side behind eye; upper margin of hypopygium not produced backward at apex, with a long spine within upper margin of hypopygium.................... 5

3. Fore coxa about twice as long as fore tibia.......................... 4

   Fore coxa less than 1.5 as long as fore tibia.........*banksi* (Baker), p. 69

4. Mid and hind femora each with more than one brown band; seventh tergite obtusely rounded, projecting little if any beyond hypopygium, *annulipes* (Stal), p. 70

   Mid and hind femora each with only one brown band; seventh tergite more acutely rounded and projecting more or less beyond hypopygium ....*fraternus* (Say), p. 70

5. Apical spine of hypopygium conspicuously backwardly curved at tip (Pl. XXI, Fig. 6); general color fuscous; surface rugulæ of abdomen both above and below forming a distinct reticulation..*uhleri* (Banks), p. 69

Apical hypopygial spine straight or almost so, only slightly curved at tip (Pl. XXI, Fig. 7); general color stramineous; surface rugulæ of abdomen chiefly longitudinal, not forming a reticulation, *neglectus* McAtee and Malloch, p. 69

FEMALES.

1. Basal posteroventral spine on fore femur less than its own length from base of femur; apical tergite entire, *aberrans* McAtee and Malloch, p. 68

Basal posteroventral spine on fore femur more than its own length from base of femur.. 2

2. Head with a pale yellowish stripe on venter which is not decidedly narrower than interocular space nor with a dark spot on each side behind the eye 3

Head with a pale yellow stripe on venter which is narrower than interocular space or has a dark spot on each side behind the eye.......... 5

3. Fore coxa only about one-third longer than fore tibia, *banksi* (Baker), p. 69

Fore coxa nearly or quite twice as long as fore tibia.................... 4

4. Mid and hind femora each with more than one brown band; spines on posteroventral surface of fore femur less elongate, the process between bases of antennæ less pronounced, wing pads in apterous forms less developed than in *fraternus*; notch in apex of apical tergite of an open type, its sides varying from concave to nearly straight, *annulipes* (Stal), p. 70

Mid and hind femora each with one brown band; spines on posteroventral surface of fore femur more elongate, the process between bases of antennæ more pronounced, the wing pads in apterous forms better developed than in *annulipes*; notch in apical tergite of a narrower type, its sides more or less convex, the apex of the notch more acute ....*fraternus* (Say), p. 70

5. Seventh tergite entire or barely emarginate at apex, general color of species fuscous (Pl. XXI, Fig. 8)................*uhleri* (Banks), p. 69

Seventh tergite with a short and acute apical incision; general color stramineous (Pl. XXI, Fig. 9)...*neglectus* McAtee and Malloch, p. 69

Metapterus aberrans McAtee and Malloch.

McAtee and Malloch, Proc. U. S. Nat. Mus., LXVII:86; 1925.

"A small, dark, robust species, with characters of male hypopygium and female genital segments similar to those of *uhleri*. The head lacks the process between the bases of the antennæ and the labrum is but little protruded, in one specimen almost imperceptibly so. The pronotum has a very deep constriction near posterior margin and its hind margin has a short backwardly projecting process in middle. Wing pads small. Apical tergite in female as in *uhleri* but shorter; male hypopygium as seen from above shows the upper margin with an erect spine.

"Length. 7-8 mm."

Locality. Austin, Tex.

Metapterus uhleri (Banks).

(Pl. XXI, Figs. 6, 8.)

Banks, Psyche, XVI:47; 1909. *Barce uhleri.*

McAtee and Malloch discuss this species as follows:

"This species, *aberrans*, and *neglectus*, agree with *linearis*, the genotype, in having an erect spine inside the hind border of male hypopygium, but like all other American species known to us differs from *linearis* in that the male claspers are not abruptly bent apically and directed upward on each side of the apical spine. *M. aberrans*, *uhleri*, and *neglectus* have another character also in common with *linearis*, namely that the pale streak on lower surface of head is narrower than interocular width or is interrupted by a dark spot behind each eye. The external genital characters of both species are illustrated.

"Length, 7-9 mm.

"Rarely a female specimen of this species has a distinct notch in posterior margin of apical tergite. The color varies somewhat and the varietal name *brunnea* Banks was applied to specimens with pale spots on the connexivum and pale irrorations on the venter; the color of the dorsum suggests bronzed leather. The proportion of winged specimens in the whole material is small."

Biology. Reported by Blatchley to have been taken under stones.

Localities. Massachusetts, New York, New Jersey, Virginia, North Carolina, South Dakota, Saskatchewan, Indiana.

Metapterus neglectus McAtee and Malloch.

(Pl. XXI, Figs. 7, 9.)

McAtee and Malloch, Proc. U. S. Nat. Mus., LXVII:87; 1925.

"A larger and much paler species than *uhleri*, the general color being yellowish brown. Male hypopygium similar to that of *uhleri*, differing in having the apical spine without a conspicuously recurved tip. Female differing as stated in the key.

"Length, 11-12 mm."

Biology. Reported by Blatchley as having been taken from beneath a pile of bricks.

Localities. New Jersey, Massachusetts, New York, Kansas.

Metapterus banksi (Baker).

Baker, Pomona, Col. Jl. Ent. II:227; 1910. *Barce banski.*

McAtee and Malloch discuss this species as follows:

"Similar in color to *fraternus*, differing as stated in key. The fore tibia of male is about three-sevenths as long as fore femur, while in the preceding two species it is but very little over one-third as long. The male hypopygium is very much less keeled on apical half than in *fraternus* and has the small process at apex above larger, while from the rear view it is much less tapered below.

Both sexes have the process between bases of antennæ moderately well developed.

"Length, 9-12 mm."

Locality. California.

Metapterus annulipes (Stal).

Stal, Berl. Ent. Zeit., X:168; 1866. *Barce annulipes.*

This species is discussed as follows by McAtee and Malloch:

"A brownish fuscous species, varying considerably in intensity of color, the darker specimens having the annulations of the legs most distinct. The broad yellowish stripe on the ventral surface of head is uniform in width throughout and not narrower than interocular space, a character *annulipes* has in common with *banksii* and *fraternus.*"

Biology. It is found beneath loose bark and on the foliage of shrubs, and hibernates beneath logs and old rails, according to Blatchley.

Localities. Maine, New Hampshire, Massachusetts, New York, New Jersey, Pennsylvania, Maryland, Virginia, Ohio, Indiana, Wisconsin, Iowa, Ontario, Manitoba, Florida.

Metapterus fraternus (Say).

(Pl. II.)

Say, Heter. N. Harm., 33; 1832. Fitch Rep., 803. Compl. Wr., 358. *Ploiaria fraterna.*

McAtee and Malloch discuss this species as follows:

"A fairly common species, closely related to the preceding, and with more southern and western distribution. All our specimens from Texas, Louisiana, and Mississippi, and one from Missouri, are winged; the others, including one from Missouri, are furnished with minute wing pads only. In the winged forms the fore wings are brownish with upper surface irregularly granulose, the slight elevations or granules darker than the remainder of wing.

"Length, 12-13 mm."

Habitat. I have found this species in four different localities in the vicinity of Lawrence, Kan. A number of specimens, at different periods of the year, have been taken from a grassy bank near a pool, down among the grass roots. A series of eight nymphs and five adults were taken in October under sticks and boards on a grassy flat at the border of an ox-bow lake. Some of these were within ten yards of the water, and were in company with hibernating Hydrometridæ. A single specimen was taken late in October under the leaves of a mullein plant which was situated near a small brook, and another single specimen taken on October 31 under a rock. It is evident that the species lives in protected places, and seems to prefer a rather moist environment.

Food. I find no records of the feeding habits of this insect, and have, myself, made no observations in the field on this point. It seems quite probable that it feeds on the abundance of small life that inhabits such places as it does. Small leaf hopper nymphs, small spiders, spring tails, caterpillars, and numerous other insects are found in company with this insect and no doubt serve as its food. I have kept an ovipositing adult alive in the laboratory on a diet of common house flies, which were made a little less active than usual by a pinch. These flies were accepted very readily, and several were consumed each day.

Seasonal Life History. Conflicting data make the determination of the seasonal life history rather uncertain. Early spring collecting has produced very small nymphs, hatched either from overwintering eggs or from eggs laid early in the spring by overwintering adults. An adult female captured June 18 deposited twenty-four eggs before she died on August 24. These eggs did not hatch, but there was no reason to think that the female had been fertilized. Thirteen individuals were collected on October 10, five of which were adults, and eight fifth-instar nymphs. In the next few days several of the nymphs changed to adults. On October 17 an adult female was collected in a different locality and when confined laid eggs freely. In addition to this evidence, there exists the record of McAtee and Malloch who report the oviposition on October 23. The question is, of course, whether the insect winters in the egg stage, or as an adult, and inasmuch as both stages are to be found very late in the season, it is possible that the insect may winter in both stages.

Eggs. (Pl. II, Fig. 5.) The eggs have been figured by McAtee and Malloch. However, no description accompanies their figures, and a description prepared by the writer is therefore given: Length, 1.4 mm.; width of top, .3 mm. Color of body of egg dark brown and shining, of flange-like longitudinal ridges whitish, of reticulated area and cone of cap grayish white.

Shape rather elongate, cylindrical with axis of cylinder slightly curved; base rounded, apex truncate, surmounted by a cap bearing a central conelike projection; body of egg with a series of longitudinal flangelike ridges occupying entire length of egg; these confluent in pairs basally on upper side of egg, but extended separately to, and a little beyond apical end of egg; cap of egg with a peripheral, slightly raised reticulated area and a central conelike structure formed of several ridge-like converging projections arising from reticulated area.

Fifth-instar Nymph. (Pl. II, Fig. 1, 2.) Length of body, 11.5 mm. to 12.5 mm.; length of front femur, 2.6 mm.; length of first antennal segment, 4.1 mm.

General color stramineous with fuscous and reddish markings; head stramineous above, darker along lateral margins, with a reddish Y-shaped mark in well-marked individuals; antennæ a little darker than upper surface of head, becoming darker toward apex; thoracic segments stramineous above with darker lateral margins and median reddish line on dorsum; reddish line faint, interrupted, and sometimes obsolete on meso- and metanota; abdomen somewhat darker, segments 3-6 with lateral fuscous vittæ, these occupying from one-third to one-fourth the length of the segments; two red lines near lateral margin of abdomen, extended for entire length of abdomen.

General shape very elongate and slender, with extremely long and slender appendages; head more than twice as long as wide, slightly swollen behind the eyes; the two tubercles characteristic of the adults of this genus present also in nymph, the one between the bases of antennæ, the other (labrum) above base of rostrum; antennæ four-segmented, filiform, first segment longest, second three-fourths the length of first, fourth about one-half the length of second, and third very short; prothorax elongate, front legs raptorial, in structure and armature similar to those of adult; tarsus consisting of a single segment, with unequal pair of claws at apex; front femur stramineous, mottled fuscous and white below, tibia with alternate bands of fuscous and white, tarsus whitish at base and fuscous at apex; middle and hind legs very long and slender, clothed with short fine hairs, tarsi two-segmented; femora banded with fuscous at apex, tibiæ thrice banded with fuscous at bases, fuscous at apices; tarsi fuscous. Wing pads visible on dorsal surface of meso- and metathorax; in individuals which are to develop into wingless adults the first pair are very short and slender, extended only a short distance over metanotum, not reaching the bases of the second pair by a distance greater than twice their length; second pair projected backwards hardly at all; in those individuals which are to develop into winged adults wing pads well developed; first pair extended completely over metanotum, first abdominal segment, and most of second abdominal segment; second pair hidden under first pair and extended equally far. Abdomen slightly swollen in middle in full-fed individuals, tapered slightly at apex; abdominal spiracles visible, first pair dorsal in position, second to eighth pairs lateral.

Localities. New York, New Jersey, Maryland, District of Columbia, Virginia, North Carolina, Florida, Ohio, Mississippi, Louisiana, Nebraska, Kansas, Missouri, Oklahoma, Texas.

Metapterus umbrosus Blatchley.

Blatchley Heterop. of Eastern N. A., p. 535; 1926.

"Elongate, slender, subcylindrical. Black, opaque; head, both above and below dark reddish brown, heavily tinged with fuscous; antennæ dark brown; beak and front tibiæ dark brownish yellow, front tarsi and spines of femora paler; all legs dark fuscous brown without annuli or pale spots. Front legs relatively very long and slender, their coxæ slightly longer than head and pronotum united, distinctly thickened from base to apex; front femora one-third longer than coxæ and but little if any stouter than apical half of latter, their basal spine at basal two-fifths of under surface, or distinctly farther forward than in our other eastern species; front tarsi about two-thirds the length of tibiæ, the latter only one-third the length of femora. Seventh dorsal of male with apex obtusely rounded, projecting beyond the apex of genital, the latter with an erect spine between the tips of the claspers.

"Length, 15 mm."

Biology. Blatchley reports taking this insect from the fallen leaves of the royal palm.

Locality. Florida.

Genus GHILIANELLA.

This genus was described originally by Spinola (1852). McAtee and Malloch characterize it as follows:

"Characters of the genus besides those mentioned in the key to genera are: The presence between bases of antennæ of a projection varying from a mere point to a prominent porrect or decurved spine; head and thorax more or less granulate, the former with a profound constriction anterior of eyes; meso- and metanota each tricarinate (or with a median tubercle and lateral rows of tubercles above) and usually unicarinate below; front tibia with a patch of short, pale golden hairs on inner side apically and a tuft of longer ones at the apex inferiorly; mid and hind legs and antennæ each longer than body. Color varies much according to age, usually the nymphs pale and the color darkens steadily with age until the final stage is dark reddish brown or even blackish; in some species, however, the adults are pale; when the legs have pale markings they are almost invariably as follows: mid and hind femora with two postmedian bands and a subapical spot, and tibiæ with a subbasal spot; in the pale species, dark markings tend to appear at these same places; frontal and femoral spines mostly pale. The whole head and body of *Ghilianella* species are sparsely pale haired, the hair tending to aggregate in patches about base of frontal spine, juncture of head and pronotum, and on sides anteriorly of meso- and meta-thoraces."

DISTRIBUTION OF GENUS.

This genus is composed of 66 described species, all Neotropical with the exception of a single species described from Florida, and a single Oriental species.

Ghilianella productilis Barber.

Barber, Bull. Amer. Mus. Nat. Hist., XXXIII:502-3; 1914.

McAtee and Malloch describe this species as follows:

"*Male.* General color light reddish brown, more or less variegated with fuscous; the legs and antennæ stramineous, punctate but not annulate with the general color. There is a distinct black dot on the upper surface of each fore femur near the apex, a pair of dots about the middle of posterior lobe of head, and another pair sometimes larger than the preceding about middle of pronotum; each abdominal sternite from 3-6 also bears near its hind margin a pair of black dots which tend to become larger and blotchlike posteriorly. Pilosity fine, short, pale, more abundant toward apices of mid and hind legs and antennæ. Abdomen almost parallel-sided, widest at hypopygium, a black wart on middle of hind margin of tergites 2-6, the connexivum more or less elevated, the spiracles dark. Seventh tergite somewhat longer than sixth, a little constricted beyond middle, the apical moiety faintly transversely corrugated, lanceolate in outline, with a rounded keel apically, and projecting a little beyond hypopygium. Posterior margins of sternites 2-6, more or less emarginate medianly, and arcuate laterally, most pronounced on 6; 7 a little emarginate, 8 a little convex medianly, both slightly concave laterally; claspers oblong.

"*Female.* Color as in male; form of abdomen much the same, seventh tergite about one-third shorter than sixth, the lateral angles produced distinctly beyond the keeled and slightly tuberculate middle of hind margin; eighth tergite about semi-circular, keeled longitudinally and corrugated transversely; ninth somewhat longer than eighth, keeled, corrugated herringbone fashion, narrowed, rounded, and upturned apically; sutures between sternites less sinuate than in male; seventh sternite somewhat shorter than sixth, its hind margin concave laterally and forming a distinct rounded process medially; eighth sternite appearing as an elliptical plate on each side, spiracle barely visible.

"Length, 23-25 mm."

Biology. "In the male nymph the eighth tergite is broadly visible across base of anal tube, the ninth apparently is membranous, the seventh has a large upwardly and backwardly projecting pointed process, and the lateral angles slightly pointed tuberculate; in the female nymph the seventh tergite has a rather prominent erect tubercle, the eighth and ninth are keeled and less rounded apically than in the adult since they form the roof of complete segments inclosing the anal tube."

Blatchley reports taking a specimen from the base of dense tufts of grass growing on the beach.

Localities. Florida, Cuba.

SUBFAMILY SAICINÆ.

This subfamily was originally designated by Stal (1859) as the group "Saicida." McAtee and Malloch characterize the subfamily as follows (1923):

"The American forms of this subfamily examined by us agree (aside from ordinal and family characters) in lacking ocelli, in having the fore coxæ more or less elongate, the second segment of the beak more or less bulbously expanded at the base, the opposed surfaces of beak and head armed with stiff hairs, a few spinelike bristles, or spines, and the lower anterior angles of pronotum, just above coxal cavity, produced and surmounted (except in *Oncerotrachelus*) by an anteriorly and downwardly directed spine or bristle."

WORLD DISTRIBUTION.

This is a small subfamily, of about thirty described species, distributed as follows: Nearctic, 3 species; Neotropical, 15 species; Palæarctic, 2 species; Ethiopian, 6 species; Oriental, 6 species; Australian, 3 species.

CLASSIFICATION OF SUBFAMILY.

The two genera of this subfamily which occur within our limits may be separated as follows:

1. Mesonotum with a long triangular process terminating in a depressed spine extending over the metanotum and basal abdominal tergite, which lack dorsal protuberances; a conspicuous spine on each side of the basal tergite projects outward, appearing to emanate from hind angle of metapleuron; basal tarsal segment shorter than third and not longer than second; fore femur and tibia without spines, armed with erect stiff hairs only; opposed surfaces of head and beak with rows of stubby bristles.......................... *Oncerotrachelus* Stal, p. 75

   Mesonotum not produced posteriorly, metanotum and basal part of first abdominal tergite with dorsal tubercles or spines; no spine on side of basal tergite; basal segment of all tarsi longest; opposed surfaces of beak and head with distinct spines or spinelike bristles; fore tibia, and femur, in part, with stiff, erect hairs, without stout spines; pronotum, mesonotum and basal abdominal tergite each with a prominent spine .... *Saica* Stal, p. 77

Genus ONCEROTRACHELUS.

This genus was originally described by Stal (1868). It may be recognized by the characters given in the key, and by the additional characteristics enumerated by McAtee and Malloch (1923).

"This genus has very distinct hairs on the upper side of basal section of the radius of the fore wings, the thoracic mesosternum and metasternum with a central carina, and the ventral surface of the head and beak with rather dense stubby hairs, which are not arranged in tufts. The coxæ of fore legs are three or four times as long as thick, finely haired, and have two outstanding long fine hairs on anterior side; in the two tropical species there is a slight hump on the inner side, which is not visible when the coxa is pressed against the prosternum. Front femora slightly curved. Color testaceous, rather strongly marked with fuscous except on one species (*pallidus*)."

DISTRIBUTION OF GENUS.

This genus is composed of four described species, two from within our limits, and two Neotropical.

CLASSIFICATION OF GENUS.

The two species of this genus which occur within our limits may be separated as follows:

1. Hairs on tibiæ decumbent, not longer than the tibial diameter; larger species 7-7.5 mm. in length, paler in color; posterior lateral angles of abdominal tergites not appreciably produced............*pallidus* Barber.

   Hairs on tibiæ in part erect and very conspicuously longer than tibial diameter on at least the mid and hind legs; smaller species 4-6 mm. in length, darker in color; posterior lateral angles of most of the abdominal tergites more or less produced and spinelike..*acuminatus* (Say).

Oncerotrachelus pallidus Barber.

Barber, Proc. Ent. Soc. Wash., XXIV:104; 1922.

"Color pale stramineous except outer marginal vein of membrane which is lightly infuscated and the apical portion of the venter which is slightly embrowned, as in the membrane.

"Compared with *O. acuminatus* Say the body parts and appendages are less densely pilose, the antennæ and legs being almost entirely devoid of long hairs so distinctive of that species. The head is more prolonged before the eyes, these being relatively larger; the posterior lobe of the head being slightly more globose dorsally and laterally.

"Size larger measuring from 7-7½ mm. long.

"Easily distinguished from *O. acuminatus* Say by differences in size, coloration and pilosity. Say's species is always of a flavotestaceous color with distinct fuscous markings above and below. Judging from the artist's figures Pl. XI, Figs. 8, *8a*, Biol. Cent. Amer., the specimens from Mexico and Central America referred to by Champion, p. 180, may in all probability be referred to *pallidus*."

Locality Texas.

Oncerotrachelus acuminatus (Say).

Say, Heter. N. Harm., 32; 1832. Fitch Rep., 800. Compl. Wr., 356. *Reduvius acuminatus*.

"Yellow, dusky along the middle; head vesicular behind, hairy.

"Inhabits Indiana.

"Body honey yellow, very shiny; head short, almost rounded, subequally divided by a deeply indented line behind the eyes; posterior lobe vesicular, somewhat inflated, short; antennæ fuscous, pale at base; rostrum, basal joint longer than the second and third together; thorax subequally divided by a deeply indented line; anterior lobe somewhat longer, deeply divided by a longitudinal line; posterior portion with an indented line before, and a blackish disk; scutel with three elevated lines and terminating in an acuminated spine; hemelytra dusky along middle; anterior tibiæ a little dilated at tip; beneath with a broad, piceous vitta each side and a carinate line along the middle.

"Length one-fifth of an inch.

"When alarmed the basal joint of the antennæ, which is nearly as long as the head and thorax, is thrown backward, and the second joint deflected."

Biology. This seems to be a common enough species, and several observations on its habits, other than the brief note in the original description, have been made. Uhler (1884) remarks the following concerning its habits:

"When pursued it often sets the basal joint of the antennæ back, and the following ones are erected, as if in the attitude of listening. Numerous individuals may sometimes be found among rubbish and weeds in low grounds, or on the edges of stubble fields, during late summer or autumn."

Fracker and Bruner (1924) record the finding of this species in spider webs in the Experiment Station building at Santiago de las Vegas, Cuba. Other records indicate that it has been taken under stones. The writer has taken it in its hibernating quarters under leaves in woodlands in the adult condition.

Localities. McAtee and Malloch record the presence of this insect over a wide range with New York, Indiana, Kansas, Texas and Florida as the extremes. This would indicate its general occurrence east of the Rocky Mountains.

Genus SAICA.

This genus was originally described by Stal (1868). It may be recognized by the characters given in the key and the additional characters mentioned by McAtee and Malloch (1923):

"Beak with one pair and head with two pairs of spines on their opposed surfaces; fore coxæ with one and fore trochanters with two patches of stubby bristles; fore femur with two rows of bristles of uniform length, the degree of aggregation of which into tufts is fortuitous and has no taxonomic value; front femora and tibiæ distinctly curved; species chiefly reddish in color with ochraceous, red veined fore wings, most of them distinctly larger than species of other American genera."

DISTRIBUTION OF GENUS.

This is a genus of eleven described species, ten of which are Neotropical in distribution, and one described from within our limits.

Saica fuscovittata Barber.

Barber, Hem. Fla., Bul. Am. Mus. Nat. Hist., XXXIII:504; 1914.

"Body elongate, narrow. Smooth, shining stramineous in color, dorsally with a broad ill-defined fuscous stripe, beginning on the vertex of the head and running through to the tip of the membrane; on the sides is another poorly defined fuscous stripe beginning back of the eyes and continued along the sides of the sternum, sometimes extended along the sides of the venter to the apex. The femora with a preapical and the tibiæ with a prebasal and apical fuscous band, with close-set fine hairs underneath on the venter and on the antennæ and tibiæ, more scattering on the sternum and femora. Head is stramineous, infuscated, swollen behind the eyes. Rostrum stramineous, sometimes apically infuscated, its apex ending between the two anteriorly projecting acute (not spines) prosternal processes; second joint swollen at base. Antennæ long, slender, dirty stramineous, with apex of second joint which is about one-third the length of the first, and the remainder infuscated; first two joints with rather close-set fine hairs, the first two with finer, appressed hairs. Pronotum smooth, shining and glabrous, the anterior lobe slightly longer than the posterior, and longitudinally deeply sulcate in the middle, with two tuberosities at each anterior angle and one on each side margin before the transverse furrow which are not so prominent; humeri elevated in a longitudinal elongate tuberosity; the anterior part of each is armed with an elongate, straight, acute, outwardly directed spine, infuscated at tip. Sternum smooth, with a few fine scattered hairs; the prosternal processes diverging, acute. The fore femora are pale with a preapical and the apical band fuscous; the trochanters are armed with a single short blunt spine; these legs are provided with close-set fine hairs and the femora beneath and the tibiæ have close-set longer and stouter setose hairs; the middle femora have a conspicuous preapical and a faint median fuscous band; the hind femora have a faint apical and median fuscous band; the middle and hind tibiæ have a prebasal band and apex fuscous; tarsi pale. Scutellum black, elevated at base into a pale backwardly inclined slightly curved spine as long as the pronotal spines; at apex of the scutellum is a short, acutely inclined black spine; midway between these two scutellar spines is a very short black blunt tubercle. Corium smooth, duller than the pronotum, glabrous through the center broadly infuscated, some of the stronger nervures faintly rosaceous, the few nervures of the infuscated membraue pale. Venter smooth, shining, finely pubescent, along the sides sometimes with a fuscous stripe; the genital segment of the female infuscated.

"Length, 8 mm. Described from a male in the collection of the American

Museum of Natural History and a female in the collection of Mr. William T. Davis. Both from Everglades, Fla., April, 1912. This species seems to be most closely related to *Saica erubescens* Champ."

Biology. Blatchly reports taking two fourth-instar nymphs from the dead leaves of cabbage palmetto on April 22.

Locality. Florida.

Subfamily STENOPODINÆ.

This subfamily was originally designated as the "Group Stenopodides" by Amyot and Serville (1843). It is distinguished by the following characteristics: Ocelli present; anterior coxæ not elongate; hemelytra with a discoidal or quadrangular aërole at the base of the membrance; the anal aërole of the membrane not extending as far proximad as the costal aërole; basal segment of the antennæ thickened, porrect, the other segments folding back under the head and first segment; hind pair of legs longer than the others, but moderately stout; body elongate, but never linear.

BIOLOGY.

The members of this subfamily whose habits are known are to be found under rocks, and undoubtedly feed on small insects which they find there.

WORLD DISTRIBUTION.

This subfamily is well represented in all the faunal realms. The distribution by numbers of species is as follows: Nearctic, 15 species; Neotropical, 50 species; Palaearctic, 47 species; Ethiopian, 48 species; Oriental, 56 species; Australian, 20 species.

CLASSIFICATION OF SUBFAMILY.

The genera of this subfamily represented by species within our limits may be separated by the following key:

1. Head armed with a ramose or furcate spine below on each side caudad of the eyes 2
   Head unarmed below or armed with a simple spine, rarely with a subfurcate spine at sides of base 4
2. Segment 1 of antennæ incrassate, apex produced in a spine beyond insertion of segment 2 .... *Pnirontis* Stal, p. 80
   Segment 1 of antennæ not produced beyond the insertion of segment 2 3
3. Apex of head at base of rostrum unarmed; segment 1 of rostrum extending caudad of eyes, nearly twice as long as the two apical segments together; fore femora unarmed ...... *Pygolampis* Germar, p. 82
   Apex of head produced into a short, porrect obtuse spine on each side at base of rostrum; segment 1 of rostrum extending to caudal margin of eyes, subequal in length to the two apical segments together; fore femora with a double series of short spines below, *Gnathobleda* Stal, p. 85

4. Ocelli not at all or only slightly elevated; postocular part of the head not at all or very slightly and uniformly narrowed caudad,
Stenopoda Laporte, p. 88

Ocelli considerably elevated, postocular part of head short, strongly narrowed caudad (margins as seen from above curved)................ 5

5. Segment 1 of rostrum nearly as long as or longer than segments 2 and 3 together 6

Segment 1 of rostrum not longer than segment 2...................... 7

6. Segment 1 of rostrum slightly longer than segments 2 and 3 together; hind femora not reaching apex of abdomen; fore femora armed beneath; head produced cephalad from bases of antennæ,
Schumannia Champion, p. 86

Segment 1 of rostrum slightly shorter than segments 2 and 3 together; fore femora unarmed, slightly incrassate; hind femora scarcely reaching apex of abdomen; head not produced cephalad from bases of antennæ ....*Diaditus* Stal, p. 101

7. Segments 1 and 2 of rostrum of equal length; fore femora very little thickened, unarmed; hind femora reaching beyond apex of abdomen,
Narvesus Stal, p. 99

Segment 1 of rostrum much shorter than segment 2; fore femora incrassate, with small spines below; hind femora just reaching apex of abdomen ....*Oncocephalus* Klug, p. 89

Genus PNIRONTIS.

This genus was described originally by Stal (1859) as follows:

"Body elongate, flat. Head cylindrical, base suddenly constricted, armed on either side behind the eyes with a series of branched spines, gena produced into a long foliaceous spine, apices of antenniferous tubercles produced, approximate, narrow space between them armed with one or two porrect spines. Ocelli distinct. Segment 1 of rostrum scarcely twice as long as apical two, these about equal in length. Antennæ abruptly bent, first segment thickened, apex acute; second segment inserted far before apex of first. Anterior angles of prothorax rather prominently acute, lower anterior angles bispinose. Hemelytra no shorter than abdomen. Abdomen longitudinally carinate. Legs rather short, anterior femora incrassate, below bearing two rows of spines; tibiæ armed with spines on inner side; fore trochanters bearing spines below."

DISTRIBUTION OF GENUS.

This genus is composed of fourteen described species, all American, and mostly occurring south of the limits of the United States. Four species, however, occur within our limits.

CLASSIFICATION OF GENUS.

The species of the genus which occur within our limits may be separated as follows:

1. Front tibiæ armed on inner edge only with three or four spines......... 2

Front tibiæ armed on both inner and outer edges, the outer edge with a stout spur and two shorter spines behind it........................ 3

2. Basal segment of antennæ unarmed beneath; genæ very prominent,
languida Stal, p. 81

Basal segment of antennæ spinose beneath; genæ not prominent, *infirma* Stal, p. 81

3. Antenniferous tubercles nearly as long as basal antennal segment and with two slender cylindrical processes between them; front tibiæ of males but slightly curved......................*modesta* Banks, p. 81

Antenniferous tubercles less than one-fourth the length of basal antennal segment, with a single short obtuse spine between them; front tibiæ of male strongly curved..............*brimleyi* Blatchley, p. 82

Pnirontis languida Stal.

Stal, Of. Vet. Akad. Forh., XVI:381; 1859.

"Pale, yellowish white, upper surface here and there flesh-colored; first segment of antennæ, except spine, hardly shorter than head, smooth; head between antennæ unispinose (later in key given as bispinose, which is probably correct), subequal in length to thorax. Thorax hardly longer than basal width, anterior femora with many long spines, minute spines between them. Anterior tibiæ with three long spines on inner margin.

"♂. Length, 12 mm.; width, 2 mm. Carolina. Brazil."

Localities. Georgia, South Carolina, Florida, Texas, Panama, Brazil, Mexico.

Pnirontis infirma Stal.

Stal, Of. Vet. Akad. Forh., XVI:382; 1859.

"Sordid pale yellowish gray, abdomen with small marks on the margin above and below and on posterior coxæ dark brown. Segment one of antennæ almost one-third shorter than head, spined below. Head slightly shorter than thorax, bispinose between antennæ; thorax hardly longer than wide; base of scutellum with light spot on either side; long spines on femora; anterior femora with three long spines.

"♂. Length, 10½ mm.; width 2 mm. Carolina."

Localities. New Jersey, "Carolina," Georgia, Florida, Texas, Mexico, Panama, Guatemala, Cuba, and Brazil.

Pnirontis modesta Banks.

Banks, Ent. News, XXI:324; 1910.

"Pale greyish-yellow with a faint median dark line on the pronotum, four black dots on each lateral margin of the venter and sometimes a black spot in front of each eye. Four large spines under femur I, the basal one short, the next about as long as width of the joint, third still longer, and fourth the longest; the third is a little nearer to the fourth than to the second; tibia I has on the inner side three long spines (closer together than in *Pn. languida*) and near the last one on the lower side is a long, erect, stout spur or spine. Tip of abdomen forked as in *Pn. languida*, but the lobes are more divaricate and broader at the tips than in that species.

"Length, 11 mm."

Localities. Virginia, Florida, Indiana.

Pnirontis brimleyi Blatchley.

Blatchley, Heterop. of Eastern N. A., p. 545; 1926.

"Form and size of *modesta*. Color much the same; head and basal lobe of pronotum tinged with fuscous; ventrals with a row of small black dots along each side in addition to those on angles of connexivals. Head and pronotum roughly scabrous. Antenniferous tubercles very short, the antennæ inserted beneath them, not apparently on their ends as in our other species; the tylus between them single, obtusely pointed. First joint of antennæ less than half the length of front lobe of head, its base half swollen, apical half tapering to an obtuse point. Front tibiæ of male strongly curved, armed as in *modesta*. Last dorsal of male broader, with apical notch wider and much more shallow, the lobes scarcely half the length of those of *modesta*. Characters otherwise much as in that species.

"Length, 10.5 mm."

Locality. North Carolina.

Genus PYGOLAMPIS.

This genus was described originally by Germar (1824) as follows:

"Body elongate. Head extended, cylindrical, base abruptly constricted, armed just before the neck with spines produced backwards, fitted below with forked and branched spines; clypeus distinct, produced into a spine, lateral lobe not elevated toothlike. Ocelli far apart. Basal segment of the rostrum much longer (about twice) than the two apical segments together; apical segment hardly shorter than the second. Thorax longer than wide, slightly narrowed behind, sinuate cephalad, soon after middle bears light transverse impression. Scutellum as long as wide. Hemelytra no shorter than abdomen. Cephalic margin of prosternum bispinose. Legs slender, anterior (especially the first pair) shorter, posterior long, fore femora lightly thickened, unarmed; apical segment of tarsus longest, on anterior legs segment one shorter than two, on hind legs segment one about equal in length to two."

DISTRIBUTION OF GENUS.

This is a small, but widely distributed genus, composed of thirteen described species, distributed as follows: Nearctic, 3 species; Neotropical, 2 species; Palæarctic, 4 species; Ethiopian, 2 species; Oriental, 3 species; Australian, 1 species.

CLASSIFICATION OF GENUS.

The species of the genus occurring within our limits may be separated as follows:

1. Head, thorax and scutellum and veins of the hemelytra gray-sericeous; antennæ short with the first segment subequal in length to the anteocular part of the head.................................. *sericea* Stal.

   Body slightly sericeous above, antennæ longer, with the first segment longer than the anteocular part of the head...................... 2

2. Pronotum about one-third longer than the basal width, median lobe of the head rather prominent .... *pectoralis* (Say).
Pronotum about one-half longer than the basal width, median lobe of head not prominent .... *spurca* Stal.

Pygolampis spurca Stal.

Stal, Öf. Vet. Akad. Forh., XVI:379; 1859.

"Sparingly sericeous, fusco-testaceous above, below with rostrum and legs grayish flavescent; posterior femora almost entirely, and anterior femora towards apex infuscate; margin of abdomen with minute pale maculæ; segment one of antennæ somewhat longer than thorax, variegated with fuscous; two metasternal vittæ nigro-fuscous; median lobe of the head hardly prominent.

"♀. Length 16, width 2 mm.

"Similar to *P. prolixa*, darker, segment 1 of antenna a little shorter, head proportionally longer, thorax a little shorter. Segment 1 of antennæ almost one-half longer than head. Head shorter than thorax. Thorax one-half longer than basal width."

Localities. "S. St.," Panama, Guiana.

Pygolampis sericea Stal.

Stal, Öf. Vet. Akad. Forh., XVI:378, 380; 1859.

"Blackish or very dark fusco-testaceous; above rather deep gray sericeous; segment 1 of antennæ of equal length with anteocular part of head; median lobe of head not prominent; thorax testaceous, membrane blackish, disk with a little whitish; ventral segments 2-5 bear two flavo-testaceous lines on the lateral disks.

"♀. Length, 14 mm.; width, 2 mm. America borealis. Pennsylvania."

Localities. Massachusetts, New York, Pennsylvania, Maryland, North Carolina, South Carolina, Texas, Indiana.

Pygolampis pectoralis (Say).

(Pl. III.)

Say, Ins. of La., 11; 1832. Comp. Wr., I:306. *Reduvius pectoralis.*

"A complicated spine beneath the eyes, and a projecting spine on each side of the pectus before.

"Inhabits Indiana, Florida and Louisiana.

"Body dark cinereous; head spinose beneath, canaliculate behind; antennæ, first joint more robust; second joint a little longer; third shortest; forth nearly as long as the third; beneath the eye a branched spine, behind which is a smaller one; base of head with four tubercles above, and spines on each side; rostrum, first joint much longest; thorax with impressed lines, somewhat caniculate; pectus before with two parallel, prominent, somewhat arquated spines extending on each side of the tip of the rostrum; anterior pair of feet a little more robust; thighs obsoletely spotted and lineated; tibiæ annulated; posterior feet much longest.

"Length less than half an inch.

"When at rest the first joint of the antennæ is porrect and the remaining joints inflected."

Biology. In spite of the fact that this species is relatively common, practically no comments on its life history or habits may be found. Gillette and Baker (1895) mention briefly that they have taken it under a board in April. The writer has made a few observations on its habits which may, when supplemented by observations of others, be valuable.

I have taken this species in two places, under boards and rocks, in close contact with the ground, and around lights in the spring. A search through lighting fixtures will often disclose dead specimens of this species. Third- and fourth-instar nymphs have been taken from under rocks and boards in October, and adults have been taken from the same situations in November, not, however, in the same collecting locality, or in the same year. This seems to indicate that they may pass the winter either in the immature or adult condition. However they may pass the winter, they are active as adults rather early in the spring. Records of their being taken around lights during May and June in Kansas are available. It seems to be clear that the insect spends the greater part of its life hidden under rocks or boards. No observations on the feeding habits have been made, but there is no reason to suppose that there is any departure from the usual habits of the family.

The third, fourth and fifth nymphal instars have been figured, and descriptions of them are given here:

Third Instar. (Pl. III, Fig. 1.) Length of body, 6.7 mm.; length of front femur 1.7 mm.; length of first antennal segment, 1 mm.

General color fuscous, obscurely striped and spotted; head fuscous, epicraneal suture visible, outlined in whitish. Thorax obscurely striped; abdomen somewhat mottled and spotted, two rows of black circular spots, one at base of each segment on either side of mid-dorsal line; hind femora conspicuously darker than fore and middle femora; tibiæ of all legs somewhat lighter than rest of body, banded twice at base, once at apex with fuscous.

Body elongate with abdomen slightly swollen. Head rather elongate, cylindrical, antenniferous tubercles prominent; first antennal segment long and stout, extended forward, others more slender and folded back under head, second segment subequal to first, third shortest, and fourth more than half as long as first; base of head with four prominent, backwardly directed tubercles, and other less prominent tubercles; under surface of head with two branched spines on each side, the larger just below the caudal portion of the eye, the smaller near the base of the head; beak three-segmented, first segment longer than second and third together, second longer than third. Prothorax subquadrate, slightly narrower apically than basally, anterior angles produced into broadly rounded lobes, and posterior angles produced backwards and sharply angled; under surface of prothorax with a pair of curved, sharply pointed, forward-projecting processes at its anterior angles. Meso- and meta-thorax with developing wing pads, those of mesonotum projected over metanotum only very slightly, those of metanotum projected backwards hardly at all. Hind legs much longer than fore or middle legs, these subequal; femora or fore legs slightly thickened. Abdomen slightly swollen, tapering at apex; openings to dorsal stink glands along mid-dorsal line at base of segments four and five.

Fourth Instar. (Pl. III, Fig. 2.) Length of body, 8.7 mm.; length of front femur, 2.2 mm.; length of first antennal segment, 1.4 mm. General color somewhat darker than in preceding; distribution of color similar with increase in number of black spots on dorsum of thorax.

Shape and structural details much as in preceding; wing pads more fully developed; mesothoracic pads extended over metathoracic pads almost to their apices, and metathoracic pads extended to base of second abdominal segment; openings to dorsal stink glands present at bases of abdominal segments four and five.

Fifth Instar. (Pl. III, Fig. 3.) Length of body, 12 mm.; length of front femur 2.7 mm.; length of first antennal segment, 1.9 mm. General color and structure similar to that of preceding; somewhat longer and more slender in proportions; wing pads longer, the mesothoracic pads extended as far caudad as metathoracic pads, both produced to the middle of the third abdominal segment.

Localities. This species seems to be of general distribution in the United States, having been reported from all sections except the Northwest. Also reported from Cuba.

Genus GNATHOBLEDA.

This genus was described originally by Stal (1859) as follows:

"Body elongate. Head elongate, subbituberculate behind, with a series of spines on either side below, before the eyes small, behind the eyes large; median lobe not prominent, apex of lobes projecting freely to sides, genæ produced backwards. Basal segment of beak subequal in length to two apical segments, which are subequal in length. Thorax behind the middle slightly constricted, anterior margin sinuate, below spined on either side. Scutellum triangular, as wide as long. Hemelytra complete, not shorter than abdomen. Legs medium in length, anterior coxæ rather short, width equal to length, trochanters unarmed, femora moderately thickened, below rarely armed with a double series of spines, tibiæ no shorter than femora. Apical segment of tarsus equal in length to two basal segments together, basal segment less than half as long as second."

DISTRIBUTION OF GENUS.

This genus is composed of three Neotropical species, one of which occurs within our limits.

Gnathobleda tumidula Stal.

Stal, Enum. Hemip., II:121; 1872.

"Very closely related and similar to *G. litigosa* Stal (Mexico), differs in that the head is a little thicker, the anteocular part seen from above distinctly swollen and rounded, thorax narrower towards the back, longer than the width behind, dark marks on posterior portion obsolete, median vitta distinct, anterior femora not thickened.

"♂. Length, 11½ mm.; width, 2 mm.

"♀. Length, 14½ mm.; width, 2½ mm.

"♂. Apex of abdomen rounded; apex of hind femur surpassing apex of abdomen a little.

"♀. Apex of abdomen acute; anal valves united and acutely produced; posterior femora scarcely reaching apex of abdomen."

Biology. Blatchley reports sifting last instar nymphs from weed debris along the margins of wet hammocks.

Localities. Georgia, Texas, Cuba, Florida.

Genus SCHUMANNIA.

This genus was originally described by Champion (1899) as follows:

"Head subcylindrical, produced anteriorly beneath the points of insertion of the antennæ, the genæ each armed with a short porrect spine; the upper anteocular portion of about the same length as the postocular portion, the sides of the latter a little rounded and armed with a row of four laterally projecting stout setiferous spines; frontal spines (jugæ) moderately long, porrect, divergent; antenniferous tubercles each armed externally with a short spine; eyes rounded, very prominent; ocelli very prominent; antennæ very short, with joint 1 about as long as the entire anterior portion of the head; rostrum short, joint 1 slightly longer than 2 and 3 united, the later equal in length. Prothorax elongate; the propleura dilated anteriorly and extending forwards to beyond the base of the head; the prosternal spines very short and scarcely distinguishable from the setiferous spines on the anterior portion of the pleura; the anterior angles of the pronotum unarmed. Scutellum with a prominent erect tubercle at the apex, the postscutellum also with a tubercle in front. Elytra ample, nearly reaching the apex of the abdomen, with the inner margin strongly sinuate before the apex, the latter pointed. Abdomen (♂) elongate, widening to the middle, with narrow connexivum, the outer apical angles of the terminal segments more or less angularly dilated. Anterior coxæ inserted very far forwards. Anterior trochanters spinose and with one longer spine at the apex beneath. Anterior femora strongly incrassate, armed beneath with rows of very short spines and with two or three longer spines at base. Anterior tibiæ as long as the femora, and with a short spongy fossa at apex beneath. Anterior tarsi with joints 2 and 3 fused into one, the other tarsi distinctly three-jointed. Posterior femora not reaching the apex of the abdomen. Mesosternum greatly produced anteriorly, rounded in front. Body very elongate, narrow."

DISTRIBUTION OF GENUS.

A single species of this genus has been described from a specimen taken in Mexico. This species has since been recorded as occurring in North Carolina.

Schumannia mexicana Champion.

Champion, Biol. Centr. Am., Heter., II:185, pl. 11, fig. 18; 1898.

"♂. Greyish ochreous, mottled with fuscous; the head with a broad blackish median vitta; separating into two narrow lines in front; the pronotum with a blackish median line, the anterior lobe in great part fuscous; the scutellum black; the elytra with a pale-greyish streak extending along the outer cell of the membrane to the apex, an interrupted, oblique fuscous streak, commencing along the inner margin and extending to near the apex, and a row of very small fuscous spots on the outer cell of the membrane; the connexivum spotted with black; the antennæ and legs ochreous, the femora slightly speckled with fuscous, the anterior and intermediate tibiæ with the apex and some spots near the middle nigrofuscous, the long spines on the anterior trochanters and femora black, the tarsi fuscous; beneath orchreous, mottled with fuscous; the body sparcely pubescent, the pronotal margins, the propleura in front, and the anteocular portion of the head beneath, armed with short setiferous spines; the antennæ and the rostrum clothed throughout with long projecting hairs; the legs hairy, the anterior femora with two rows of short setiferous spines behind as well as two rows of short spines beneath. Antennæ with joint 1 much stouter than 2, 2 slender, nearly twice as long as 1, 3 very slender, short (4 broken off). Prothorax at the sides nearly twice as long as broad, narrowing from the base to the middle, and then becoming subcylindrical; the pronotum with the posterior lobe much shorter than the anterior lobe, the latter canaliculate down the middle, and with a deep fovea in the center and a sinuous groove on each side behind, the anterior margin thickened, and the hind margin with angles obtuse and a little swollen. Abdomen gradually widening to about the middle, with the outer apical angles of the segments becoming more and more dilated, that of the fifth segment strongly so; the fifth segment parallel; the sixth segment triangularly produced on each side posteriorly, the apex appearing deeply arcuate-emarginate, and not quite covering the terminal genital segment. Ventral segments 1-3 carinate.

"Length, 18 mm; breadth of the pronotum, 2½ mm; of the abdomen, 3½ mm.

"One specimen. The longer spines on the anterior trochanters and femora are black and therefore very conspicuous."

Localities. North Carolina, Mexico.

Genus STENOPODA.

This genus was described originally by Laporte (1832) as follows:

"Antennæ four-segmented, bent after first; first segment longest; second next in length; last two short. Rostrum short, thickened, apex produced into a prosternal groove. Tarsi three-segmented, segments subequal, claws simple. Body elongate, linear; head produced before the eyes; scutellum conspicuous.

"Head elongate, eyes globular, prothorax elongate, scutellum small, triangular; hemelytra long, covering the abdomen; legs very long, slender, especially the last pair; anterior femora shorter than those of the other legs."

DISTRIBUTION OF GENUS.

This genus is composed of four Neotropical species, one of which occurs within our limits.

Stenopoda cinerea Laporte.

Laporte, Essai Classif. Syst. Hemip., 26, pl. 52, fig. 2; 1832.

"Dark cinerous; lines on pronotum dark; membranous portion of hemelytra bilineate with black; antennæ and legs yellowish."

This insect was described previous to the time of Laporte's description of it by Fabricius (1775), whose name, *culiciformis,* being preoccupied, has fallen into the synonymy. The description given by Uhler (1884), being somewhat fuller than that given above, is included here:

"A very large species of this group, *Stenopoda culiciformis,* inhabits the southern United States from North Carolina southward to Cuba and westward to Mexico. It is of a pale, dull, tawny color, with spines, and stiff bristles spread over the surface of the head and thorax, and bristly hairs upon the wing covers, sides of tergum, legs and antennæ. The head is nearly cylindrical, a little flattened on top, very nearly as long as the prothorax, ribbed and grooved lengthwise, having the central ridge forked at tip, with some stripes on the cheeks, the throat, and the raised lines whitish, and the spines and bristles blackish. The antennæ are nearly as long as the abdomen, the basal joint is thicker than the others, shorter than the second, and is set with stiff, blackish bristles, while the third, fourth, and intervening jointlets are very slender, delicately hairy, and threadlike. A rather small but characteristic form, with the prothorax of long triangular outline, situated on the sides, having the front angles acuminate and the posterior ones produced into somewhat blunt processes, and with two longitudinal, flat ridges spreading apart behind, ending in prominent tubercles, presents a facies unlike that of any other group of Reduviodea. The discoidal ærole of the corium, and usually two streaks of the membrane are black; and the end of the posterior femora is broadly clouded with brown. Beneath, on the middle of the abdomen, is a strongly elevated keel. The sides of the thorax, and the posterior coxæ are striped with brown; several carinate, pale lines run across the pleura of the prothorax, and its lateral margins are ribbed and remotely spinose. It measures about one inch to the tip of the venter, and is nearly one quarter of an inch across the abdomen. The under sides of the fore femora are armed with short, acute spines, which serve to secure the bodies of the insects they seize."

Biology. Uhler says: "It, as well as its young, lurks about the branches of trees, watching for caterpillars and other insects upon which to leap and transfix with the curved, acute rostrum, and, while holding one between the fore femora and tibiæ, soon sucks it to death."

Dr. W. H. Hoffmann (1925) reports that this species flies to lights quite often on summer evenings and will defend itself with its bite. This is the only record of any of the members of this subfamily found in the United States biting human beings. Dr. Hoffmann also attempted to induce this insect to feed on human blood, but without success, and concluded that it must feed as a predacious insect, and not as a hæmatophagous one.

The writer's only observations on this species are that it does appear around lights during the summer months in Kansas, and is not an uncommon insect.

Blatchley reports taking nymphs in February and March from dead leaves of cabbage and royal palms, and from weed debris.

Localities. New Jersey, North Carolina, Georgia, Florida, Alabama, Arkansas, Texas, Oklahoma, Kansas, Cuba, Mexico, Nicaragua, Panama, Colombia.

Genus ONCOCEPHALUS.

This genus was described originally by Klug (1830). The description given by Reuter (1872), in his monograph of the genus, is more satisfactory than the original description and is given here:

"Body elongate or oblong-oval; first segment of beak not at all longer than the two apical segments together, never extended behind the eyes; apices of genæ not at all prominent; eyes of male large or very large; hemelytra rarely shortened, and pleura complete and the discoidal five-angled aërole produced before the inner aërole of the membrane, this interior aërole shorter than the exterior and produced backwards far less. Apex of scutellum produced platelike, occasionally recurved, never armed with a long erect spine; posterior legs long to medium long; anterior femora distinctly thickened and distinctly spined below; anterior tibiæ subequal in length to femora.

"Body with short or very short, sparse pubescence, smooth above, occasionally tibiæ and antennæ long pilose; head for the most part extended, rarely slightly bent, usually cylindrical, before the eyes produced platelike, rarely the front declines distinctly before the apex, behind the eyes bearing a transverse sulcus above, the part behind the sulcus bearing ocelli in macropterous adults, in brachypterus individuals lightly or not at all elevated, usually bearing some small lateral tubercles which are fitted with short hairs; juga between the antennæ produced or elevated into two prominent spines or teeth; gula very long. Eyes of the male always larger and more convex than those of the female, below very close together, sometimes subcontiguous. Antennæ situated near the apex of the head far in front of the eyes, four-segmented, second always longer than first (frequently twice the diameter of the last), the apical segments very slender, both together much shorter than second, pilose; second segment of male bears always for its whole length rather long and dense pile, female bearing always much pile towards apex; first segment of male pilose or smooth, of female always smooth. Base of pronotum widely rounded, truncate in middle above scutellum and apex usually more than half the width, this subtruncate or rarely lightly sinuate; anterior angles acute or rather acute and projecting laterally; at middle or behind middle lightly contracted at the sides, and the disk transversely impressed, anterior lobe frequently more strongly convex than posterior, this inclined lightly toward apex, marked by two longitudinal median carinæ rather far produced on the posterior lobe, lateral margin a little before the transverse impression frequently produced into an elevated tubercle, sometimes the whole margin lightly serrulate, with short piliferous denticles. Apex of scutellum acuminately produced, base with a small tubercle on either side at margin. Hemelytra usually folded over the length of the abdomen, sometimes a little shorter, rarely much shortened and without membrane; exterior vein of corium elevated; often the whole area is occupied with fuscous or nigrofuscous spots and stripes. Prosternum angularly produced between coxæ, disk bearing a deep stridulatory sulcus running longitudinally for its length, lateral margins of sulcus frequently crenulate and shortly pilose, anterior margins produced into teeth or spines ('prosternal spines') which are usually quite prominent. Disk of mesosternum flat, anterior margin produced between acetabula, sometimes with delicate, dense pubescence, on either side above the external angles of the acetabula with a denuded spot. Metasternum equal in length to mesosternum, apex subtruncate or lightly emarginate. First ventral abdominal segment only half the length of the second, in the male the first five segments with a longitudinal median carina, in the female the first four segments and frequently likewise the fifth with a median carina to a greater or less degree, this female segment, to be sure, narrowed by a median incision, sometimes cut even to base; last dorsal segment of male lightly rounded at apex. Genital segments of male may be seen only from below, the first short, frequently linear and sinuate behind, second larger, convex, usually almost reaching the apex of the suboval aperture, apex truncate, with rounded or sinuate median portion, and usually bearing two copulatory lobes; female with the dorsal segment long and acuminate toward the apex, second segment ventral, totally incised in middle, composed of two lobes. Legs rather long, anterior femora distinctly swollen and with a series of distinct spines below, of which the larger ones alternate with the smaller; sometimes the interior series the shorter."

DISTRIBUTION OF GENUS.

This is a very large genus of over eighty described species, distributed as follows: Nearctic, 3 species; Neotropical, 3 species; Palæarctic, 30 species; Ethiopian, 22 species; Oriental, 21 species; Australian, 5 species.

CLASSIFICATION OF GENUS.

The males of the three species of this genus which occur within our limits may be separated as follows:

1. Basal segment of antenna of male covered on lower and lateral surfaces with numerous long hairs.............. *nubilus* Van Duzee, p. 98
   Basal segment of antenna of male with only a few, short hairs.......... 2
2. First segment of antenna of male a little longer than the anteocular portion of the head; hind femora practically reaching apex of abdomen .... *geniculatus* Stal, p. 91
   First segment of antenna of male about equal in length to anteocular part of head; hind femora not reaching apex of abdomen; hind angles of pronotum long apiculate.................. *apiculatus* Reuter, p. 97

Oncocephalus geniculatus (Stal.).

(Pl. V.)

Stal, Enum. Hemip., II:123; 1872. *Spilolonius geniculatus*.

Although Stal's original description of this species is available, I prefer to quote that given by Reuter (1872) in his monograph of this genus:

"Postocular part of head directly behind the eyes towards the neck strongly narrowed, rounded, a single lateral tubercle distinct; pronotal margin provided with a tubercle, posterior angles shortly apiculate; antennæ, with base and apex of first segment excepted, dark fuscous; eyes of male large. Length, ♂ 14 mm.

"Body elongate, pale grayish yellow or grayish testaceous. Head a little shorter than pronotum, some lines on the anteocular part frequently obsolete and above on the postocular part and laterally fusconigrous; gula testaceous, interocular space of male equal in width to the basal and third segment of the rostrum. Second segment of antenna twice as long as first. Width of pronotum at posterior margin equal to length, anterior exterior angles produced toothlike, hind angles with fairly prominent apex bearing a small rather acute apiculate tubercle, lobes lightly declined, anterior part with five dark lines, the lateral four shortened forward, the outer curved; posterior lobe obscure fuscous, two discoidal carinæ from anterior margin to median region and on lateral margin testaceous. Scutellum nigrofuscous, entirely subhorizontal, extreme apex testaceous. Hemelytra reaching apex of abdomen, pale fuscescente, densely and minutely pale variegated and mottled. Venter with elongate black lines. Lateral region of venter with dark oblong fuscous markings; first genital segment of male with apex deeply sinuate, median one the length of the second, this touching the large part of aperture, apex truncate in middle and lightly sinuate. Femora of all legs nigrofuscous towards apex, the anterior mottled with fuscous, posterior with dark, wide fascia before the middle; anterior femora of male equal in length to the pronotum and head to the transverse sulcus, and four times as long as high, below with a series of nine spines. Base and apex of tibiæ, and the anterior tarsi with a wide stripe nigrofuscous, this stripe on anterior tibia close after middle, on the hind tiba placed below the basal fourth."

In the literature on this species I find no reference to anything but the male sex. Stal described the species from a male, and Reuter, in his monograph, mentions only the characters of the male. Recently I have come into possession of some wingless females of this genus, and possibly of this species. Reuter, in his discussion of *O. apiculatus*, describes a brachypterus female which answers the description of those in my possession. Inasmuch as they have been found to mate with males answering the above description, it seems probable that they should be assigned to this species rather than to *apiculatus*. That, however, leaves the female of *apiculatus* unaccounted for.

Biology. This is one of the more common species of this subfamily, yet nothing concerning its life history and habits has been recorded. The writer has had the opportunity to make a number of observations on this species, and records them here.

Habitat. This species is a resident of the undersides of rocks and boards, both in the immature and adult conditions. There it has been taken frequently by the writer.

Seasonal Life History. This insect has been found to hibernate as a nymph, and in several different instars. In one case an overturned rock yielded second-, third-, fourth- and fifth-instar nymphs on November 24, and the assumption was made that these had developed as far as they would for that season. It may be that the younger insects die off during the winter months and that only the older insects survive, for I have never taken one younger than the fourth instar in the early spring. The fact that no adults have been taken during the winter months, and that no very young individuals have been taken in early spring indicate that the insect must winter as a nymph, and not as an egg or adult insect.

It is usual for the adult insect to appear in late spring and early summer. Adult males are attracted to lights, or may be collected during the day under the rocks which protect them. The females, being wingless, must be sought under rocks. Collecting records indicate that on June 15, 1924, two nymphs of this species were taken from under rocks on a rather dry, hilly field. One of these had long wing pads and the other short. On June 19 the individual with long wing pads molted and became a long-winged male, and on June 26 the individual with short wing pads molted and became a short-winged female. Other records show the collection of males at lights on June 13, 17 and 19, 1925, and the finding of a wingless female under rocks on June 17, 1925.

It is assumed that mating and oviposition follow shortly after the appearance of the adults. Laboratory egg-laying records extend from June 18 to June 24. After a short egg stage the insect spends the rest of the warmer part of the year developing to a size which will be able to withstand the cold of winter. It is quite certain that there is but one generation a season.

Food. It has not been determined what the normal food of this insect is. In the laboratory it was given house flies, and was observed to feed on them occasionally. However, the failure to keep a large number of these insects alive led the writer to believe that this diet might not be normal for them. It is likely that they feed on small insects that inhabit the same localities that they do.

Eggs. The eggs of this species are laid in the ground with only the top of the egg visible. In the laboratory a female was confined in a small tin box of about two inches in diameter and one and a half inch in height, provided with earth which was kept moist, and with a small stone. The act of oviposition was never witnessed, but the eggs were found easily. Each egg is laid singly, inserted into the earth, as is the egg of *Melanolestes picipes* (Herrich-Schaeffer).

The total number of eggs deposited by a single female has not been determined satisfactorily. The writer has had in confinement only a single ovipositing female, whose record is as follows: June 17, collected and placed with a fully winged male which had been collected from a light; these observed mating the same day. June 18, one egg found in container; June 20, 2 eggs; June 21, 2 eggs; June 22, 2 eggs; June 23, 2 eggs. The total number of eggs laid by this female was 12, a much smaller number than one would expect. The description of the egg is given later.

The hatching process was not witnessed. It could be seen that the cap of the egg was pushed off, as is the case in all of the Reduviidæ studied, and that the membrane of the postnatal molt was left attached to the shell. The cap was not entirely loosened, but remained attached by one side.

Length of Instars. Only a small amount of material on this subject is available, as rearing records are not complete. The only individual which was reared at all successfully has the following record: June 20, egg laid; July 5, hatched; July 24, molted to second instar; August 12, molted to third instar; August 27, molted to fourth instar; September 20, molted to fifth instar, dead.

It is assumed that normally this insect would have passed through the winter in the fifth instar and changed to the adult the following spring.

Habits. This insect is one of the most sluggish of the Reduviidæ. It is normally very inactive, at least during the time of day when one normally observes it, though it may be more active at night. The normal resting position is flattened close down against a rock, the first segment of the antennæ extending straight out, and the other segments folded back against the first segment and the head. The protective coloration of the insect is perfect, especially that of the immature stages. The mottling of dull browns and greys makes them practically invisible when resting on a similarly colored rock. When grasped, the insect, in common with all the other Reduviidæ that I have worked with, nods its head up and down, sliding the tip of the beak back and forth along the prosternal groove, and producing the very faint squeak which is its warning note. This species has not been known to offer to use its beak in defense against a human being. It has been observed that the under side of the abdomen of the nymphs is thrown into a series of supporting ridges, or arches, which seems to be a definite adaption for supporting the body under the weight of a superimposed rock.

DESCRIPTION OF INSTARS.

Eggs. (Pl. IV, Figs. 1-3; Pl. V, Fig. 8.) Total length, 1.4 mm.; greatest width, 1 mm.; diameter at cap, .7 mm.

Uniform dull white in color, surface reticulated.

Body of egg nearly spherical in shape, slightly longer than wide; base smoothly and evenly rounded, apex squarely cut off and with a distinct cap; narrowed in the region of the cap to a distinct collar, above collar chorion extended in an irregular fringe; cap within collar, circular in outline, somewhat concave, periphery of cap with a regular and closely spaced circle of erect appendages of uniform length; convex disk of cap with clothing of rather closely spaced, hairlike appendages.

First Instar. (Pl. V, Fig. 1.) Length of body from 2.4 mm. to 3.4 mm.; length of front femur, 1. mm.; length of first antennal segment, .27 mm.

General color dirty greyish and brownish, mottled; dorsum of head, pro-, meso- and lateral margins of metathorax darker, abdomen and median region of metathorax lighter, antennæ rather dark; rostrum dark at base and apex, light in middle; femora dark with lighter bases and median bands; tibiæ dark at bases and apices and with a single dark band between these two markings, tarsi dark.

Narrowly pear-shaped with abdomen somewhat swollen; head less than twice as long as wide, joined to prothorax by constricted neck; postocular region distinctly wider than anteocular region; apex bluntly rounded; eyes conspicuous; epicraneal suture visible; antennæ four-segmented, first and third segments short, second and fourth longer, first segment broadest, curved outwards, with two conspicuous setæ on inner margin near base; other segments sparsely hairy. Prothorax subquadrate with concave anterior margin and square posterior margin; meso- and metanota smaller than pronotum; front femora swollen, with about ten small teeth in a regular row on under side; tibiæ and tarsi of anterior legs noticeably stouter than those of hind legs; mid and hind legs normal walking legs, hind legs longest. Abdomen swollen; openings to dorsal stink glands visible at anterior margins of segments four and five.

Second Instar. (Pl. V, Fig. 2.) Length of body, 4.3 mm.; length of front femur, 1.17 mm.; length of first antennal segment, .34 mm.

Color similar to preceding, slightly darker with more of a brownish tone.

Surface of body more gibbous than in preceding instar; first antennal segment now with three conspicuous setæ on its inner margin; margin of head laterad of and very close to base of antenna with a tubercle bearing two setæ; ventral surface with sutures making segments V-shaped; openings to dorsal stink glands as before.

Third Instar. (Pl. V, Fig. 3.) Length of body, 5.8 mm.; length of front femur, 1.53 mm.; length of first antennal segment, .42 mm.

Somewhat darker than in preceding with less distinction between color of thorax and abdomen.

Surface of body more gibbous than in preceding; wing pads present at posterior margins of meso- and metanota, broadly rounded at apices; mesothoracic pads extended backwards about as far as the middle of that segment, as are metathoracic pads to about middle of that segment.

Fourth Instar. (Pl. V, Fig. 4.) Length of body, 7.7 mm.; length of front femur, 2.2 mm.; length of first antennal segment, .6 mm.

Body of a general dark-brown color, distribution of color as in preceding.

Body very rugose; wing pads more conspicuous, those of mesothorax extended back over bases of metathoracic pads, and metathoracic pads extended over first abdominal segment for about one-half its length; both more sharply pointed in this instar.

Fifth Instar. (Pl. V, Fig. 5.) Length of body, 10.1 mm. to 11.1 mm.; length of front femur, 2.7 mm.; length of first antennal segment, .78 mm.

Body mottled with light and dark brown; antennæ brown with exception of base of first segment, this light; rostrum with first segment light at base and at extreme apex, second segment light for nearly basal half, third segment entirely dark; legs banded with alternate light and dark; femora dark at base and apex with median light band; tibiæ dark at base and apex with a third dark median band, this in hind tibia very near the base; tarsi dark.

Body very rugose, with numerous small tubercles, each surmounted by a seta, on surfaces, as well as on femora of fore legs and first antennal segment; head constricted at base, widened abruptly to swollen postocular region, this wider than anteocular region; eyes prominent; epicraneal suture prominent; conspicuous tubercle with two setæ at base of antennæ; antennæ four-segmented, second segment longest and almost equal in length to the other three combined; first segment widest, curved outward, with three conspicuous setæ on inner margin. Prothorax subquadrate, anterior angles somewhat produced but blunt; posterior angles produced backwards slightly; posterior margin with two somewhat elevated rugulæ near median line; wing pads much longer in this instar; in nymphs of winged adults extended to base of third abdominal segment; in nymphs of short-winged adult extended only to base of second abdominal segment; abdominal segments indicated by sutures, these V-shaped in median portion; openings to dorsal stink glands visible at anterior margins of segments four and five; ventral surface of abdomen ridged, each segment being thrown into two ridges by a transverse suture, sutures, both between segments and within segments V-shaped, the V towards the head.

Localities. Texas, Colorado, Kansas.

Oncocephalus apiculatus Reuter.

Reuter, Acta Societ. Scien. Fennicæ, XII:728; 1882.

"Similar to *geniculatus*, but shorter and paler, head built differently, eyes less prominent, legs shorter, etc. Body elongate-oval, above pale lurido-testaceous, below pale yellow. Head a little shorter than pronotum, pale, lateral vittæ, postocular marks and two anteocular vittæ obsolete fuscous; apex of jugæ between antennæ elevated into two teeth; postocular part before the neck wider than anteocular part. Rostrum pale yellowish, a narrow median annulus and upper margin of first segment, the apical half of the second, and the third with basal margin excepted piceo-nigris. First segment of antenna (male) ferrugineous, base and apex pale yellow, second twice length of first, pale towards base. Basal width of pronotum about length, base twice wider than apex, lobe towards apex slightly declined; two diverging obsolete carinæ on disk of posterior lobe, do not reach middle of this; posterior lobe between the outside of carinæ obscure fuscescente; anterior five fuscescente lines obsolete. Scutellum fuscous, densely and minutely pale variegated, outer veins of corium strongly elevated and pale. Prosternum pale, narrowed at sides, and partly fuscous, marginal line outside the anterior acetabula and an oblong mesosternal spot on either side behind the anterior coxæ fuscous. Segments of connexivum with small fuscous dots before the apical angles. Lateral region of venter irregularly infuscated, dense fuscedine with pale droplike spots; first genital segment of male with apex rather broadly sinuate and one-third the length of the median second segment; the apex of this truncate and slightly sinuate in the middle. All legs as in preceding. Anterior femora equal in length to the pronotum and the head to the anterior margin of the eyes, and about four times as long as maximum width, above curved, wide at base, below with series of ten spines.

"Obs. Short-winged female from boreal America (Missouri). Sent by Bergroth, similar to this species. Body subelongate. Head rather thick, anteocular part parallel to postocular part behind eyes, behind middle suddenly and strongly constricted into a neck, three small lateral tubercles on either side, above the base two backwardly directed tubercles; testaceous, lateral vittæ on either side, and upper postocular spot and two anteocular vittæ towards narrowed apex fuscous; interocular gular space a little wider than the eye. Rostrum testaceous, first segment with a wide median annulus, apical half of second and all of third nigrofuscous. Antennæ dark fuscous, first segment with base and apex testaceous, about one-fourth shorter than anteocular part of head, glabrous, second segment about two and three-fourths the length of the first, apex short pilose. Pronotum length of head, somewhat longer than basal width, anterior angles slightly extended and produced toothlike, marginal tubercle obsolete, posterior angles acute; testaceous, three median vittæ; median one wide, lateral ones incurved, and a lateral vittula on posterior lobe fuscous. Scutellum with exception of extreme apex nigrofuscous, apex horizontal. Hemelytra much shortened, longer than scutellum by half, apex rounded, dark fumed, veins pale, small discoidal area black. Dorsum of abdomen dark testaceous, and lateral connexiva nigrofuscous, with testaceous punctate margin behind middle. Prosternum testaceous, dark lined. Venter testaceous, laterally dark variegated, fifth ventral segment cut to base, sixth almost twice length of fifth in middle, apex widely rounded, genital segments short, together about one-third shorter than fifth ventral segment, the second a little shorter than the first. Anterior trochanters with small, acute spines. Anterior femora equal in length to pronotum and half the head, length three times maximum height, base above lightly sinuate, lower margin with nine to ten large spines, testaceous, irrorate fuscous, apex fuscous, behind the apex nigrofuscous and a band before the middle nigrofuscous. Base of tibia and apical annulus nigrofuscous, median annulus on anterior tibiæ, past middle on intermediate tibiæ, in four parts on hind tibiæ. Tarsi fuscous.

"Length, 14½ mm."

Several females answering to the above description have been collected in the vicinity of Lawrence, Kan., and have been discussed under the preceding species, since the male accompanying these females belonged to the species *geniculatus*. The systematic position of these insects should be more carefully worked out.

Biology. This species is so closely related to the preceding that what has been said about the biology of that species will undoubtedly apply to this species also. It is certain that this insect normally lives under rocks and logs, and probable that it hibernates as a nymph.

Locality. Missouri.

Oncocephalus nubilus Van Duzee.

Van Duzee, Trans. San Diego Soc. Nat. Hist., II:12; 1914.

"Most nearly allied to *cincticrus* Reut. from Africa. Basal joint of the antennæ bald above; testaceous with a dorsal fuscous cloud. Length, 18 mm.

"Head normal, unarmed beneath; anteocular portion equal to the postocular portion and eyes together; postocular portion gibbous and abrubtly narrowed behind, strongly elevated about the ocelli; armed beneath on either side behind the eyes with three porrect stiff bristles and there are about three on the tubercular antennal sockets. Basal joint of the antennæ thickened toward the apex, bald above, below and on either side armed with long stiff bristlelike hairs as is the entire second joint, these becoming shorter toward the apex; second joint one-half longer than first; third joint shorter than first. Rostrum with the first joint subequal to the second, the apical only fuscous. Pronotum unarmed on the disk and humeri, the anterior angles with a blunt tubercle; disk with the two median carinæ distinct, the humeri prominent, sharply right-angled; sides obtusely carinate; prosternal tubercles short and blunt. Scutellar spine long as in *geniculatus* and the characters of the legs and elytra as in that species.

"Color pale testaceous; a broad dorsal fuscous cloud is narrowed to a point at the posterior margin of the pronotum and is deepened almost to black on the posterior disk of the pronotum, covers the scutellum except the pale apical spine and its basal carina, and is dispersed over the elytra where it omits the broad base of the costa and becomes obscurely dotted with pale posteriorly. Eyes, tumid base of the head, its lower surface and a line behind the antennæ, black. Antennæ infuscated with the incisures and hairs paler. Legs marked as in *geniculatus;* femora fuscous at apex, the posterior with a broad median annulus; tibiæ with the base and apex and a median annulus fuscous, the annulus on the posterior displaced to near the base. Margins of the connexivum with a black line near the base of each segment.

"Described from a single male taken by Prof. F. H. Snow on the San Bernardino ranch, Cochise county, Arizona, in August, at the altitude of 3,750 feet. What I believe to be the immature female of this species occurred in numbers with its dark fuscous larvæ under stones on the adobe lands at Alpine, April 2, 1913. The nymphs differ in being darker with the elytra more or less clouded with brown. These, which just pass the middle of the tergum, infuscated and pale irrorate, the antennæ want the long hairs."

Localities. Arizona, California.

Genus NARVESUS.

This genus was described originally by Stal (1859) as follows:

"Body subelongate. Head cylindrical, thorax equal in length to head, head bidentate near the apex between the antennæ, below armed on either side with obtuse spines. Antennæ inserted near apex of head, segment 1 somewhat longer than head. Eyes placed just behind the middle of the head. Ocelli elevated, large. Rostrum with segments one and two equal in length. Thorax transversely impressed midway, anterior angles armed with thick spines, posterior angles prominent, subacute. Apex of scutellum reflexly produced. Abdomen a little wider than hemelytra. Legs long, slender, anterior femora scarcely thicker than posterior; posterior tarsi with first segment slightly the shorter, the apical segments slightly longer."

DISTRIBUTION OF GENUS.

This genus contains a single species, shared by both the Nearctic and Neotropical regions.

Narvesus carolinensis Stal.

(Pl. VI.)

Stal, Of. Vet. Akad. Forh., XVI:385; 1859.

"Livid, a mark on the posterior part of the head, a discoidal aërole of the hemelytra, a small oblong almost median membrane, also marginal spots on the abdomen above and below, and a series of small spots situated towards the sides of the venter black; lateral macula of the pectus, legs, and rostrum fuscous; antenniferous tubercles farther apart than the distance from them to the eyes.

"♂. Length, 13 mm.; width, 2⅔ mm. Carolina."

Habitat. This insect, in common with the members of the genus *Oncocephalus*, inhabits the under sides of rocks and logs. Both adults and nymphs have been taken from such places. The adults also are attracted to lights.

Seasonal Life History. This species is evidently very similar to *Oncocephalus geniculatus* in this respect, though records are not so numerous as in the case of that insect. The writer has, however, taken this insect several times in early spring in the nymphal condition, the indications being that it hibernates as a nymph, probably in the fourth or fifth instar. In one case a fifth-instar nymph was collected on June 12, and became adult in confinement on June 21. The probable life history would demand that the eggs be deposited in late June and early July.

DESCRIPTION OF INSTARS.

Fourth Instar. (Pl. VI, Fig. 1.) Length of body, 7.7 mm.; length of front femur, 1.6 mm.; length of first antennal segment, .51 mm.

General color testaceous, obscurely striped and mottled; eyes with faint reddish tinge, dorsum of abdomen with darker median stripe; legs lighter above and darker below, apices of tibiæ and all of tarsi darker; under surface of body darker laterally, lighter medially.

Surface of body covered with numerous tubercles; head constricted at base, widest behind eyes, region behind eyes provided caudally with two backward-projecting processes; antennæ rather short, curved, first segment stout, following segments narrower, second segment longest, first and fourth intermediate, third shortest; beak three-segmented, first and second segments subequal, third segment shorter. Pronotum subquadrate, anterior angles produced forward and armed with a blunt tubercle; posterior angles produced backwards slightly and bluntly rounded; prosternum with a forward projecting process at each anterior angle, this bearing tubercle, blunt at apex; wing pads present on dorsum of meso- and metathorax, first pair extended over second pair but not to extremities, second pair extended over first abdominal segment almost to its extremity; mesosternum with median ridge. Hind legs longest, fore and middle tibiæ subequal, fore femora slightly thickened, unarmed. Abdomen somewhat swollen, hind angles of abdominal segments 2-7 produced into rounded lobes; openings to dorsal stink glands located along middorsal line at base of abdominal segments four and five; ventral surface of abdomen thrown into a series of ridges by the intersegmental sutures and an additional transverse suture which divides each segment transversely, sutures V-shaped, the apex of the V toward the head.

Fifth Instar. (Pl. VI, Fig. 2.) Length of body, 10.1 mm.; length of front femur, 2.1 mm.; length of first antennal segment, .68 mm. Color as in preceding.

Structure similar to that of preceding. Tubercles at anterior angles of pronotum now more distinct; wing pads much larger, of nearly equal length, both reaching the base of the third abdominal segment. Produced posterior angles of abdominal segments 2-7 now less distinct.

Localities. New Jersey, South Carolina, Florida, Missouri, Texas, Arizona, Kansas, Cuba, Mexico, Guatemala.

Genus DIADITUS.

This genus was described originally by Stal (1859) as follows:

"Body strongly oblong. Head cylindrical, antenniferous tubercles apical, subproduced, between them two porrect spines, extending beyond them. Segment one of rostrum of almost equal length with apical two. Legs slender, rather long, anterior femora hardly thickened, unarmed, posterior femora about equal in length with abdomen; segments one and two of hind tarsi of equal length, together equal in length to third segment."

DISTRIBUTION OF GENUS.

This genus is composed of five described species, four of which are Neotropical, and one Oriental in distribution. One of the Neotropical species extends its range to come within our limits.

Diaditus pictipes Champion.

Champion, Biol. Centr. Am., Heter., II:189, pl. 11, fig. 21; 1898.

"Very like *D. hirticornis* and similarly colored, but sometimes with the head and the basal joint of the antennæ paler; the pronotum with the median space between the two carinæ usually infuscate; the femora and tarsi more or less fuscous or blackish, the anterior and intermediate pairs with a fuscous ring about the middle, that on the intermediate pair sometimes obsolete; the antennæ with joints 2-4 clothed with short fine projecting hairs. Head with the ocelli in the male moderately large and placed on a slightly raised prominence, smaller in the female; eyes moderately large in the male, smaller in the female, transverse if viewed laterally; frontal spines stout, approximate, blunt at tip; antennæ with joint 1 considerably shorter than head, 2 rather slender, about one-fourth longer than 1, 3 and 4 very slender, 4 slightly longer than 3. Pronotum as in *D. hirticornis*. Abdomen with the sixth dorsal segment slightly emarginate in the center at the apex in the male and rounded in the female; the female with two genital segments visible from above—the first broad, declivous, and trapezoidal in shape, the second short and strongly transverse. Prosternal spines short. Anterior tarsi with the second and third joints almost fused into one.

"Length, 8-8½ mm; breadth, 2½-2⁹⁄₁₀ mm. (♂ ♀)."

Localities. Texas, Mexico, Guatemala.

SUBFAMILY REDUVIINÆ.

This subfamily was originally designated as the "Groupe Reduvides" by Amyot and Serville (1843). The characteristics of the subfamily are as follows: Ocelli present; fore coxæ not elongated; anterior and usually middle tibiæ with spongy fossa at apex; the transverse furrow of the pronotum midway, or nearer the cephalic than the caudal margin; ocelli not farther cephalad than the caudal margin of the eyes; apex of the scutellum narrow, without spines or with a single spine.

BIOLOGY.

The subfamily includes household and field species, some forms which feed on insects, others which are typically hæmatophagous.

WORLD DISTRIBUTION.

This is the second largest subfamily of the family Reduviidæ, being surpassed in number of species only by the subfamily Harpactorinæ. In all, 639 species have been described as belonging to this subfamily. These are distributed as follows: Nearctic, 16 species; Neotropical, 170 species; Palæarctic, 57 species; Ethiopian, 182 species; Oriental, 192 species; Australian, 33 species. It will be observed that by far the larger numbers of species are located in the Oriental, Ethiopian and Neotropical realms.

CLASSIFICATION OF SUBFAMILY.

The four genera of this subfamily which occur within our limits may be separated by the following key:

1. Antennæ inserted in lateral or dorsolateral margins of head; antenniferous tubercles projecting slightly from sides of head; head produced strongly cephalad 2

   Antennæ inserted on top of head between margins, close to eyes; antenniferous tubercles not projecting from sides of head 3

2. Body slightly hairy; pronotum distinctly constricted, angles distinct; anterior lobe quadrituberculate with the middle tubercle large and conical .... *Meccus* Stal, p. 112

   Body glabrous, margins of pronotum sinuous, scarcely constricted; anterior lobe lined with little tubercles .... *Triatoma* Laporte, p. 114

3. Anterior lobe of pronotum with a bispinose or bituberculate disk; femora unarmed .... *Spiniger* Burmeister, p. 124

   Disk of pronotum unarmed; apex of scutellum produced into a spine, *Reduvius* Fabricius, p. 103

Genus Reduvius.

This genus was originally characterized by Fabricius (1775) as follows:

"*Reduvius.* Os rostero arcuato. Antennæ supra oculos insertæ."

Later descriptions define the genus more closely than this. Herrich-Schaeffer gives the following satisfactory description of the genus (1848):

"Elongate oval, broadest behind the middle, rather flat. The whole body, but especially the antennæ and legs, covered with long and thick hair. The head a little longer than broad, the middle portion longer and narrower than the side portions. The eyes are placed somewhat behind the middle, and are large, kidney-shaped, and approach one another closely below, more so than above, especially in the male, in which they almost touch one another here. The ocelli are very large, are placed close behind the eyes and moderately far from one another. Behind them the head narrows gradually.

"The antennæ are shorter than the body, the antenniferous tubercles stand close before the eyes, over a line drawn from the middle of the eyes to the apex of the middle portion of the head. They are bristle-shaped, four-segmented, segment one the shortest and thickest, two and three about the same length, four shorter.

"The beak reaches the base of the fore coxæ, and is bent. Segment two is the longest, three the shortest, one the thickest.

"Thorax with a transverse furrow before its middle and midlongitudinal depression not very well defined, which causes the anterior half to appear as two flat half-balls. Scutellum rather large, three-cornered, with a sharp keel-shaped apex.

"The wing covers hardly expose the margin of the abdomen, their thickened portion is hardly more coriaceous than their membranous, with five closed cells, without adjacent cells. The membranous portion with the customary two cells, a free vein at the inner margin, and a forked vein from the apex of the outer wall.

"Legs about the same thickness, the anterior coxæ and middle coxæ are closer together than the hind coxæ, the hind femora a little more slender and about one-fourth longer than the four anterior femora. The hind tibiæ are about one-fourth longer than the femora. The four anterior tibiæ with elongate-oval soles at apex, one-fourth to one-third as long as total length; the free apex of sole not as long as the first tarsal segment. The claws are long and simple, without pulvilli. First tarsal segment the shortest, third by far the longest.

"The last abdominal segment of the male forms a raised oval, behind with two blunt little knobs, which in the female is a small triangle with a longitudinal fissure."

BIOLOGY OF GENUS.

The habits of one member of this genus, *personatus* (Linnæus), are well known, and there is no definite data on the other species of the genus for purposes of comparison.

WORLD DISTRIBUTION OF GENUS.

This genus is widely distributed, having representatives in all of the faunal realms excepting the Neotropical. It is composed of 48 described species, distributed as follows: Nearctic, 2 species; Palæarctic, 27 species; Ethiopian, 14 species; Oriental, 7 species; Australian, 1 species. This is one of the few genera which have a larger representation in the Palæarctic realm than in any other.

CLASSIFICATION OF GENUS.

There are but two species recorded from our limits and they may be separated as follows:

1. Larger, 26 mm. or more in length, piceous..........*personatus* (Linnæus).
   Smaller, about 17 mm. in length, pale testaceous brown..*senilus* Van Duzee.

Reduvius personatus (Linnæus).

(Pl. VII.)

Linnæus, Syst. Nat., edn. 10, I:446; 1778. *Cimex personatus.*

"Antennæ capillar at the tip; body subvillous brown.
"Inhabits Europe.
"The larva preys upon the common house bug."

While the above description is hardly full enough to be satisfactory, the insect may be recognized from the generic description and the key to species.

Biology. Numerous references to the habits of this species may be found. Because of the fact that it is a household insect and common in Europe it has been referred to many times by European workers.

Linnæus' comments on the habits of the insect are given above, and consist of the brief statement, "The larva preys upon the common house bug."

Fabricius (1775), in his first reference to this insect, states, "Larva horrida, personata, consumit *A. lectularium*," which comment he repeats in his later references to this insect.

De Geer (1773), in his Memoires, seems to have been the first to observe that its bite was poisonous. A free translation of his observations follows:

"It moves just as rapidly, when it wishes to, as the other bugs, but usually its progression is slow, in other words, *a pas compte;* for, after having placed one foot forward, it stops a little, then advances a second, at each movement leaving the opposite foot in repose, and thus continues successively, so that it seem to walk by jerks and by measure, while the other insects advance each pair of legs together, and in the same time. It makes an almost similar movement with the antennæ, which it moves equally at intervals and as if jerked. All its movements have an aspect more peculiar than one can easily describe. It feeds upon insects of all species so far as I have been able to observe. After it had been presented with May flies and flies which equalled it in size, and it had approached closely, feeling its way without pause with its antennæ, it pounced and seized in an instant with one of its anterior legs one of the flies, which then, though in vain, bent all of its energies towards escaping; for the bug, having inserted into the body the point of its beak, occupied itself with sucking. The fly, once pricked, died promptly, which showed clearly that the bug, without doubt, poured into the wound some venom which is very quick in its effect. It would seem likely that the ornamentation by the peculiar clothing of dust, and the method of progression, as though feeling its way, serve only to deceive the other insects which serve as its prey."

De Geer also says that the insect passes the winter as an engorged larva without taking food; and that at that time its body becomes thin and flat; that at the return of warm weather it discards its lethargy and recommences feeding. He has also observed that the adult produces an acute sound by rubbing the head against the prothorax.

Burmeister (1835) makes the following comments upon the habits of the insect:

"Not infrequently found in houses; however, for the most part one finds this insect hanging dead in spider webs, since it is only at night that it seeks its prey, which consists of all kinds of small vermin. Its bite is very poisonous to them, and for that reason the spiders do not attack it, but let it hang in the web until it starves. The larva may be found in dusty corners, and it is entirely covered with grains of sand and dust by which it is made almost unrecognizable and so may apprehend its prey more surely. Linnæus and Fabricius maintain that it lies in wait for the bedbug."

Amyot and Serville (1843) review the observations of De Geer and Burmeister and report that it flies to lights, which attract it, and that it may bite one who grasps it.

Latreille (1804) reports being bitten on the shoulder by this insect. In this case the whole arm became numb, and this condition lasted several hours.

Fabre (1903) studied the habits of this insect and reported rather fully on his studies. He observed the insect feeding, and obtained the eggs. He gave a very interesting account of the hatching process which is quoted, translation by Heidemann:

"The opening of the cover widens and through the crack I perceive something shining. It is an iridescent skin, globelike, that pushes the cover. Now emerges out of the shell a spherical vesicle, which, by degrees, enlarges itself like a soap bubble, blown at the end of a straw. More and more, pushed by the enlargement of the bladder, the cover is displaced. Then the bomb explodes, that is to say that, swollen beyond the limits of its resistance, the bubble ruptures at its summit. The envelope membrane of extreme tenuity remains, generally adhering to the brim of the orifice, where it makes a high and white margin. At other times the explosion detaches it and throws it out of the shell. Now the way is free; the little one can come out either by breaking the skin set in the opening or by throwing it over, or else by finding the way out when the bursted bubble has detached itself from the egg. It is simply marvelous! To come out of its coffer the pentatomid has invented the miter and the push of the hydraulic ram. The reduviid has constructed the explosive engine."

E. A. Butler (1923), in "Biology of British Hemiptera," gives an excellent account of the life history and habits of this insect. He quotes the description of the egg given by Leuckhart, describes the appearance and habits of the larvæ, gives notes on the life cycle, and discusses stridulation and distribution. His discussion of the larva is particularly enlightening and interesting:

"The larva is somewhat similar in form to the adult, and has the peculiar habit of covering itself, body, legs and basal joint of antennæ with fragments of foreign matter, which might perhaps collectively be called 'dust,' its appearance is thereby greatly altered, as is suggested by the name *personatus*, 'masked.' These particles are attached not so much to the body itself as to the long and fine hairs with which it is covered, and which appear to have some adhesive power. By what means the fragments are placed in position I cannot say, but there seems to be no doubt that the devise is intentional and not accidental, as it occurs in all examples and all stages. The habit is not peculiar to *Reduvius*. I have a large larva of an Indian species of *Acanthaspis* which carries on its back an extraordinary load consisting of numbers of pappose flower seeds, a little flower, the skin of a hairy caterpillar, and part of the bleached skeleton of a woodlouse, all these being mixed up with various sand grains. Mr. Champion has shown me a young larva of *Reduvius* which he took at Guildford; this has no foreign matter on the dorsum of the abdomen, nor on the antennæ, except the basal joint, but all the other parts are more or less covered. The fragments are too small to be identifiable, except under the generic name of 'dust.' The insect, so far as can be seen, is of a pale-brown color, and is thickly set with fine hairs, except on the dorsum of the abdomen; that is the tenderest part of the body, and has collapsed in consequence of the drying up of the abdominal contents; this elasticity may be one reason for the absence of the cover of dust. The parts most thickly covered are the two front pairs of legs. The hind femora appear to have three parallel transverse dark stripes at the apex, but nothing can be seen of markings elsewhere. Its length is about 3¾ mm., so that it is probably about half grown."

Butler's comments on the possible seasonal life history are as follows:

"The imago has been found from May to September, but as it is associated more or less with places of human occupation, it probably partakes of the habits of such insects and has no definite seasons for the different stages in its life history."

He also describes a rearing conducted by Poujade (1888), who kept a nymph which he collected in August, 1887, until it molted and became an adult in June, 1888, thus living ten months without undergoing more than one molt, its final one. This insect remained torpid during the winter and took no food. This seems to agree with De Geer's observations recorded above.

There is no definite information as to the time this insect was introduced into this country. Walsh and Riley (1869) mentioned the fact that such an insect existed at that time in Europe, but that we had no corresponding insect of similar habits. Previous to this time, however, Le Conte (1855) had rescribed as new *Reduvius pungens*, an insect which was later identified as being identical with *personatus*. In 1878 Uhler reports:

"This European species (*personatus*) is fully established, though not numerous, in the United States. I have examined specimens from Maine, Massachusetts, New York, Pennsylvania, Maryland and Georgia. After a comparison with European specimens I find no difference to separate them as distinct species."

Several writers in this country, among them Howard (1899); Le Conte (1855); Felt (1912); Riley and Johannsen (1915) and others have discussed the habits of this insect and particularly its poisonous bite. Heidemann (1911) has figured and described the egg.

A summary of what is known of the life history is given below:

Habitat. There seems to be no doubt about the species being normally an inhabitant of houses and other buildings, living in dusty corners and in less used portions of the dwellings as nymphs, and coming to lights at night as adults.

Food. Bedbugs, flower beetles, May flies and other insects have been mentioned as food of this insect. The writer has had excellent success in rearing this insect on a diet of house flies, and has also observed them feeding on other insects offered, such as leaf hoppers, Miridæ, small grasshoppers and other insects easily swept from fields. A convenient and satisfactory winter food was the larvæ of mud daubers taken from their cells on the insectary wall. One insect which was not accepted as food was the meal worm, *Tenebrio molitor*. In several cases nearly mature larvæ of this insect were offered to fifth-instar assassin-bug nymphs, which allowed them to change to the pupa, and then to the adult, without molesting them. An attempt was made to see whether the insect would feed on meat, since that possibility has been suggested with several Reduviidæ. Small pieces of fresh beef were put into the containers with the bugs, and allowed to remain there until very putrid. However, the insects were never found to be eating the meat, either in its fresh or putrid condition, though they may have done so unnoticed.

Eggs. (Pl. IV, Fig. 4; Pl. VII, Fig. 7.) The fact that the eggs are deposited singly, without attachment, has been reported upon previously by Fabre, who obtained from thirty to forty eggs from each female. The writer has had the opportunity to obtain what was apparently the full number of eggs from a female kept in captivity, since she had been reared from the egg herself, and apparently lived out her full and normal life. On May 29 this insect molted to an adult. There was no adult male available at the time, but on June 6 one became adult and was placed in the cage with the female. Mating was not observed, but undoubtedly occurred. On June 9 twelve eggs were found in the cage, and from that time on eggs were found nearly every day until July 27, when the female died. The number deposited in a day varied from 4 to 12, and the total number deposited during the life of the female 273. The following description of the egg is one prepared by Leuckhart (1855):

"The eggs of *R. personatus* recall by their form those of the Pentatomidæ. They are oval and obese, fully 1 mm. long, narrowed towards the base and furnished at the flatter end with a rather flat lid which carries a groove. The brownish-yellow chorion is decidedly hard. The outer surface is quite smooth and shining, the inner, on the contrary, is of finely granulated appearance. No further structure can be seen except here and there a minute canal leading to the under surface of the chorion, and undoubtedly intended to bring air into close contact with the yolk and embryo. The outer margin of the groove round the lid is lengthened into a thin, projecting, rimlike lamella, on the inner wall of which there are a number of vertical prominences. These are the micropyles, and their number may amount to about eighty. In each of these micropyles can be distinguished two parts, one outer and cup-shaped, the other inner and canal-shaped. The former is attached all along to the inner surface of the lamella; it begins with a transverse opening close beneath the upper margin of the rim, and gradually narrows till it reaches the bottom of the groove. The free, cup-shaped part is continued into a canal which penetrates the chorion. Out of the lower end of the cup there arises a fine passage, the above-mentioned under segment of the micropyle, which runs down for a space in the substance of the chorion."

Feeding Habits. De Geer, as quoted above, gives an account of an attack of this insect on its prey, and Fabre gives other interesting details on this subject. The writer has not witnessed the attack except in the case of young nymphs, but has witnessed feeding several times Fabre calls attention to the fact that the assassin bug shifts its position several times while sucking an insect dry.

Seasonal Life History. Several writers have reported that this insect passes the winter in the nymphal stage, though Butler thinks it likely that the life history is not seasonal, because of the fact that the species is domestic. However, the writer's experience points to a seasonal life history in which the winter is spent as a nymph, usually in the fourth or fifth instar, though third-instar nymphs have been found during the winter in a few instances. The insect normally becomes an adult in May or June, though some do not undergo the final molt until July and possibly August. The egg and young nymphal stages of course occupy the rest of the warm season of the year. Several observers have reported that the insect becomes torpid and does not feed during the winter. The writer's observations show that the insect does indeed become much less active and feeds much less during the winter, and that its transformations do not ordinarily take place at that time. However, some individuals have been observed to take food rather regularly during that season when kept in a warmed room, and one individual changed from the third to the fourth instar on January 4, and from the fourth to the fifth on January 24, feeding between the molts. This is unusual, however, and those which enter the winter season in the fifth instar usually are much less active and feed much less than this would indicate. In one instance an individual which entered the winter as a fifth-instar nymph changed to the adult after the first few warm days of early spring, on March 3, but in this case also we see the unusual.

Length of Stages. There is considerable variation in the length of the stages, especially in the older nymphal stages, since the insect may winter either as a fifth, fourth, or possibly third instar.

The length of the egg stage varied from 13 to 16 days.

The first instar varied from 11 to 20 days. It undoubtedly may be prolonged still more if food is not abundant.

The second instar varied from 11 to 20 days, and also may be much longer.

The third instar lasted from 22 days to as long as 5 months.

The fourth instar lasted from 11 to 78 days. The winter, or a large part of it, may be spent in the fourth instar.

The fifth instar normally occupies the greater part of the winter, and varied from four to five months in the cases reared. It may last still longer, as it did in the case of the insect reared by Poujade (1888), who kept a fifth-instar nymph ten months before it molted finally to the adult.

DESCRIPTION OF INSTARS.

First Instar. (Pl. VII, Fig. 1.) Length of body from 1.9 mm. in newly hatched individuals to 3.2 mm. in older individuals; length of front femur, .85 mm.; length of first antennal segment, .34 mm.

General color whitish; top of head and thorax somewhat more heavily chitinized than top of abdomen, darker; third, fourth and tip of second antennal segments darker; eyes reddish.

Body rather pear-shaped; head narrowed to a neck basally, swollen to greatest width across eyes, tapered slightly to anterior end, this bluntly rounded. Beak stout, pointed, three-segmented, second and third segments strongly tapered. Antennæ filiform, four-segmented, first segment shortest, second slightly longer, third and fourth longer and subequal, all with long, fine hairs. Prothorax emarginate at anterior margin, subrectangular in outline; meso- and metanota shorter than pronotum. Abdomen swollen. Fore and middle legs raptorial, femora shorter and stouter than those of hind legs, tibiæ with small spongy pads at apex for holding prey. Tarsi of all legs two-segmented, the first segment very small and inconspicuous.

Second Instar. (Pl. VII, Fig. 2.) Length of body from 3.4 mm. to 4.4 mm.; length of front femur, 1.2 mm.; length of first antennal segment, .47 mm.

Slightly darker in color than preceding; dorsum of head and thorax distinctly chitinized, brownish, shining. Antennæ darker, more so beyond middle of segment; eyes red; epicraneal suture visible; darker areas present on lateral margins of abdominal segments; darker chitinized plates present at tip of abdomen.

Shape of body similar to preceding; structure similar with proportional increase in size.

Third Instar. (Pl. VII, Fig. 3.) Length of body, 7.2 mm.; length of front femur, 1.87 mm.; length of first antennal segment, .68 mm.

Color much darker; abdomen still whitish, head, thorax, legs, and antennæ more heavily chitinized and darker, brownish; eyes reddish; dorsum of first segment of abdomen with a pair of dark plates; five pairs of dark spots present on lateral margins of segments 2-6, other smaller spots scattered over abdomen; ventral surface light, darker on under side of head and at points of attachment of the legs; dark median dots present on caudal segments; other dots present in lateral region.

Shape somewhat stouter than preceding instars; wing pads present on the caudal margins of the meso- and metathorax, those of metathorax barely extended to first abdominal segment; spongy pads of fore and middle tibiæ larger than in preceding instars.

Fourth Instar. (Pl. VII, Fig. 4.) Length, 9.1 mm.; length of front femur, 2.2 mm.; length of first antennal segment, .85 mm.

General shade and distribution of color much as in preceding instar, with abdomen slightly darker; abdomen with five dark spots on lateral margins of segments 2-6, a second series of smaller dots mesad of these, a third series of five dots, still smaller, mesad and somewhat cephalad of second series, near anterior margins of segments. Ventral surface with row of median dots, and three series of lateral dots, the first series the continuations of lateral dots on dorsal surface, the second series of two dots to a segment, the caudal dot the heavier, with the abdominal spiracles between the two; the third and innermost series of one dot to a segment, near the cephalic margin of segment. Wing pads now extended barely to second abdominal segment.

Fifth Instar. (Pl. VII, Fig. 5.) Length of body, 14.2 mm.; length of front femur, 3.2 mm.; length of first antennal segment, 1.2 mm.

General color darker than in preceding, particularly in the region of abdomen which is now brownish. Abdominal markings as in preceding; median, dark, triangular spot on dorsum of first abdominal segment conspicuous.

Head elongate, narrowed to neck basally, widest across eyes, tapered gradually to rounded apex; antenniferous tubercles quite distinct, between these two raised tubercles directed cephalad; epicraneal suture conspicuous; antennæ four-segmented, filiform, first segment shortest, second segment slightly longer, third and fourth longer than second and subequal, covered with long, fine hairs. Beak short, stout, curved, three-segmented, tapering, the pointed tip fitted into ridged groove of prosternum, third segment very short.

Pronotum narrowed cephalad, with raised cephalic margin; wing pads produced over middle of second abdominal segment. Front and middle legs raptorial, with femora shorter and stouter than those of hind legs; tibiæ with spongy fossa beneath; hind legs normal; tarsi of all legs two-segmented, the first segment very short and inconspicuous.

Distribution. Probably universally distributed throughout the United States and southern Canada, though not reported from the Pacific coast as yet. Found throughout Europe, on the north coast of Africa, on the Canary and Madeira Islands, and in the Australian region and Asia Minor. Kansas.

Reduvius senilus Van Duzee.

Van Duzee, Ent. News, XVII:390; 1906.

"Much smaller and paler than *personatus*. Pale testaceous brown inclining to piceous on the head, pronotum and scutellum; hemelytra clouded with brown with an indefinite spot behind the scutellum, the base of the costa and apex of the corium whitish; whole surface covered with rather long hairs. Head more tumid behind the eyes, a little narrower and more deflexed before the eyes than in *personatus;* eyes and vertex about the ocelli black; anterior lobe of the pronotum strongly convex and polished, with a deep median sulcus; posterior lobe rather strongly rastrate-punctate, the collar of the anterior lobe shorter than in *personatus.* Scutellum shorter with the apical spine less developed than in the allied species. Beneath paler with the sides and apex of the venter in some individuals suffused with blackish; the metapleura and venter sharply keeled through their whole length, the extreme edge of this keel piceous. Length, 10 mm.

"Described from three specimens taken by Prof. F. H. Snow in the Baboquivari mountains, Arizona.

"*Reduvius personatus,* the so-called 'kissing bug,' is the only species of this large genus heretofore recorded from America. Most of the known species have their home in the palæarctic region, but a few are found in the tropical portions of Asia and Africa. The species here described is but one of the interesting Hemiptera discovered by Professor Snow in his entomological explorations in the far Southwest."

Locality. Reported only from the type locality, as recorded above.

Genus MECCUS.

This genus was originally described by Stal (1859) as follows:

"Body pilose. Head produced before the eyes in a long cylinder, antenniferous tubercles of equal length with the apex of the head and remote from the eyes. Beak with the basal segment longer than the apical, the second, however, the longest. Ocelli present. Thorax with distinct median constriction, posterior angles somewhat prominent. Legs slender, rather long.

Abdomen (at least of female) much widened on either side, more than twice width of hemelytra."

Champion gives the following discussion of the genus:

"*Meccus* is scarcely separable from *Conorhinus*, merely differing from it in the rather longer postocular portion of the head (exclusive of the neck), and the more prominent tubercles on the anterior lobe of the pronotum. The females (the only sex known to Stal when he described the genus) appear to be more thickly pilose, and more rugose, than the males, and to have the elytra relatively shorter than in *Conorhinus*, extending to about the apex of the fifth segment."

DISTRIBUTION OF GENUS.

This genus is composed of three described species, all typically Mexican. One of them has been taken in California.

Meccus phyllosomus (Burmeister).

Burmeister, Handb. der Ent., II:246; 1835. *Conorhinus phyllosomus.*

"Possesses an almost keeled, boat-shaped abdomen, and a very long cylindrical head.

"Black, abdomen very widely oval, margin of abdomen and base of elytra with sanguineous markings, length 14‴.

"From Mexico. Anterior portion of the prothorax with obtuse spines; transverse suture definite, wing covers much narrower and shorter than the almost circular, rather thick abdomen."

Stal (1859) describes the species a little more fully:

"Black, thorax rather long; anteocular part of head almost twice as long as postocular part, lateral lobes equal in length to the median lobe, obtuse, scarcely prominent. Eyes protrude but little. Rostrum with basal segment about twice the length of the apical, with short pile. Anterior lobe of thorax with two discoidal tubercles and posteriorly with a lateral tubercle on each side; posterior lobe rugulose, angles somewhat prominent. Scutellum with apex somewhat produced, about one-half as wide as long. Hemelytra much shorter than abdomen, testaceous, a very wide median fascia and horns at apical angle nigro-rufous. Abdomen with disk rather flat, the banded portion of connexivum occupying almost a half of the apical segment, marked with testaceous. Anterior femora armed below, before the apex with two spines. Anterior tibiæ without fossa. Tarsi fusco-testaceous."

Uhler (1876) reports the taking of a single specimen of this species, which he describes as "deep black, highly polished on the surface of the pronotum, and the only red present is upon the outer edge of the abdomen."

Biology. Champion (1899) has figured the nymph of this species and mentions the fact that it has two-segmented tarsi.

Localities. California, western Mexico.

Genus TRIATOMA.

This genus was described originally by Laporte (1832) as follows:

"Antennæ with three segments; first short; second elongate; third setiform. Rostrum straight, very short, scarcely reaching base of anterior legs. Tarsi with three segments; claws simple. Body elongate-oval, depressed; ocelli far apart; thorax with faint transverse sulcus.

"Head elongate; eyes a little prominent; pronotum flattened; scutellum triangular, pointed behind; legs rather long."

In his supplement to "Essai d'un Classification Systematique de L'ordre des Hemipteres," the work in which the above description appears, Laporte speaks of his mistake in describing the genus as having only three segments to the antennæ, and giving it the name "*Triatoma*" descriptive of this condition, and substitutes the name "*Conorhinus*" for "Triatoma." This substitution, however, has not been accepted.

Biology of Genus. The habits of this genus have received considerable attention recently because of the fact that its members are hæmatophagous, and have been implicated in disease transmission. Nieva, Del Ponte, and Hoffmann have been the most active in the study of the habits of this genus. The habits of this genus as given by Nieva (1914), reviewed by Hussey (1922), are as follows:

"Nieva concluded that the species of *Triatoma* are strictly hæmatophagous, and take their food either directly from some warm-blooded host or from some other ectoparasites, such as the bedbug or other Reduviidæ, which have fed recently. Oviposition begins within thirty days after mating; a single female lays from 160 to 220 eggs, which are deposited in small masses containing from 1 to 45 ova. The eggs hatch in from 8 to 16 days, and the nymphs begin to feed three or four days later. The length of the life cycle varies in the different forms. In *T. rubrofasciata* it covers 210 days, in *T. megista* 260 days, and in *T. infestans* and *T. sordida* the period is intermediate between these two extremes. There is probably but one brood each year.

"Many species have become 'domesticated,' and some are strictly confined to houses and to outbuildings about farms; such species are *T. megista, T. sordida, T. sanguisuga, T. infestans, T. rubrofasciata, T. maculata,* and *T. rubrovaria.* Nieva believes that this adaption is of comparatively recent date, and has been acquired since the discovery of America, since, he says, even to-day the Indian villages are not infested with these insects. The primitive habits of the species of *Triatoma* are to occupy the nests of various mammals; thus *T. geniculata* occurs in the nests of the armadillo *Dasypus novemcinctus* L., while the North American *T. neotomæ* has been taken only in the nests of the wood rat *Neotoma*, and the South American *T. brasiliensis,* though now domesticated, is frequently found in nests of the rodent *Cerodon* *ruprestis* Wied. The domesticated species have received many vernacular names, of which Nieva lists some twenty-five."

It is interesting to note that one of the species which Nieva considers to be domestic in habit is our North American *T. sanguisuga*.

DISTRIBUTION OF GENUS.

Nieva lists 39 species, several of doubtful authenticity, as belonging to this genus. Of these the majority are from South and Central America, about twenty species being found in these localities. Twelve species are to be found in North America, with eleven species represented in the fauna of the United States. Two species are recorded from Africa, one from Java, one from Cuba, and one, *T. rubrofasciata*, is rather widely distributed over Asia, the islands of the Pacific, parts of Africa, and South America.

CLASSIFICATION OF GENUS.

It is rather difficult to identify the species of the genus, and since the writer has been informed by Dr. Nieva that the latter has a monograph of this genus nearly completed, it seems wiser to omit the key to the species.

Triatoma gerstæckeri (Stal).

Stal, Berl. Ent. Zeit., III:111; 1859. *Conorhinus gerstæckeri.*

"Black, base of head very short, anteocular part more than twice as long as postocular part, antenniferous tubercles inserted somewhat behind the middle of this part, lateral lobes of equal length with the median part. Ocelli moderately prominent. Antennæ with the first segment scarcely reaching the apex of the head, second almost twice as long as first. Thorax rugulose, anterior lobe one-half shorter than posterior lobe, two distinct discoidal tubercles before middle, and on either side there are produced two obsolete tubercles; posterior lobe with obtuse, evanescent discoidal carinæ. Apex of scutellum produced, width at base same as length. Hemelytra equal in length to abdomen; the base and the narrow costal margin towards the base and also a small oblong spot on the middle apical margin between the branches of the second vein sordid yellow testaceous; membrane infuscated. Prothorax rugose. Apical angles of abdomen and also the apical margins of the segments on either side yellow testaceous. Anterior femora armed below before the apex with two spines. Anterior tibiæ provided at apex with a minute spongy fossa."

Localities. Texas, Mexico.

Triatoma heidemanni Nieva.

Nieva, Brazil-Medico, XXV, No. 44, p. 3; 1911. Revis. Triatoma, p. 40; 1914.

The following description is a translation of the original description given by Nieva:

"Rostrum, head and antennæ castaneous. Pronotum with the lobes, lateral regions and posterior region castaneous; the central part is black, forming at times three large striæ of this color. Scutellum black, with the apex almost always castaneous. Corium with a large black spot bordered on either side by castaneous, which, in some specimens, shows a very distinct reddish tone. Connexivum reddish and black. Venter of castaneous color. Legs of same color as venter; the tarsi, however, are always lighter.

"Length 18-22 mm.; width, 7-8 mm."

Biology. Nieva states that this species inhabits dwellings and that a specimen was captured while biting the lip of a child.

Localities. Pennsylvania, Illinois, Tennessee, Texas, Kansas.

Triatoma indictiva Nieva.

Nieva, Brazil-Medico, XXVI, No. 3, p. 5; 1912. Revis. Triatoma, p. 44; 1914.

The following description is a translation of the original description:

"Rostrum light castaneous. Antennæ, head and thorax dark; the latter lighter at the posterior angles. Corium with light spots at base and apex; the central region, however, is dark, as is the membrane also. Connexivum dark, with narrow reddish stripes; venter castaneous, as are the legs; the tarsi are of a lighter color.

"Length, 22 mm.; width, 8 mm."

Localities. Texas, Arizona.

Triatoma maxima (Uhler).

Uhler, Proc. Cal. Acad. Sci. (2), IV:286; 1894. *Conorhinus maximus.*

"Coal black, shining, narrower than *C. dimidiatus* Lat. Head much thicker than in any other species known to me, rough and transversely wrinkled, somewhat pubescent, the tip of tylus projecting over a notch, each side of which the cheek projects in a rounded point, base of this cheek long triangular and scooped out; the buccular tip knoblike and protracted anteriorly; rostrum barely reaching upon sternum; space behind the eye very short, with a strongly constricted collum directly behind the head, the outer ends of which are drawn out and knoblike; anterior lobe very short and narrow, deeply sunken in the middle, with the tumid elevations each side set with sinuous series of coarse grains, the posterior lobe thick and wide, coarsely and unevenly wrinkled in several separate divisions, the divaricating lines almost obsolete; the lateral border thick, broadly curved, coarsely tuberculated below the slender, waved carinæ; posterior margin almost straight and abruptly steep against the base of the scutellum, each side of this obliquely curved. Scutellum coarsely knobbed at base, more finely toward the tip, deeply scooped out, the apical portion narrow, subcylindrical, ending in a knoblike tip. Corium minutely scabrous, and the clavus more coarsely so. Abdomen long ovate, wider than the wing covers, but not broadly expanded, with the margin bright red all around; venter highly polished, transversely wrinkled.

"Length to tip of venter, 35 mm. Width of pronotum, 8½ mm.

"Only one specimen, a male, has thus far been brought to my notice. It was kindly given to me by Dr. George H. Horn, as having been taken in Lower California. It differs from all species known to me by having the outer edge of the connexivum thickened, not sharp-edged, as is common to the large Mexican forms."

Localities. California, Lower California.

Triatoma neotomæ Nieva.

Nieva, Brazil-Medico, XXV, No. 42, p. 4; 1911. Revis. Triatoma, p. 53; 1914.

A translation of the original description is given:

"Rostrum castaneous, its last segment lighter, very pilose; antennæ dark castaneous, with exception of the articulations and the last segment, which are lighter. The anterior lobes of the pronotum are little produced, as are also the posterior angles; these of a lighter color. Median part of the pronotum divided by two protruding, divergent striæ. Scutellum of the same color as pronotum. Corium yellow with a large dark spot at the middle and another longitudinal one at the apex; membrane dark. Connexivum with black and yellow spots. Venter of castaneous color, as are also the legs, the tarsi of which are lighter. The body is shining.

"Length, 19 mm.; width, 6 mm."

Biology. Neiva records the finding of specimens of this insect in the nest of *Neotoma albigula* Hartley by Hubbard, and in the nest of *Neotoma micropus* Baird by H. S. Barber.

Localities. Texas, Arizona.

Triatoma occulta Nieva.

Nieva, Brazil-Medico, XXV, No. 44, p. 4; 1911. Revis. Triatoma, p. 56; 1914.

A translation of the original description is given:

"Rostrum, antennæ and head castaneous; the color of the head is more accentuated. Pronotum with the anterior part darker than the posterior, whose angles and median region are light castaneous. Scutellum dark with the apex lighter. Corium with a black spot in the center; the base is light, as is also the subapical region; membrane dark. Connexivum with black and ochreous spots, the latter larger. Venter castaneous; legs of the same color, the tarsi lighter.

"Length, 18 mm.; width, 7 mm."

Locality. Texas.

Triatoma ocellata Nieva.

Nieva, Revis. Triatoma, 55; 1914.

Locality. Arizona.

Triatoma protracta (Uhler).

Uhler, Proc. Cal. Acad. Sci. (2), IV:284; 1894. *Conorhinus protractus.*

"Piceous-black, narrow, approaching nearest to *T. rubrofasciata* De G., but much narrower and with the eyes small, deeply seated and placed low down on the side of the head. The head long and narrow, thicker in the female than in the male, with the posterior lobe almost as wide as the eyes; the surface minutely scabrous and feebly pubescent, the basal joint of antennæ not reaching the tip of the head; the third and fourth joints slender, pilose, dull testaceous; space behind the eyes densely and coarsely granulated; rostrum thick, fuscous, closely pubescent, reaching to the middle of the prosternum. Pronotum obsoletely rugose, narrower than in *T. rubrofasciata*, less deeply sinuate on the sides, and having the carinate line closely uniting with the humeral tubercle, coarsely and obsoletely punctate. The scutellum moderately granulated on the carinate flaps. Corium minutely pubescent, very finely and closely scabrous. Venter but little wider than the corium, with the notches of the segments marked by a pale streak; under side paler brown, minutely wrinkled. Tarsi and end of tibiæ dull pale fulvous.

"Length to tip of venter, 16-17 mm. Width of pronotum, 3-3½ mm."

Biology. The greater number of articles concerning this species occupy themselves mostly with a discussion of the blood-sucking habits. An early note by Dr. L. O. Howard (1898) is the first that can be found that concerns its habits:

"August 15, 1898, Dr. G. W. Harvey, of Salt Lake City, Utah, sent specimens of *Conorhinus protractus* Uhler, with the information that the species inhabits houses and barns of the southern part of that state. It is said by some to be an enemy of the bedbug, killing every one that is found, but is not yet verified, although our correspondent admits that it may be true. The species closely resembles the so-called blood-sucking cone-nose, or big bedbug, *C. sanguisuga*, of the Middle Western states, and doubtless has very much the same habits and life history."

Marlatt (1902) probably is referring to this species when he quotes J. B. Lembert as observing that the common Pacific coast species of this genus is attracted by carrion.

Van Duzee (1914) reported this species as common in the nests of wood rats in San Diego county, California. This may indicate the normal host of the insect.

Herms, in "Medical and Veterinary Entomology," gives some of the details of the life history. He describes the bite and mentions the fact that it frequently attacks sleeping individuals during the night, and that injury of this nature seems to occur most commonly during May and June. Herms figures the egg, young nymph and adult and gives the following notes on the life history:

"*Triatoma protracta* deposits large whitish eggs, in small numbers (3 to 6) at a laying under laboratory conditions in almost any sort of vial or container in which the female may happen to be imprisoned. The eggs are deposited during midsummer and late summer at least until early September in Berkeley (California) indoors. Hussey, reporting the observations of Nieva of Rio de Janeiro, states that oviposition begins within 30 days after mating and that a female lays about 160 to 220 eggs in masses containing from 1 to 45. Hoffmann reports about 600 eggs from one female *Triatoma flavida* Nieva. The eggs hatch in from 8 to 16 days. Under cooler climatic conditions (Berkeley) we have found 2 and 3 weeks, the first molt taking place in 7 to 8 days after hatching, the first larval feeding having taken place in from 2 to 5 days after hatching. The larvæ are wingless and usually feed on soft-bodied insects, but if opportunity is given may suck from warm-blooded animals very early. The length of the life cycle of *Triatoma rubrofasciata* was found by Nieva to require 210 days and for *T. megista* 260 days, which evidently indicates that as for *T. protracta* there is but one generation a year."

Kofoid and McCulloch have discovered this insect to harbor a trypanosome parasite, *Trypanosoma triatoma*, so that in this respect it is similar to *Triatoma megista*, which acts as the intermediate host of Chagas fever, a trypanosome disease.

From the evidence at hand, it would seem logical to consider this a native species which, before the advent of man, fed naturally on the blood of wood rats in the nests of which it lived. There seems to be no doubt, however, that at the present time it is a rather troublesome household pest.

This insect has been known by the following common names: Big bedbug of the Far West; monitor bug; China bug.

Localities. California, Utah, Lower California.

Triatoma rubida (Uhler).

Uhler, Proc. Cal. Acad. Sci. (2), IV:285; 1894. *Conorhinus rubidus.*

'Narrow, a little wider than the preceding species (*protracta*), with a long narrow head and prominent eyes, dark smoke-brown, with the basal part of pronotum and the outer part of the connexivum more or less widely red, or reddish, and with the costal margin red, but more broadly so at base. Head subcylindrical, the anterior portion not tapering, rugulose; antennæ thick, longer than in the preceding species, the basal joint reaching to the apex, second joint longer than in *T. protracta*, the two apical joints also long, obscurely testaceous, space behind eyes almost smooth, the constricted neck red; rostrum short, chestnut brown, banded with white at the joints, reaching to the middle of the short prosternum, ciliated with long hairs. Pronotum short and moderately wide, obsoletely wrinkled and roughened, the anterior lobe short, simply a little convex on each division separated by the longitudinal deep line, with the carinate longitudinal lines divaricating and subobsolete; lateral margin distinctly constricted and a little sinuated behind the anterior lobe, with the exterior margin carinated and the carinæ extending along the outside of the humeral tubercle. Scutellum filled up in the middle, coarsely transversely wrinkled, with the tip acutely protracted, long, and rufous. Corium very minutely scabrous, with a short pale streak on the middle of the posterior border; veins of the membrane blackish on a pale-brown surface. Feet and tip of tibiæ dull fulvous. Abdomen broadly bordered with red both above and below, incisures of the tergum more or less red; the margin not covered by hemelytra narrow.

"Length to tip of venter, 19-21 mm. Width of pronotum, 4-4⅔ mm."

Localities. Arizona, Lower California.

Triatoma sanguisuga (Le Conte).

Le Conte, Proc. Acad. Nat. Sci. Phil., VII:404; 1855. *Conorhinus sanguisugus.*

"Black, head and thorax granulate, neck rather long projecting. Antennæ slender, first joint much shorter than the head, second, fourth and fifth about the length of the head and subequal, tip of the rostrum brown. Thorax triangular, with a tubercle in front on each side, slightly constricted before the middle, in front with two raised lines diverging backwards, and most raised in front, margined with red; scutellum with two raised diverging lines directed forwards and joined at the base. Wings granulate at the base, with two triangular red spots on each side, one at the base, the other near the middle on the outside. Abdomen with six red spots on each side, both above and beneath.

"Length, 1 inch. Inhabits Georgia."

Biology. Observations on the biology of this insect, which seems to be the most common of the genus in our limits, have been made by several writers. The first to be noted accompanies the description, and is as follows:

"This insect inflicts a most painful bite. It is remarkable also for sucking the blood of mammals, particularly of children. I have known its bite to be followed by very serious consequences, the patient not recovering from its effects for nearly a year."

Walsh and Riley (1869) introduce unquestionable evidence to the effect that the insect is a seeker of human blood, whether that was its original habit or not. The evidence is worth quoting:

"This insect belongs to the same extensive group as the two-spotted corsair, but to a very different division of it. Like that insect, it insinuates itself into beds, but instead of having the same commendable habits, it sucks human blood at first hand. 'While taking its meal,' we are informed, 'it fairly spraddles itself out, and seems to enjoy itself hugely.' In the more southern parts of Illinois, namely in Madison, Jersey and Union counties, we know of no less than eight specimens having been found in beds, and it must also occur as far north as Adams county, for we saw it in a collection of insects made at Quincy and exhibited at the state fair in 1868. Mr. Uhler, as he informs us, 'formerly received a specimen from southern Ohio, near Marietta, at which place it was said to be occasionally found in beds and to cause severe inflammation by its puncturing.' Dr. E. S. Hull, of Alton, Ill., was once, as he tells us, bitten in three places in the arm by one of these creatures; and the arm became so inflamed, in consequence, that for three days afterwards he almost lost the use of it. In the more northerly parts of the United States, so far as we are aware, it does not occur. Like many of its allies, it passes through winter in the perfect state; for we have ourselves captured it in southern Illinois under loose bark in November, in company with its pupa.

"According to Burmeister (1835), all of the species of this genus fly into houses by night and live upon the blood of mammals, the puncture of their beaks causing great pain. In the larval and pupal states they probably suck the blood of insects; for being wingless in those states, they would have no means of reaching the larger animals. The single pupa that we found under the bark in the winter time occurred in a place about a half mile from the nearest house; so that at all events it certainly could have no chance to suck human blood by night."

The next contribution to our knowledge of this insect was made by Miss Bertha Kimball (1894). Miss Kimball describes the species, compares it with the true bedbug, discusses its bite, and mentions the fact that it is often found in henhouses in large numbers and also infests barns and attacks horses. She says, also, that it has increased in numbers in that vicinity (Manhattan, Kan.) so as to become a common insect, whereas it was formerly rare.

The habits of the insect are described in some detail. The bug is nocturnal, is attracted to lights, and may often be found crawling on screens or flying around the room. It finds its way into the sleeping room and enters the bed. There is a difference in the susceptibility of persons to its bite, as some are not molested by it If looked for immediately after the pain of the bite is felt it will be found still among the bed clothes, but soon leaves the bed and hides among clothes or furniture around the room, appearing again in a few days.

Miss Kimball attempted to rear this insect. She obtained the eggs by capturing adults and keeping them confined in a bottle, providing them with flies for food. She observed that they were active only at night. Eggs were laid by the insects in late August, though the number laid by each female was not observed. In most cases the eggs were laid loosely in the bottle, though some were attached. The first eggs were laid August 27 and began to hatch on September 18, which gives an egg stage of 22 days. The following description of the egg is given by Miss Kimball:

"The egg, which is about the size of a mustard seed, and of a yellow color, is peculiar in its shape, resembling that of a bottle with a thickened rim around the top, giving this portion the appearance of a stopper, especially after the egg hatches, as the insect pushes out this tiny saucerlike tip, which falls to the ground. Though yellow when first laid, the egg soon changes in color to pink, and then to red as the insect develops within, until just before hatching, when the segments of the body can be seen through the transparent shell."

Miss Kimball also figures the first instar, and describes it as follows:

"The young insects are about one-eighth of an inch in length, very active, of a delicate pink color, the legs and antennæ almost transparent. The head, prothorax, mesothorax and a spot on each side of the metathorax soon show a grayish tinge, and in a few days are black, the change taking place without molting."

Her observations on the habits of the young insects, and her speculations as to the normal habits of the species are interesting:

"The small insects are almost if not quite as troublesome as the adult, and on account of their color and diminutive size are difficult to discover in the evening. Like the adults, they were provided with flies, and killed on an average four or five each night, having excellent appetites until about the middle of November, when they seemed no longer to care for food, and will probably pass the winter in this stage, eating nothing more until spring. Once, when the bugs had been forgotten from Saturday until Monday, and consequently were hungry, fresh flies were given them, the dish was partly covered, and the bugs were then watched feeding. One small insect with its extended beak, formidable-looking even in such a little creature, approached a half-dead fly until it touched it, when, bracing itself firmly, it pushed so hard as to roll the fly over, although it was many times larger than the bug. The sense of touch of these small cone-noses seemed not to be very delicate, as they prodded alike upon all parts of the fly's body, trying first the wing, then the eyes, and finally succeeded in puncturing the abdomen. To withdraw the beak, the insect, after bracing itself again, gave such a sudden pull backward, and if the cover darkening the dish was removed they immediately stopped feeding and hid themselves as quickly as possible. Without doubt, the cone-nose preys upon other insects, and, to that extent, is beneficial, but its bad deeds so outweigh its good ones, that it must be classed among the injurious insects. By many it has been credited with infesting dwellings for the purpose of preying upon the common bedbug, but its designs are quite probably of a sinister kind. The conclusion that they prey upon the common bedbug must arise from a supposition, as the bugs are nocturnal, feeding at night and hiding if a light is brought into the room, so that such a habit could hardly have been observed."

A later contribution is made by Marlatt (1902). He considers that the normal food of the species is other insects, that the habit of molesting human beings has been acquired only recently, and is limited to the adults, only a few of which ever taste blood. This seems to be contrary to the opinion of Miss Kimball, who says that the immature insects are almost, if not quite, as troublesome as the adults. Marlatt reports the insect being found in houses with bed-bugs, upon which it unquestionably feeds, and also reports an instance of one feeding on a young roach. Marlatt believes that the eggs are normally placed out of doors and that the immature stages are normally passed there also, the food of the young being other insects. He states that the winter is passed both in the nymphal and adult stages under the bark of trees or with other protection. It is only during the spring and early summer that it enters houses and becomes a nuisance to man. Marlatt does not question the fact, however, that it is found in houses at that season, and that it does attack sleeping human beings. He describes several cases where severe injury has been caused by this insect, and suggests that some of the serious results which follow may be due to contamination of the wound by the insect which may have previously fed upon carrion. No evidence to show that the insect ever does feed on carrion is introduced, however, although an observation that the common Pacific coast species, probably *T. protracta* (Uhler), is attracted by carrion is mentioned. Marlatt figures the egg, four nymphal instars, the adult, and the head and mouth parts of the insect.

Heidemann (1911) figures the egg and describes it as follows:

"Egg, 1 mm. long; ovate; chorion somewhat flattened near lower end; the inner side of the extension of the rim shows the chorial processes very plainly; outer surface very fine granulate, pearly white."

There are numerous other references to the habits of this insect, most of which refer to its bloodsucking propensities and add nothing to the above material.

An important thing which should be settled is just what the natural and original food of this insect consists of. If it is true, as Nieva says, that all of the members of this genus are normally hæmatophagous and that the habit of feeding on human blood is of recent acquisition, then it should be possible to determine upon what animal the species originally fed. However, if it is true, as Marlatt believes, that the species normally feeds on other insects, no original host animal would be expected.

A list of the common names which have been applied to this insect follows: Blood-sucking cone-nose; big bedbug; Mexican bedbug; Texas bedbug; Arizona bedbug; Arizona tiger; bellows bug.

Localities. Maryland, Florida, Texas, Kansas, Illinois, Ohio, New Jersey, Virginia, North Carolina.

Triatoma uhleri Nieva.

Nieva, Brazil-Medico, XXV, No. 42, p. 4; 1911. Revis. Triatoma, p. 66; 1914.

A translation of the original description is given:

"General color castaneous, more or less clouded. Rostrum, antennæ and head of the same color as the pronotum, the tubercles and lateral margins of which are decidedly lighter; the median region is transversed longitudinally by two protruding, divergent lines. Scutellum of the same color; at times, however, the apex lighter. Hemelytra of more pronounced coloring on the corium; the coloration of the base, however, is identical with that of the lateral region of the pronotum. Connexivum with spots almost black, which do not reach the reddish margins. Venter of the same general color, as are the legs; knees and tarsi lighter.

"In the males the spots on the connexivum are less distinct; also the tone of the coloration is paler. In old individuals the discoloration also reaches the connexivum which may lose its reddish color."

Biology. Nieva states that this species frequents human habitations.

Localities. Texas, Arizona, California, New Mexico.

Genus SPINIGER.

This genus was originally described by Burmeister (1835) as follows:

"Antennæ bristlelike, four-segmented, the first and second segments about the same thickness, the two following, hair-fine, of equal length, the second much longer. Beak far from body, the second segment the longest. Legs thin, lightly haired. Soles of the tibiæ very slender, reach almost to the middle of the tibiæ. Femora hardly thickened, the first most thorny; tarsi especially long, also the claws and the bristles at the base. Transverse suture of pronotum nearer hind margin, on the anterior half two divergent spines, and two smaller ones on margin. Lateral angles produced into spines; scutellum with a projecting spine. Wing covers dull colored, firmer at base, parchmentlike."

DISTRIBUTION.

This genus is composed of over 60 described species, for the most part South American. But two species have been recorded from the United States, one of which has been taken only here.

CLASSIFICATION OF GENUS.

The two species of the genus occurring within our limits may be separated as follows:

1. Disk of anterior lobe of pronotum provided with two tubercles, *bicolor* Stal.

   Disk of anterior lobe of pronotum without tubercles, *arizonica* Banks.

Spiniger bicolor Stal.

Stal, Stet. Ent. Zeit., XX:396; 1859.

"Head oblong. Thorax distinctly constricted directly behind middle, disk of anterior lobe of prothorax provided with two tubercles, posterior lobe with posterior angles rounded, hardly prominent. Apex of scutellum produced backwards in a spine. Anterior femora armed below with a double series of spines.

"Rufescent-testaceous, clavus behind middle, corium towards commissures, and membrane nigrofuscous.

"♂. Length, 15 mm.; width, 3 mm.

"♂. Ventral segments 1-6 carinate."

Localities. Texas (?), Arizona (?), Brazil.

Spiniger arizonica Banks.

Banks, Ent. News, XXI:324; 1910.

"Shining deep black; the posterior margin of the pronotum narrowly reddish, broader at the humeri, and from thence extends inwards and forwards a narrow red line to the transverse furrow, lower lateral margin narrowly reddish; dorsum of abdomen red, a black spot at apex of each segment on the connexivum; venter black, with a broad median red stripe reaching to middle of penultimate segment, and the lateral margins rather broadly red, almost interrupted with black on the apical third of most of the segments. Anterior lobe of the pronotum smooth, a deep median groove, and two grooves each side reaching only one-half way forward. Posterior lobe depressed rugose, growing weaker behind; humeri moderately prominent, right-angled; the scutellum margined, spine cylindrical oblique, and nearly as long as the scutellum; meso- and metapleura vertically, coarsely striate; in front and rather between base of antennæ are two short, slightly divergent ridges; legs and antennæ all finely, densely hairy; ventral segments of abdomen finely transversely striate; male genital lobe smooth on sides, hairy below and behind, rounded, with a slight apical swelling containing a median depression. Wings reaching beyond tip of abdomen. None of the femora are swollen, and there are no spines on the pronotum.

"Length, 22 mm."

Locality. Arizona.

SUBFAMILY PIRATINÆ.

This subfamily was originally designated as "Groupe Piratides" by Amyot and Serville (1843). Its members possess the following characteristics: Fore coxæ not elongate; ocelli present and not farther cephalad than the caudal margin of the eyes; anterior and usually middle tibiæ also with a spongy pit below at the apex, and the transverse suture of the pronotum is closer to the caudal than to the cephalic margin.

BIOLOGY.

The members of this subfamily with which the writer is acquainted are ground-dwellers, living under rocks and logs and feeding on insects which inhabit such places. There are several references in literature to habits differing from these. Uhler (1884) reports *Rasahus biguttatus* (Say) as lurking on the branches of trees, and several others have recorded the same species as being something of a household species, possibly with the habits of *Reduvius personatus* (Linn.). The observations of the writer have convinced him that while these insects may have been taken on the branches of trees, and in houses, their normal habitat, however, is that mentioned above. The structure of the insects, as well as actual field observations, confirm this opinion. To be sure, the adults of several of the members of this subfamily, and possibly of all of them, are attracted to lights, and may get into houses in this manner, as they undoubtedly do.

WORLD DISTRIBUTION OF SUBFAMILY.

This family is of universal distribution, and is composed of about 224 described species. These are distributed as follows: Nearctic, 5 species; Neotropical, 45 species; Palæarctic, 19 species; Ethiopian, 31 species; Oriental, 70 species; Australian, 35 species. It will be observed that our own fauna is the poorest in number of species of this subfamily, while the fauna of the Oriental realm is the richest.

CLASSIFICATION OF SUBFAMILY

Three genera, containing in all five species and one variety, of this subfamily, are represented in our limits. The genera may be separated by the following key:

1. Middle tibia without spongy fossa; head long, no lateral tubercles on neck .... *Sirthenia* Spinola, p. 142

Middle tibia with spongy fossa; fore tibia convex above; neck with a small tubercle on each side 2

2. Apical portion of anterior tibia angularly dilated beneath, the spongy fossa being preceded by a small prominence . . *Melanolestes* Stal, p. 127

Tibia not dilated; spongy fossa elongate; metapleural sulci close to margin . . . . *Rasahus* Amyot and Serville, p. 136

Genus MELANOLESTES.

Stal (1866) characterizes this genus, which he erected, as follows:

"Neck region of head with a more or less elevated tubercle on each side; anteocular part of head longer than postocular; body elongate; thorax not granular; apices of posterior angles of prothorax rounded; spongy fossa never more than a half, sometimes occupying only a third of tibia; tylus as seen from the side somewhat elevated; apex of scutellum somewhat produced, acute; anterior tibia gradually thickened at the base of the fossa, a third of the length thickened and bearing the spongy fossa; third segment of hind tarsus subequal in length to the two basal segments."

DISTRIBUTION OF GENUS.

This genus is composed of six described species, all of which may be found within the Neotropical realm, and two, or one and its variety, within our limits.

CLASSIFICATION OF GENUS.

In North America north of Mexico but one species of this genus, *picipes* Herrich-Schaeffer, is recognized. At the same time that this species was described, Herrich-Schaeffer described another species of the same genus as *abdominalis*. Since then, however, it has been decided that the second species is but a color variety of *picipes*, which it resembles in structural details. The history of *abdominalis* is interesting. The descriptions of the two forms, as originally described by Herrich-Schaeffer (1848) are as follows:

"*Pirates picipes*—a black insect, antennæ and legs black. Appears to be very similar to *Reduvius personatus*, but still has the generic characters of the genus *Pirates*, stouter form, shorter antennæ, thicker femora, and so forth. A male from North America; from Mr. Sturm.

"*Pirates abdominalis*—a very black insect, abdomen scarlet, anal region black. The sole of the tibia bears golden-yellow hairs. A male from Mr. Sturm from North America."

Stal (1872) later refers to the second form as a variety of *picipes*. He adds to the characterization of Herrich-Schaeffer by noting that the hemelytra and wings of the variety are very much shortened.

Uhler consistently treated these two forms as distinct, and in at least two instances he defends this position. His opinion in the matter is given thus (1876):

"The evidence at present in my possession does not warrant the uniting of these two species. Both are quite common in Maryland, sometimes occurring under the same stone; but while I have seen the sexes united, I have never seen a male of the one caress or unite with a female of the other. The width and proportions of the head and pronotum vary considerably in the specimens of both of these species, so that, in the absence of a long series of them, they might be made to constitute a number of species."

Provancher (1887), Champion (1899), and Fracker (1913) apparently concur with Uhler in giving *abdominalis* the rank of a distinct species, and Bueno (1923) separates the two "species" as follows:

1. Generally apterous; entirely black, with piceous legs and antennæ. .*picipes.*
   Winged; connexivum and sometimes entire abdomen coral red, *abdominalis.*

Parshley (1918) apparently settles the question in favor of *abdominalis* being but a color variety of *picipes.*

"I have in my collection examples showing all gradations from those having only the slightest tinge of red along the connexivum to those having the abdomen entirely red; I have also a pair taken in copulation in which the male is an entirely black long-winged *picipes* and the female a short-winged *abdominalis,* with red connexivum. It would seem, therefore, that the *abdominalis* form should be ranked as a mere color variety and not as a species distinct from *picipes,* as I have done in my New England list."

Indeed, this does seem to settle the question as far as the color character, which of course was that used originally to differentiate between the forms, and would seem also to indicate that the short- or long-winged condition was not specific, since the two forms were taken mating. However, there is a possibility of separating the two forms on wing characters. I have in my collection five different kinds of individuals, as regards sex, coloration, and long- or short-winged condition. These are: (1) male, long-winged, entirely black; (2) male, long-winged, reddish abdomen; (3) female, long-winged, entirely black; (4) female, short-winged, entirely black; (5) female, short-winged, reddish abdomen. It will be observed that no short-winged males appear in this list, and it is doubtful that they exist. However, the short-winged and long-winged females may represent the female sex of two distinct species, the males of which will have to be separated, if this supposition is true, by some other character. Some evidence obtained by the writer while studying the biology of these forms suggests the possibility of two distinct species. This evidence will be presented later.

Melanolestes picipes (Herrich-Schaeffer).

(Pl. VIII.)

Herrich-Schaeffer, Wanz. Ins., VIII:62; 1848. *Pirates picipes.*

The original description of this insect has been quoted above. It is one of our most common reduviids, and is easily recognized.

Habitat. This insect is a ground-lover, and may be found in close contact with the earth, beneath rocks and logs. While this is the normal habitat for both young and adults, the latter, at certain times of the year, leave their protecting retreats at night and fly to lights, probably for the purpose of finding mates, though several have been observed to feed on other insects found in the vicinity of the light. It is this habit which has brought this insect its notoriety as a "kissing bug." The flights usually take place in the spring of the year, in May and June in Kansas, though an occasional insect of this species may be taken at light in the fall.

Food. The food of this insect is unquestionably other insects. While it may bite human beings when molested by them, it certainly does not attack them for the purpose of feeding on human blood. The writer was interested to know just what insects made up the greater part of this insect's food supply. Several adults were isolated in cages of about a square foot of floor space, given plenty of moist earth and a small piece of rock, and provided with the insects and other animals which were found most abundantly under the rocks from which they were collected. These consisted of cut worms (Noctuidæ); meadow maggots, or crane fly larvæ (Tipulidæ); larvæ of the clover-leaf weevil (*Phytonomous posticus,* Curculionidæ); larvæ of soldier beetles (Cantharidæ); larvæ of May beetles (Scarabæidæ); grasshopper nymphs (Oedopodinæ, Locustidæ); young harvestmen (Phalangidea); and sow bugs (Oniscidæ). Of these the only forms accepted were the May beetle larvæ. The only exception to this was an instance where one of the assassin bugs was seen to be feeding on a grasshopper nymph, but in most cases the grasshopper nymphs, as well as the other animals mentioned, lived in the same cage, in fact under the same rock, in perfect harmony with the reduviid. White grubs, however, were readily accepted as food and soon sucked dry. Later, the adult May beetles began to make their appearance and they were offered to the assassin. Their reception left no doubt as to the natural food of the species. The May beetles were readily attacked, at night or during the day, under the rock, or out in the open. The attack on a May beetle by an assassin bug is most interesting. When I wished to witness this, I would first carefully remove the rock, under which the bug was almost sure to be hiding, and place the May beetle somewhere in his vicinity. The moving May beetle almost immediately attracted the attention of the bug, which followed the movements of his intended prey very closely. Sometimes the May beetle was allowed to crawl a short distance, sometimes attacked immediately. In any case, the end was always the same. The assassin bug finally ran to the beetle, mounted it from behind, grasping it firmly with the front, and sometimes the front and middle legs, the hind legs usually remaining on the ground and acting as braces, and inserted the stylets at the juncture of the head and thorax, on the under side of the body, or at the joint between two of the thoracic segments. A struggle now began. The May beetle turned and twisted, sometimes turning over on its back and actually pinning the assassin bug beneath it. However, the assassin bug always kept its hold, and in a very short time, usually less than a minute, and in some cases in less than half a minute, the May beetle was dead and at the disposal of the assassin bug for feeding purposes. The part that the spongy pads on the tibiæ of the front legs of the assassin bug play in this attack is very important. They are admirably adapted for holding on to the smooth and shining wing covers and prothorax of the beetle, and there can be no doubt that this is their intended function. The feeding of the bug after the prey is killed continues for an hour or two. The bug shifts his position now and then, and inserts his mouth parts in several different places before discarding the beetle. During the process of feeding the abdomen swells noticeably. The beetle, when discarded, is quite empty of liquid material. Four and five May beetles have been killed in a single night by one assassin bug, and in the morning they all seem to be empty, though it seems unreasonable to consider the bug capable of taking so much food.

An attempt was made to see whether the bug would accept all kinds of beetles without discrimination as to kind. During the early spring months the only other beetles available were ground beetles, of the genus *Galerita*, and *Passalus cornutus*. The assassin bug attacked neither of these, nor was it it turn attacked by the ground beetles. Later, adults of the clover-leaf weevil, *Phytonomous posticus,* and of the Colorado potato beetle, *Leptinotarsa decimlineata*, were introduced, and were fed upon occasionally, but by no means with the greed with which the May beetles were attacked.

What the normal feeding habits of the nymphs may be the writer is unable to say. It is possible that they confine themselves mostly to the larvæ of May beetles, which of course would be abundant in their habitat. The writer reared this species from egg to adult, and fed the nymphs various insects, none of which seemed to be entirely satisfactory, judging from the very high rate of mortality. Among the insects used were plant lice, *Macrosiphum pisi*, for the very small individuals; nymphs and adults of the tarnished plant bug, *Lygus pratensis;* several species of leaf hoppers; and maggots and adults of the house fly. Adult house flies were at least as satisfactory as any of the other foods used. The nymphs were fed four flies daily, each fly being crushed slightly when introduced so as not to be too active. They were seen to feed quite often, and indeed fed somewhat on all the foods used. A supply of small May beetle larvæ was not available, or experiments with them as food would have been made.

SEASONAL LIFE HISTORY.

This species has one generation a year. It winters as an adult, in some cases under the rocks which protect it during the warmer parts of the year, but in other cases in more protected places. For instance, several have been found during the winter in cells in stumps. The cells are not of their own making, but have been appropriated for winter homes. Just how common this habit is the writer does not know. The adult becomes active in the spring, when it may be found more commonly under rocks, and appears at lights during the warm evenings of spring. Mating and oviposition take place at this time. Eggs have been laid in the laboratory as early as April 18, and as late as June 22. It is probable that oviposition in the field does not begin as early as this. The eggs hatch in less than a month and the nymphs spend the rest of the summer in feeding and growing, becoming adults by fall.

Eggs. The eggs are placed in the ground, under the same protecting stones which cover the adult. Each egg is inserted into the ground singly with only its starlike top visible. A detailed description of the egg is given later. Eggs have been found in such situations both in the laboratory and in the field.

The number of eggs laid by a single female as recorded by the writer is small, probably smaller than is actually the case. The largest number of eggs laid by any female in the laboratory was 21. This is a smaller number than is usual in the Reduviidæ, and probably does not indicate the normal fecundity of the insect.

The act of oviposition has not been witnessed. The eggs are deposited only at night.

The hatching process has not been witnessed. It has been observed, however, that as incubation progresses, the eyes of the immature insect become visible through the shell of the egg, and appear as two red spots.

Mating. Mating in this species has been observed in one instance. In this case the female and male were placed together in a small container. The male made several unsuccessful attempts to mate, and was threatened several times by the female, who seemed to use her beak quite carelessly on her mate. Finally the male made a successful attempt by mounting from behind and maintaining his position with the assistance of all six legs and the beak. The beak seemed to be very important, and was placed at the juncture of the head and prothorax. While in this position the male extended the tip of the abdomen bearing the genital organs to the under side of the female abdomen, and accomplished copulation. The act of copulation lasted five minutes in this case. The female was observed to stridulate by rubbing the tip of the beak over the ridged groove in the prosternum several times during the act.

Habits of Nymphs. The nymphs are similar to the adults in their habits. They inhabit the same environment, and are very active. They are very secretive by day, which probably indicates that they are most active at night.

Length of Stages. The life histories of several individuals of this species have been carried through from adult to adult, and their records will show the length of time spent in the various stages. It is very interesting to note that only four nymphal instars have been found for this insect. This is the only species of the family so far studied where this is the case, all others reported upon having five nymphal instars.

The egg stage, in ten instances where record was kept, varied from seventeen to thirty-one days, with twenty-four days as an average.

The first instar lasted from twelve to eighteen days, with sixteen days as the average of ten.

The second instar lasted from nine to fifteen days in ten records, with twelve days as the average for the ten.

The third instar lasted from eleven to seventeen in ten records, and the average for the ten was fifteen days.

The fourth instar lasted from twenty-six to forty days in eight records, with thirty-one days as the average for the eight.

Inheritance of Color. An attempt was made to see whether the red color of the abdomen, characteristic of variety *abdominalis*, was inherited. The attempt was first made to select both male and female parents, and mate them in various combinations, such as both male and female typical *picipes*, male typical *picipes* and female *abdominalis*, *etc.* It was soon found, however, that in most cases the females collected in the field had previously mated, as they produced fertile eggs without being mated in the laboratory. The next best thing was to keep track of the offspring from the different types of females, which was done.

From short-winged females, of both color varieties, long-winged males and short-winged females only were produced. These were always of the black variety, without respect to the color of the mother.

From long-winged females, of the black variety only, since no long-winged *abdominalis* females could be found, long-winged individuals only were produced. This seems to indicate that while the color character is not inherited, and is probably due to conditions of temperature, moisture, etc., under which the insects are reared, that the long- or short-winged condition of the females is inherited. Unfortunately only a few offspring from each type of adult female were carried through to maturity, so these results cannot be considered as conclusive. However, they give some indication of the true nature of things.

DESCRIPTION OF INSTARS.

Eggs. (Pl. IV, Figs. 5-7; Pl. VIII, Fig. 6.) Length to extension of chorion 3 mm.; greatest width, 1.7 to 1.9 mm.; diameter of extension of chorion, 2.5 to 2.8 mm.

Color entirely dull white when laid, later of darker color with appendages and indications of segmentation visible

Shape elongate-oval; a distinct collar at upper end, beyond this chorion extended in a series of flat, elongate scales; these arranged radially around cap, each scale slightly narrower towards tip, with many small teeth along margins; scales 40-50 in number. Cap with central, more or less sunken area, margin with a series of flat, radiating scales, these extended over the scales of the extension of the chorion, equal in number to these.

First Instar. (Pl. VIII, Fig. 1.) Length of body, 3.8 mm. in newly hatched individuals to 5.8 mm. in insect about to molt to the second instar; length of front femur, 1.15 mm.; length of first antennal segment, .44 mm.

General color yellowish red and black; head black, eyes with faint reddish tinge, antennæ yellowish, beak dark brown; prothorax black in some individuals (those from long-winged females), reddish yellow in others (those from short-winged individuals); dorsum of meso- and metathorax yellowish, dorsum of abdomen more reddish with dark markings along median dorsal line; legs yellowish brown, apex of front and middle tibiæ and apex of hind femur and all of hind tibia somewhat darker.

Body rather elongate; head less than twice as long as wide, narrowed at juncture with prothorax, widened abruptly to widest point just caudad of eyes, tapered to rounded apex; antennæ four-segmented, slender, first segment shortest, second and third subequal, fourth segment longest, almost equal to second and third combined. Prothorax subquadrate, narrower at cephalic margin with small lobes at anterolateral angles; meso- and metanota smaller than pronotum, abdomen very slightly swollen, transverse divisions of segments sinuate, openings to dorsal stink glands visible at anterior margins of segments four, five and six along median dorsal line. Front and middle legs modified for grasping; fore coxæ rather long, femora short, stout, much swollen, tibiæ more slender but swollen apically and with spongy pad present; middle legs with coxæ shorter, femora swollen somewhat, tibiæ with spongy fossa present but not so well developed as in fore legs; hind legs normal, more elongate and slender; tarsi of all legs two-segmented, the first segment short and inconspicuous.

Second Instar. (Pl. VIII, Fig. 2.) Length of body, 9.3 mm.; length of front femur, .73 mm.; length of first antennal segment, .61 mm.

Color in general much darker; head black, eyes with reddish tinge, antennæ brownish; dorsum of prothorax black, margined posteriorly by a light line; dorsum of meso- and metathorax very dark brown, nearly black; abdomen reddish marked with dark as follows; a pair of dark plates on dorsum of first segment, three median black plates at anterior margins of segments four, five and six of median dorsal line at opening of stink glands, six pairs of rather small black dots along lateral margins, a pair each on dorsum of segments

2-7; a corresponding set of six pairs of black dots on ventral segments; legs very dark brown or black, tarsi slightly lighter.

Structure as in preceding instar; wing pads visible at caudal margins of meso- and metanota, barely discernible in this instar.

Third Instar. (Pl. VIII, Fig. 3.) Length of body, 10.4 mm.; length of front femur, 2.21; length of first antennal segment, .75 mm.

Color practically as in preceding, with red coloration of abdomen deeper.

Similar in structure to preceding; small tubercle now visible at lateral margins of neck region of head; tibiæ of fore and middle legs more distinctly swollen apically; wing pads increased slightly in size.

Fourth Instar. (Pl. VIII, Fig. 4.) Length of body, 14.5 mm.; length of front femur, 3 mm., length of first antennal segment, .9 mm.

General color black and red; head, antennæ, dorsum of thorax, wing pads and legs black or dark brown; abdomen dark reddish marked with black as follows: Three plates along cephalic margins of abdominal segments four, five and six, longitudinal stripes on lateral margins of each segment, circular dots near lateral margins, a pair each on segments 2-7 on both dorsal and ventral surfaces, and entire surfaces of terminal ventral segments.

General shape rather elongate, but slightly widened in abdominal region; head less than twice as long as wide, narrowed at junction with prothorax; a lateral tubercle on each side of neck at cephalic limit; head widest immediately behind eyes, tapered thence to rounded apex; eyes protruded but little from margins of head; antennæ four-segmented, filiform, with delicate hairs on surface, first segment shortest, each segment in turn longer than preceding; ring segments present between main segments; epicraneal suture a broad, shallow, median U, with lateral arms extended to the eyes; beak rather short, stout, curved, three-segmented; second segment longest, third segment short, tapered, pointed, tip fitted into ridged groove on prosternum. Prothorax subquadrate, narrower at cephalic margin with anterolateral angles lobed; mesonotum slightly narrower than pronotum, wing pads extended almost to caudal margin of first abdominal segment (nymph of short-winged female). Abdomen slightly swollen, smoothly rounded, dorsal stink glands located along median dorsal line at cephalic margins of segments four, five and six; spiracles of first abdominal segment dorsal in position, those of segments 2-8 ventral in position. Front legs with coxæ long, femora short and swollen, with two rows of rather fine ventral bristles, tibiæ fit between these when folded; tibiæ narrow at base but much widened at apex, with spongy fossa ventrally occupying apical half. Middle legs similar to fore legs, with coxæ shorter, femora less swollen, ventral spongy fossa of tibiæ less developed. Hind legs normal, longer and more slender; tarsi of all legs two-segmented, the first segment short and inconspicuous.

Localities. Probably universally distributed over the United States, southern Canada, and represented by the variety *abdominalis*, at least, in Mexico.

Genus RASAHUS.

This was originally described by Amyot and Serville as follows:

"Prothorax with five or six longitudinal furrows on its anterior portion; its posterior portion smooth. Head produced in front. Abdomen very elongate. Anterior femora without long and strong spines below."

HABITS OF GENUS.

It is the opinion of the writer that the members of this genus normally live out of doors on the ground under protecting rocks, and that they feed normally on such insects as are to be found in such situations. This is contrary to the published opinion of some other workers. A further discussion of the habits will be taken up under the discussion of the particular species.

DISTRIBUTION OF GENUS.

Twenty-four species have been described for this genus, all of which are typically Neotropical. Of the twenty-four, three have been recorded as occurring within our limits. One of the three has since been reduced to varietal rank, and is so considered here.

CLASSIFICATION OF GENUS.

The species of the genus occurring within our limits may be separated as follows:

1. Costal margin of hemelytra pale at base................*biguttatus* (Say).
   Costal margin black to base; elytra with narrow ochreous patch on corium and clavus...............................*hamatus* (Fabricius).

Rasahus biguttatus (Say).

(Pl. IX.)

Say, Ins. La., 13; 1832. Compl. Wr., 1:307. *Petalocheirus biguttatus.*

"Hemelytra with a yellow spot behind the middle and another at base. Inhabits Louisiana. Body black; antennæ brown; pronuscis and feet dull honey yellow; scutel at tip extending into an obtuse spine; hemelytra, around the tip of the scutel a yellow spot, and an orbicular one on each beyond the middle; abdomen yellowish on the margin. Length seven-tenths of an inch. A fine insect, readily known by the two yellow spots on the hemelytra. The disk which occupies the extremity of the anterior tibia, in this species is not confined to the extremity, but extends up the inner side of the tibiæ, nor is its limit so definite as in some other species."

Stal (1872) described as a distinct species *Rasahus thoracicus*, which by later writers (Champion 1899) is considered to be only a variety of *biguttatus*. A translation of Stal's description of *thoracicus* is given here for purposes of comparison.

"Black, shining; antennæ, rostrum, posterior lobe of prothorax, edge of abdomen, towards apex of coxæ, tibiæ and tarsi flavo-testaceous, anterior femora towards base frequently fuscous or black; clavus, excepting a median black macula, a stripe on the corium to the claval suture, and the costal margin beyond the middle, also a rounded discoidal spot of the membrane testaceo-flavescent; apex of membrane sometimes marked with pale obsolete spots; margin of abdomen yellowish, frequently marked with black. ♂. ♀. Length, 18 mm.; width, $4^1/_3$ mm. Mexico. Similar to the preceding (*biguttatus*), distinguished by color of rostrum and posterior lobe of prothorax; varying a great deal. Six examples seen. Posterior lobe of thorax granulate at anterior end."

Champion comments as follows upon the variation in color in this species:

"The head and pronotum are sometimes entirely rufous, sometimes entirely black, or, usually, black, with the posterior lobe only of the latter rufous (*thoracicus* Stal); the legs are generally rufo-testaceous, with the intermediate and hind femora broadly flavous at the base, but sometimes the reddish portions are almost entirely black; the ochreous coloration at the base of the hemelytra varies in extent, usually extending down the outer portion of the corium; the membrane, however, is constantly black or blackish, with a large oval or rounded ochreous patch about the middle, and sometimes with indications of a paler spot at the apex. The pronotum is entirely rufous in the earlier stages of this species. One of Stal's types of *R. thoracicus* has been seen."

Habitat. Uhler (1884) says that this is one of the forms which lurks on the branches of trees and bushes in search of prey; and Walsh and Riley (1869) report finding it between the mattresses of a bug-infested bed, and speculate as to whether or not it has the habits of *Reduvius personatus* (Linnæus). Lintner considered it to be a natural enemy of the bedbug, while others considered that it entered houses for the purpose of feeding on human beings. The writer's opinion is that it is an out-of-doors species and that it is not naturally an enemy of the bedbug, though it probably will feed on it when in a place where bedbugs are to be found; that it does fly to lights at night and may, during these flights, be attracted to the insides of houses; that it will bite human beings for its own protection, but not if unmolested. The writer has collected so many of these insects in their natural habitat under rocks that his opinion on this subject is quite definite.

Food. Just what animals make up the favored food of this insect I am unable to say. I found the insect most abundantly on rocky hillsides, covered with weed and brush plants, and supporting a variety of insect life. The rocks under which the nymphs and adults were found also sheltered numerous ground beetles, scorpions, harvestmen, etc. It is doubtful if any of these mentioned are used for food by the assassin bugs. In the laboratory they fed on a wide variety of insects, including grasshoppers, mirid nymphs and adults, leaf hoppers, flies, beetles, and other insects, but seemed to show no particular preference, as does *Melanolestes picipes,* for May beetles. The assassin bug has been observed to pounce on small insects.

SEASONAL LIFE HISTORY.

As is usual in this family, this insect passes through but a single generation a year. The winter is spent in the nymphal condition, either as a fifth-instar nymph, or, less frequently, as a fourth-instar nymph. It has been found in its hibernating quarters under rocks, but little if any more protected from the weather than during the warmer months. With the coming of spring it completes its development. Adults have been taken as early as May 24, and as late as July 15 in Kansas, while nymphs have been taken as late as June 14. Oviposition occurs during June and July, and after the short egg stage the nymphs appear in the field and develop to the fourth or fifth instar before the coming of winter. This insect differs from its rather close relative, *Melanolestes picipes,* in that it spends the winter as a nymph, rather than as an adult.

Eggs. The eggs are very similar to those of *Melanolestes picipes.* They are inserted into the ground singly, the egg being buried with only the top visible. The act of oviposition has not been witnessed. As incubation progresses, parts of the immature nymph are visible through the shell. The red eyes, the darker legs and antennæ, and the segmentation of the abdomen can be made out. The hatching process has not been witnessed.

The number of eggs laid by a single female has not been determined satisfactorily. The greatest number laid by any female in the laboratory was 63, and it is probable that this does not represent her entire capacity. These eggs were laid over a period of 14 days in July, from one to nine eggs being laid every day during this period. It is probable that in the field a single female produces eggs over a period of a month or more, and that the total number laid would be many more than in the case of the female mentioned above.

Habits of Nymphs. The nymphs are exceedingly active insects, usually content to remain under their protecting rock during the day time, but very active in escaping when disturbed. In this respect they are like the adults, which are most difficult insects to capture alive. On a warm day, particularly, it is almost impossible to catch the adults without being bitten.

Length of Stages. Unfortunately I was unable to rear this insect through all the stages of its life history, and consequently the story is incomplete.

The egg stage varied from 13 to 15 days in length in the records available.

The first instar lasted from 16 to 23 days in the records available.

The second instar lasted from 13 to 29 days in four individuals for which records exist.

Only one insect completed its development to the fourth instar, and in this insect the third instar lasted 30 days. There seems to be no doubt that there are five nymphal instars in this insect, instead of the four found in *Melanolestes picipes.*

DESCRIPTION OF INSTARS.

Eggs. (Pl. IV, Figs. 8, 9; Pl. IX, Fig. 7.) Length to extension of chorion, 3 mm.; greatest width, 1.7 mm.; length of extension of chorion, .6 mm.

Color, dead white, darker later, with red eyes, dark legs, red and white striped abdomen of unhatched insect visible through shell.

Shape elongate-ovate, top with extended scales formed by extended chorion, these curving, erect, with no teeth along margins, about forty in number; central area of cap with very distinct, erect spine; margin of cap with radiating scales, produced over scales on extension of chorion, long, slender, extended almost to apices of scales of extension of chorion, equal in number to these.

First Instar. (Pl. IX, Fig. 1.) Length of body from 3.8 mm. to 5.3 mm.; length of front femur, 1.2 mm.; length of first antennal segment, .44 mm.

General color yellowish red; head light red, antennæ pale fuscous, two basal segments lighter; prothorax more yellowish than red, shining; dorsum of meso- and metathorax fuscous; abdomen reddish marked with dark spots, seven pairs of dark spots, lateral, one each to abdominal segments 2-8; three dark median spots at openings to dorsal stink glands, at cephalic margins of segments four, five and six; median spots on dorsum of terminal abdominal segments. Legs mottled with yellowish red and fuscous, almost white basally.

Head narrowed at neck, widest immediately behind eyes, tapered to narrow apex. Epicraneal suture visible. Antennæ four segmented, filiform, first segment shortest, second and third subequal, fourth longest, about equal to two and three combined. Prothorax large, subquadrate, rounded dorsally, with lobes at anterolateral angles. Mesonotum smaller than pronotum and metanotum smaller than mesonotum. Front legs raptorial with long coxæ, comparatively short, stout femora, and tibiæ with padded cushions on ventral surface for apical half. Middle legs, coxæ normal, femur as long but not so stout as fore femur, tibia with suggestion of pad; dorsal surface of tibia at apex with conspicuous brush of hairs. Hind legs normal, femora and tibiæ longer and more slender than those of other legs. Tarsi of all legs two-segmented, the first segment very short and inconspicuous. Abdomen slightly swollen; openings to dorsal stink glands visible along cephalic margins of segments four, five and six.

Second Instar. (Pl. IX, Fig. 2.) Length of body, 6.3 mm. to 7.2 mm.; length of front femur, 1.6 mm.; length of first antennal segment, .54 mm.

General color much as in preceding; antennæ somewhat darker; abdomen more fuscous, lateral dark spots larger. Two dark transverse bands on abdomen, one near cephalic, the other near caudal end. Plates showing location of dorsal stink glands now lighter in color, yellowish brown. Coxæ and trochanters whitish with some fuscous, femora reddish yellow except for bases, these whitish, tibiæ reddish and fuscous.

Head with two tubercles at cephalic limits of neck region; pads on front and middle tibiæ proportionally larger; abdominal spiracles larger; those on first abdominal segment dorsal in position, others lateral.

Third Instar. (Pl. IX, Fig. 3.) Length of body, 8.2 mm. to 9.5 mm.; length of front femur, 1.6 mm.; length of first antennal segment, .64 mm.

General color reddish marked with fuscous and white as in preceding; transverse dark bands across abdomen near cephalic and caudal ends more distinct; pronotum marked with indistinct longitudinal reddish stripes.

Slightly longer and more slender proportionally than preceding instars; pads on fore and middle tibiæ more than proportionally larger; pad on fore tibia much larger that that on middle tibia. Wing pads present as barely discernible outgrowths at caudo-lateral angles of meso- and metanota.

Fourth Instar. (Pl. IX, Fig. 4.) Length of body, 10.6 mm. to 12.5 mm.; length of front femur, 2.5 mm.; length of first antennal segment, .75 mm.

Similar in general color to preceding instars; transverse dark bands across abdomen now very distinct; anterior band occupies second and third abdominal segments; posterior band located on dorsum of sixth and seventh abdominal segments.

Shape of body similar to preceding; abdomen swollen slightly. Wing pads larger, the anterior pair extended over posterior pair, and both extended partially over first abdominal segment; spiracles of first abdominal segment not concealed by wing pads.

Fifth Instar. (Pl. IX, Fig. 5.) Length of body, 17.3 mm.; length of front femur, 3.3 mm.; length of first antennal segment, 1.02 mm.

General color reddish with black, white and yellow. Head reddish with dark eyes; antennæ fuscous, basal half of first segment lighter; dorsum of thorax yellowish red; slightly lighter in shade than head. Legs of a general yellowish red, coxæ, trochanters, and bases of middle and hind femora whitish with fuscous; tibiæ fuscous. Abdomen much darker than thorax, entire dorsum of segments two and three, and six and seven, as well as lateral spots on the other abdominal segments dark; dorsum of terminal segments solid red. Openings to dorsal stink glands located in plates slightly darker than surrounding area; white spots alternated with dark along lateral margins. Ventral surface of head reddish, of prothorax fuscous; of meso- and metathorax fuscous with exception of median whitish line; of abdomen dirty whitish with exception of reddish lateral margins.

Body rather elongate; head narrow, joining prothorax by narrow neck; this with lateral lobes; head widest caudad of eyes, tapered to narrow apex; epicraneal suture visible. Antennæ four-segmented, filiform, first segment shortest, each segment slightly longer than preceding; ring segments present between main segments. Beak three-segmented, curved, second segment longest, third segment finely pointed. Prothorax subquadrate, narrower cephalad, rounded, with lightly impressed, longitudinal sutures. Meso- and metathorax with conspicuous wing pads, now extended to anterior margin of third abdominal segment, hiding spiracles of first abdominal segment. First two pairs of legs raptorial, front legs with coxæ long, femora short and very stout, tibiæ about equal in length to femora, enlarged apically and with raptorial pads on ventral surfaces, coxæ of middle legs normal, femora only slightly swollen, tibiæ with ventral pads, not so large as in fore legs. Hind legs normal, with longer and more slender femora and tibiæ. Tarsi of all legs two-segmented, the first segment short and inconspicuous. Abdomen swollen very little. Openings to dorsal stink glands located at anterior margins of segments four, five and six.

Localities. North Carolina, Florida, Louisiana, Texas, Kansas, Arizona, California, Mexico, West Indies.

Rasahus hamatus (Fabricius).

Fabricius, Spec. Ins. II:381; 1871. *Reduvius hamatus.*

The original description of this insect not being available, a redescription by Stal (1868) is given:

"Black, shining; a stripe of the corium to claval suture, the basal margin of the membrane to the apex of the corium, spots on margin of abdomen, base of posterior femora, tarsi, sometimes also the coxæ towards apex and a stripe on the anterior femora sordid pale flavescent; round spot of the membrane yellow; impressed lines of the prothorax distinct, rugulose; apex of scutellum produced into a spine.

"♂. Length 17 mm.; width, 4 mm."

Biology. Blatchley reports taking specimens from beneath boards in damp places, and at lights.

Localities. Texas, Mexico, South America, Guatemala, Panama, Florida.

Genus SIRTHENIA.

This genus, originally described by Spinola (1837), is characterized by Stal (1872) as follows:

"Anterior coxæ rather long, produced far behind the posterior margin of the prosternum; head before the ocelli transversely impressed; posterior coxæ rather far apart; interior aërole of the membrane noticeably or scarcely noticeably narrowed behind the middle; intermediate tibiæ without spongy fossa; head long, porrect, neck without lateral tubercles; hind legs rather short; spongy fossa of anterior tibia occupying a third to a half of the length."

DISTRIBUTION OF GENUS.

This is one of the few genera of Reduviidæ which is of world-wide distribution. It is a genus of fourteen species represented in all but one of the faunal realms. The distribution by species is as follows: Nearctic, 1 species; Neotropical, 4 species; Palæarctic, none; Ethiopian, 1 species; Oriental, 3 species; Australian, 6 species.

Sirthenia carinata (Fabricius).

Fabricius, Ent. Syst., Suppl., 545; 1798. *Reduvius carinatus.*

"Black with elytra, abdomen at margin and legs reddish.

"Habitat in Carolina.

"Large. Head, beak and antennæ fuscous. Thorax black, impressed dorsally with five shining lines; intermediate shortened. Scutellum black; elytra red. Wings black. Abdomen black with margin elevated, carinate, red. Legs red, anterior femora strongly thickened."

Biology. The form and structure of this insect is so similar to that of the two preceding that one would expect to find it of the same habits. I have a specimen taken in Kansas which bears a label indicating that it was taken under a rock, which may indicate that its habitat is the same as that of the other members of the subfamily. Data on its life history are lacking.

Uhler calls attention to the fact that there is considerable variation in the color of this species.

Localities. New Jersey, North Carolina, South Carolina, Georgia, Florida, Louisiana, Texas, California, Kansas, Mexico, Costa Rica, Colombia, South America.

SUBFAMILY ECTRICHODIINÆ.

This subfamily was originally designated by Amyot and Serville (1843) as "Groupe Ectrichodides." Its structural peculiarities are as follows: Ocelli present; anterior coxæ not greatly elongated; ocelli not farther cephalad than the caudal margin of the eyes; thorax constricted cephalad of the middle; apex of scutellum broad, with two or three spines; anterior tibiæ and usually the middle tibiæ also with spongy fossa.

WORLD DISTRIBUTION OF SUBFAMILY.

This subfamily contains nearly 200 described species. These are distributed as follows: Nearctic, 3 species; Neotropical, 4 species; Palæarctic, 16 species; Ethiopian, 59 species; Oriental, 77 species; Australian, 4 species.

CLASSIFICATION OF SUBFAMILY.

The two genera which may be found within our limits may be separated by the following key:

1. First segment of beak more than half as long as head, longer than segments two and three together; first segment of antennæ short, *Pothea* Amyot and Serville, p. 145

   First segment of beak not extending behind eyes, subequal in length to second segment; first segment of antennæ about as long as the head, *Rhiginia* Stal, p. 144

Genus RHIGINIA.

This genus was originally described by Stal (1859) as follows:

"Head oval, behind the eyes rather suddenly narrowed, neck very short. Antennæ eight-segmented. Beak with segments one and two of about equal length. Thorax before the middle slightly constricted. Scutellum narrowed behind, apex pointed very abruptly. Legs very slender, femora unarmed, anterior femora hardly thickened; anterior tibiæ with spongy fossa; first segment of hind tarsus very short, second and third segments longer, of about equal length."

DISTRIBUTION OF GENUS.

Eight species have been described as belonging to this genus. Of these one is found in the Palæarctic realm, two in the Nearctic realm, and five in the Neotropical realm.

CLASSIFICATION OF GENUS.

The two species of the genus within our limits may be separated as follows:

1. Legs black or piceous; dorsal surface of head, base of hemelytra, dorsal disk and margin of the abdomen, sometimes also disk or discoidal spots on the venter, yellowish; eyes of the male prominent; postocular portion of head shorter than in other species; tylus somewhat elevated..*cinctiventris* Stal.

   Legs pale except for apex of femora; elytra short and fuscous; postocular portion of head broad; eyes small....................*cruciata* (Say).

Rhiginia cruciata (Say).

Say, Heter. N. Harm., 33; 1832. Fitch Repr., 802. Compl. Wr., I:358. *Petalochirus cruciatus.*

"Sanguineous, thoracic spot, scutel and hemelytra black; scutel bifid at tip. Inhabits United States. Body sanguineous; head black behind the eyes; antennæ black; thorax with a longitudinal impressed line extending nearly to the base and forming a cruciate mark with the transverse line; an irregular black spot on disk; scutel rugulose; lip (tip?) orbicularly bifid; hemelytra black; feet whitish; thighs at tip and tibiæ at tip and base blackish: tarsi dusky; rostrum pale, second joint blackish.

"Length half an inch."

Biology. Uhler reports that this is a rare insect in Maryland. Blatchley reports taking it from beneath logs in Indiana, and from vegetation in Florida.

Localities. New Jersey, Pennsylvania, Maryland, Georgia, Florida, Indiana, Louisiana, Texas, New Mexico, Kansas.

Rhiginia cinctiventris Stal.

Stal, Enum. Hemip., II:103; 1872. *Ectrichodia cinctiventris.*

"Black; upper surface of head, pronotum, base of hemelytra, dorsal disk and margin of abdomen, sometimes also a disk or discoidal spot on the venter subsaffron; base of veins and also basal margin of the membrane towards the exterior basal angle saffron. ♂. ♀. Length, 18-20 mm.; width, 5-6 mm.

"♂. Antennæ for whole length with rather dense and long pile; head above in the middle distinctly longitudinally trisulcate, rather flat, a little swollen below and behind the eyes.

"♀. Antennæ scarcely pilose, smooth towards the base; upper surface of head convex in middle region, median sulcus obsolete, lateral sulci distinct, postocular part below rather swollen.

"Similar to the preceding (*cruciata*), larger, more variegated, postocular part of head a little shorter, eyes of male more prominent, head of female below and behind more swollen. Thorax with cruciform impression more or less distinctly black, two discal spots on or behind transverse impression and the posterior margin of abdomen black. Tylus obtusely elevated. Tubercle bearing ocelli entirely or posterior part black. Wings fuscescent."

Localities. Texas, New Mexico, Mexico.

Genus POTHEA.

This genus was described originally by Amyot and Serville (1843) as follows:

"Neck long and slender. Antennæ with a variable number of segments. Beak long and slender; first segment much longer than the second. Prothorax having a very pronounced longitudinal furrow which crosses the transverse furrow."

Distribution. This genus is composed of thirteen described species, one of which has been described from within our limits, "America borealis," and twelve from the Neotropical realm.

Pothea æneo-nitens Stal.

Stal, Ann. Soc. Ent. Fr., Ser. 4, IV:59; 1864.

This species is characterized by Stal as follows:

"Hemelytra fuscous or fusco-testaceous, veins pallescent; tylus of the male unarmed; tubercle bearing ocelli very obtuse, lower than the interocular portion of the head; anterior femora beyond middle as seen from the side distinctly sinuate above; differs from preceding in its slender form. Head slender, postocular portion long, neck long, cylindrical."

Localities. Stal reports this insect from "America borealis." Van Dusee (1917) notes that this is probably an error. Fracker (1913) reports it from the "Southern states."

SUBFAMILY HAMMACERINÆ.

The members of this subfamily possess the following characteristics: Ocelli present and cephalad of the caudal margins of the eyes; the first segment of the antennæ stout, the second segment divided into many small divisions; the head not prolonged at all behind the prominent eyes.

BIOLOGY.

Champion says that the habitat of these insects is under the bark of decaying trees, and that some of them are common in the forest regions of tropical America.

WORLD DISTRIBUTION.

This subfamily contains only two genera and twelve described species. Eleven species are to be found in the Neotropical realm, and five species in the Nearctic realm, four of the species being common to both.

CLASSIFICATION OF SUBFAMILY.

The two genera belonging to this subfamily may be separated as follows:

1. Antennæ inserted near the eyes; head in front of the eyes short, subequal to distance between eyes............................*Homalocoris*, p. 150

   Antennæ remote from eyes; head in front of eyes over twice as long as distance between eyes............................*Hammacerus*, p. 146

Genus HAMMACERUS.

Laport (1832) originally described this genus as follows:

"Antennæ filiform, of numerous segments, segment one very robust, subinflated; segment two rather elongate, followed by twenty-seven, each provided with two or three rigid hairs; segment twenty-nine long, pubescent. Rostrum very much bent, the length of the head. Tarsi covered with hair, first and intermediate segments short, segment one hardly conspicuous, the second longer; all the claws simple.

"Body much depressed, flat; head very much prolonged before the eyes, these globular and situated behind; ocelli close together, placed on a little transverse elevation situated on the vertex; prothorax almost flat, narrowed a little in the middle by a transverse furrow; posterior margin rounded; scutellum triangular, bifid behind; hemelytra rather large; abdomen depressed; femora of the anterior legs swollen, bearing a small spine near the insertion of the tibiæ; this is short; the posterior legs very long, especially the tibiæ."

DISTRIBUTION OF GENUS.

This genus is composed of six species, one of which has been reported only from within the limits of the United States, one common to this country, Mexico, and Central America, and the other four exclusively Neotropical.

CLASSIFICATION OF GENUS.

The two species of this genus which may be found within the United States may be separated as follows:

1. Femora entirely black; rod-shaped black spot at base of corium, *luctuosus* Stal.

   Posterior femora rufous at base; no rod-shaped spot at base of corium, *purcis* (Drury).

Hammacerus purcis (Drury).

(Pl. X.)

Drury, Illustr. Exot. Ent., III:63, pl. 45, fig. 4; 1872. *Cimex purcis*.

"Black, entirely granulate, base of elytra white, base of posterior femora sanguineous. (Length of body, 1 une.) Habitat: Virginia, Georgia.

"Head, eyes, and thorax black; the latter rough. Antennæ setacious, consisting of innumerable articulations. Scutellum triangular and black. Corium white, terminal membrane black. Wings white and transparent. Abdomen black, the edges marked with scarlet and black spots. Rostrum black and short, not reaching to the fore legs. Legs black, the hinder thighs next the body scarlet."

Biology. A small amount of data on the biology of this insect is available.

Habitat. Several references describing the habitat of this insect as under the bark of trees are to be found. Bueno and Brimley (1907) report finding both adults and nymphs under the bark of dead pine trees in winter. Inasmuch as this coincides with the habits reported by Champion for the subfamily, it seems logical to consider it the normal habitat.

Food. No references to the food of this insect are to be found. There can be but little doubt that it is predacious, as are the other members of the family to which it belongs, but just what insects it prefers cannot be stated.

Seasonal Life History. No direct study of this subject has been made, but collecting records throw some light on the subject. Bueno and Brimley (1907) report finding both nymphs and adults during the winter. The writer has a series composed of both nymphs and adults collected by Mrs. Grace Wiley in Colorado county, Texas, on March 7. In this lot there are represented the last three nymphal instars, as well as the adults. The nymphs are apparently much more abundant than the adults at this time of year. It would seem that the insect may overwinter either as a nymph or adult, but more commonly as a nymph, and in several different instars. Though there is no data on the subject, it seems quite probable that there is but a single generation a season.

DESCRIPTION OF INSTARS.

The writer has figured and prepared descriptions of the third, fourth and fifth nymphal instars.

Third Instar. (Pl. X, Fig. 1.) Length of body, 9-10 mm.; length of front femur, 2.2 mm.; length of second antennal segment, 2.1.

General color rather dark, upper surface of head and thorax darker, piceous; upper surface of abdomen lighter. Antennæ somewhat lighter in color than head; legs of a uniform dark brown with exception of hind femora which are bright red for about two-thirds their basal length, then dark brown to apex; abdomen with numerous dark spines and with dark median dorsal plates at anterior margins of segments four, five and six, at openings of dorsal stink glands.

Entire upper and lateral surfaces of body with numerous dark, conspicuous spines. Length of head about equal to width across eyes; postocular portion slightly narrower than anteocular portion; transverse suture broadly U-shaped; antennæ slender, first segment shortest and stoutest, hardly exceeding apex of head; second segment longest, composed of 18-19 divisions; third and fourth segments subequal, the two taken together subequal to the second; rostrum stout, curved, first and second segments stoutest, subequal, third segment shorter and more slender. Prothorax narrowed at apex, broader at base, angles rounded; meso- and metanota slightly wider than pronotum, each bearing wing pads; those attached to mesothorax extended only slightly beyond caudal limits of that segment, and those attached to metathorax extended backwards not at all. First two pairs of legs apparently raptorial, with swollen femora and tibiæ bearing a hairy pad at apex; pad of middle tibia much less developed than that of fore tibia; first tarsal segment very short, tarsal claws toothed at base; hind legs normal, with longer and more slender femur and tibia than preceding, first tarsal segment also longer. Abdomen somewhat swollen, broadly rounded behind. Openings to dorsal stink glands visible at anterior margins of segments four, five and six; location marked by dark plates.

Fourth Instar. (Pl. X, Fig. 2.) Length of body, 13 mm.; length of front femur, 3 mm.; length of second antennal segment, 4 mm.

Color practically as in preceding instar.

General structure similar to preceding; numerous spines present on upper and lateral surfaces of body as in preceding; head now distinctly longer than width across eyes; second antennal segment now composed of 20-21 divisions. Wing pads larger, first pair extended over second pair for more than one-half their length, and second pair extended over first abdominal segment for more than one-half its length; plates marking openings to dorsal stink glands present, and in addition plates present in a corresponding position at the caudal margin of segments six, seven and eight.

Fifth Instar. (Pl. X, Fig. 3.) Length of body, 16 mm.; length of front femur, 4 mm.; length of second antennal segment, 5.5 mm.

Color as in preceding instar.

General structure as in preceding; more hairs and spines in this instar; second antennal segment now composed of 26-27 divisions; pads at apices of fore and middle tibiæ much better developed in this instar; transverse suture present near the caudal margin of the pronotum; wing pads larger, both extended to the base of the third abdominal segment.

Localities. Virginia, Georgia, North Carolina, South Carolina, Florida, Alabama, Oklahoma, Texas.

Hammacerus luctuosus Stal.

Stal, Of. Vet. Akad. Forh., XI:237; 1854. *Hammatocerus luctuosus.*

"Black; large median spots on hemelytra dirty white. Length, 21 mm.; width 5 mm. Mexico."

Stal later enlarges somewhat upon this description (Stet. Ent. Zeit., XXIII:455; 1862):

"Black, granulate; coriaceous part of hemelytra, with base and apex excepted, dirty white; legs unmarked.

"♂. Length, 20-24 mm.; width, 5½-6½ mm."

Stal designates two varieties of this species, one of which has the connexivum unmarked, the other having the connexivum marked with dirty livid fascia. He states that the males of this genus have the ventral surface bearing a flat disk, and that segments three and four bear in the middle region a very short, dense pile. The writer has observed that in the preceding species the pile is not confined to the male sex, but is present in the females also.

Biology. There are practically no data on the biology of this species, though it is assumed that it is similar to the preceding in habits. Champion notes that the nymph has the tarsi two- instead of three-segmented, and that the hind femora to the tip, as well as the others at the base, are rufous.

Localities. Texas, Mexico, British Honduras, Guatemala, Panama.

Genus HOMALOCORIS.

Perty's original description to this genus is not available (1834). In addition to the characters given in the key to the genera, the following characters may be useful in separating this genus from the preceding: Second segment of antennæ divided into 8-18 jointlets, instead of 23-28, as in *Hammacerus;* second and third ventral segments of abdomen not densely pilose, as is the case in *Hammacerus.*

DISTRIBUTION OF GENUS.

This genus is composed of six described species, all of which are typically Neotropical, although three of them extend their range into southern United States.

CLASSIFICATION OF GENUS.

The three species of this genus to be found within our limits may be separated by the following key:

1. Corium flavous or ochreous, with a median black spot, the membrane pale at the apex.......................................*maculicollis* Stal.
   Corium with black the predominating color.............................. 2
2. Corium and membrane black, the corium with a small spot at the base, and the membrane with a small spot at the base and another about the middle of the basal margin, pale flavous; pronotum with two small ochreous spots on the posterior lobe in front....*guttatus* (Walker).
   Corium and membrane black, marked with sanguineous....*minutus* (Mayr).

Homalocoris minutus (Mayr).

Mayr, Ver. Zoöl.-Bot. Ges. Wien, XV:439; 1866. *Hammatocerus minutus.*

"Length, 11-7 mm. Tawny black, partly fuscous, two stripes on disk of pronotum and the anterior portion of the anterior margin, the hemelytra near the base, quadrangular spots of the connexiva and minute spots on anterior femora, two basal spots on membrane, and discoidal markings before the apex and the tarsi in part testaceous."

Locality. This species was described originally without knowledge of place of collection, but was recorded later by Snow from Arizona (1907).

Homalocoris maculicollis Stal.

Stal, Enum. Hemip., II:101; 1872.

"Black, above with femora and sides of prothorax bearing setiferous granules; two spots of the rather large thoracic lobe converging into two vittæ, also the coriaceous part of the hemelytra dirty testaceo-flavescent; two spots, one basal, the other placed somewhat behind the middle, also the apex of the clavus itself, and a somewhat larger transverse subtriangular basal spot grey; quadrangular marginal spots of the abdomen testaceo-flavescent.

"♂. Length, 12 mm.; width, 3 mm."

Localities. Arizona, Mexico, Guatemala.

Homalocoris guttatus Walker.

Walker, Cat. Heter., VII:181; 1873. *Reduvius guttatus.*

The following descriptive notes taken from Champion (1899) will serve to identify this species:

"Legs black; second antennal joint divided into 13-18 jointlets; corium and membrane black, the corium with a small spot at base, and the membrane with a small spot at the base and another about the middle of the basal margin, pale flavous; pronotum with two small ochreous spots on the posterior lobe in front."

Localities. Arizona, Mexico.

SUBFAMILY APIOMERINÆ.

The following characters will serve to distinguish this subfamily, which was originally designated as the "Groupe Apiomerides" by Amyot and Serville (1843). Ocelli present, very far apart, placed laterally behind the eyes, farther apart than the eyes themselves; anterior and middle tibiæ without the spongy fossa found in several of the preceding subfamilies; anterior tarsi very small and received in an indentation of the tibia above; legs noticeably hairy, the anterior tibiæ long and arched.

WORLD DISTRIBUTION OF SUBFAMILY.

This subfamily is composed of about seventy-five species, the greater number of which are to be found in the Neotropical realm. The species are distributed as follows: Nearctic, 9 species; Neotropical, 63 species; Ethiopian, 7 species; Oriental, 15 species. The subfamily is not represented in the Palæarctic and Australian realms.

BIOLOGY.

In a few species in which the habits are known, the adult insects live on plants and feed on the insects found on plants. The nymphs have been reported as occurring on foliage also, and have been observed by the writer, in the case of one species at least, to live on the surface of the ground under rocks. The eggs have been reported as being placed both on foliage and on rocks lying on the surface of the ground.

CLASSIFICATION OF SUBFAMILY.

Within our limits but one genus of this subfamily, *Apiomerus,* is represented.

Genus APIOMERUS.

This genus is described by Amyot and Serville (1843) as follows:

"Body thick and hairy. Head rather noticeably prolonged into a blunt cone before the eyes; neck very elongate. Eyes large, projecting in a hemisphere, a little flattened. Ocelli far from one another, placed behind, and rather far from the eyes, on a tubercle. Antennæ shorter than the body; first segment rather long, a little thickened; the second noticeably shorter than the third, which is very long; the fourth sometimes almost the length of the preceding. Beak reaching the point of insertion of the anterior legs; the second segment straight, very long; the first and third very short. Prothorax trapezoidal, without spines on its disk, with a rather large swelling, divided into two lobes on the anterior margin; its posterior angles hairy; its posterior border truncate, leaving the scutellum uncovered. Scutellum triangular, rather short. Elytra at least as long as the abdomen, a little narrower than it; membrane with three large cells formed by some of the large longitudinal veins, of which the last only reaches the anterior margin, towards the extremity; the two first cells round and become closed rather far caudad, having the margin internal. Abdomen elongate, flattened on the margin, extending beyond the elytra on each side, and lightly notched; the males showing, at the extremity of the anal plate which is rounded and swollen, two lateral filiform appendages and two other intermediate points, the latter disappearing sometimes, however. Legs rather large and strong, very hairy; the four anterior tibiæ are stronger than the others, a little curved and thickened towards the middle or extremity, with an indentation at the tip, above, to receive the tarsus, which is very small; the posterior tarsi are larger than the others."

BIOLOGY.

Champion (1899) gives the following discussion of the habits of this genus:

"The females have the power of exuding a sticky fluid from the ventral surface, and probably from the tibiæ also; the hairs on the venter are matted and stuck together with this substance in nearly all the specimens examined. From what I have observed of the habits of one of the largest species, *A. vexil-*

larius, which is quite common in forest clearings in the 'tierra caliente' of Chirique, this viscous fluid appeared to be used for the purpose of securing a firm grasp of its prey—freshly emerged Longicornia, etc., nearly as large as itself—during the process of suction. Doctor Sharp, however, has recorded a curious fact in connection with the mode of deposition of the eggs of an Amazonian reduviid (possibly a species of Harpactorinæ or Apiomerinæ), showing that this fluid is used for gumming them down on a leaf. The foliaceous appendages of the females of *A. vexillarius*, etc., are bright sanguineous in life, and very conspicuous, looking like two red flags waving about, as the insect runs over the surface of fallen timber in search of its prey. These appendages, like the more or less expanded and similarly colored sixth dorsal segment of the males of the same species, often fade after death to flavous or even black. The anterior and intermediate tarsi are short and retractile, fitting into a groove along the outer face of the stout, broad tibiæ.

"Some of the smaller forms are found upon flowers or herbage. I am unacquainted with the larvæ or pupæ of any of the species of the genus."

A. C. Morgan (1907) has worked out the details of the life history of one species of this genus, *A. spissipes* (Say), and the writer has some additional data on the same species to add to that of Morgan. This material is given under the discussion of that species.

WORLD DISTRIBUTION OF GENUS.

This genus is entirely American in distribution, the larger number of species, however, being found south of the United States. Of the forty-five species described for this genus, forty-four are represented in the Neotropical realm, and nine in the Nearctic realm, eight of these, of course, being common to both realms.

CLASSIFICATION OF GENUS.

The species of this genus which occur within our limits may be separated by the following key:

1. Female with foliaceous genital appendages; male with two divergent, upwardly curved spines at apex of the last genital segment, *repletus* Uhler, p. 156
   Female without foliaceous genital appendages........................ 2
2. Female with the sides of the first genital (terminal dorsal) segment forming a continuous outline with the connexival margin............ 3
   Female with the outer apical angles of the first genital (terminal dorsal) segment deflexed and not forming a continuous outline with the connexival margin; male with the apex of the last genital segment produced into a short process in the center and armed with two spines.. 6
3. Male with the two spines at the apex of the last genital segment arising from a short broad process, the apical margin of this segment not toothed at the sides above the points of insertion of the claspers, *subpiceous* Stal, p. 154
   Male with the two spines at the apex of the last genital segment not arising from a short process 4

4. The apical margin of the terminal genital segment toothed or subangulate at the sides above the points of insertion of the claspers (appearing emarginate on each side); corium dark, *immundus* Bergroth, p. 156

The apical margin of the terminal genital segment not toothed or angulate at the sides above the points of insertion of the claspers........ 5

5. The spines very long, acuminate, and divergent; elytra moderately long, the corium and membrane dark; body robust, *longispinis* Champion, p. 155

The spines very much shorter, divergent; elytra moderately long, the corium with some of the nervures partly ochreous (rarely in great part ochreous), the membrane blackish; legs rather slender; body narrow (♂), broader (♀)........................*moestus* Stal, p. 155

6. Male with two genital spines upwardly curved and obliquely divergent, 7

Male with the genital spines horizontal, rather short and stout, and laterally extended 8

7. Pronotum partly rufous; the corium rufous or reddish-ochreous, with the apical margins narrowly ochreous; connexival margins, at most, very narrowly pale ....*spissipes* (Say), p. 157

Pronotum black, with reddish or pale basal margin; corium obscure rufopiceous; connexival margins more broadly pale, *crassipes* (Fabricius), p. 156

8. Ventral segments flavous, with the sutures very narrowly black; species larger, more robust, and more brightly colored, *flaviventris* Herrich-Schaeffer, p. 165

Ventral segments more broadly banded with black; species smaller and less brightly colored................*pictipes* Herrich-Schaeffer, p. 166

Apiomerus subpiceous Stal.

Stal, Stet. Ent. Zeit., XXIII:454; 1862.

"Dark pilose; black or yellowish black; head, anterior lobe of thorax, and abdomen black, spots on margin of abdomen and the bases of the veins of the membrane pale fuscous; antennæ always yellowish black; posterior lobe of the prothorax rather smooth. ♂. ♀. Length, 12-16 mm.; width, 3½-4½ mm.

"♂. Apex of anal segment lightly produced, armed in middle with two spines, bent upwards, divaricating.

"♀. With anal appendages."

Champion gives the following notes on this species:

"In this species the corium and the posterior lobe of the pronotum are usually brownish or piceous, rarely black. The legs vary in color from piceous, with tibiæ (the base excepted) ferrugineous or testaceous, to entirely black. The antennæ in some specimens are ferrugineous, and in others almost entirely black. The membrane is uniformly fuscous. The males have the apex of the last genital segment broadly produced in the center and armed with two, moderately long, widely divergent, upwardly curved spines; the claspers are long and somewhat abruptly bent inwards towards the apex."

Localities. Arizona, Mexico, Guatemala, Costa Rica.

Apiomerus moestus Stal.

Stal, Stet. Ent. Zeit., XXIII:455; 1862.

"Dark pilose, black; membrane fuscous; the base of the veins of the membrane, and also a fascia behind the middle of the corium fuscoflavescent; thorax smooth. ♀. Length, 13 mm.; width, $3^{3}/_{4}$ mm.

"Very similar to *A. subpiceous*, scarcely differing except in black color and longer hemelytra."

Champion gives the following notes on this species:

"A rather small species, the males comparatively narrow, with the elytra extending far beyond the abdomen in both sexes. The corium usually has an irregular narrow transverse fascia towards the apex, and one or two of the inner nervures, ochreous, this color sometimes extending over the greater portion, leaving the base and the apex only dark. The basal margin of the pronotum is sometimes flavescent. The posterior tibiæ are in some specimens broadly ferrugineous or testaceous in the middle. The apical joint of the antennæ is shorter than the third, and ferrugineous at the tip. The males have two moderately long, divergent, upwardly curved spines at the apex of the terminal genital segment; the claspers are long, strongly curved, and rather stout."

Localities. Arizona, Mexico, Guatemala.

Apiomerus longispinis Champion.

Champion, Biol. Centr. Am., Heter., II:239, pl. 14, fig. 17; 1899.

"Moderately robust, shining, black, the corium and posterior lobe of the pronotum sometimes obscure reddish brown, the membrane uniformly fuscous or nigro-fuscous, the nervures of the latter usually ochreous at the base, the connexival sutures indicated laterally by a rufous or ochreous mark, the antennæ varying in color from black to ferrugineous; the anterior and intermediate femora, trochanters, and coxæ sometimes in great part ferrugineous; the body rather sparsely clothed with erect blackish setæ and also with short decumbent pallid pubescence; the legs somewhat sparsely setose. Antennæ with joints 1 and 2 in equal length, 3 nearly twice as long as 2, 4 slightly longer than 3. Pronotum with the base feebly sinuate on each side near the hind angles. Elytra longer than the abdomen in both sexes. Legs moderately stout, the femora feebly swollen before the tip.

"♂. Terminal genital segment armed with two very long, stout, tapering, upwardly curving divergent spines; the claspers long and stout, and with a dense brush of short bristly hairs on the upper edge beyond the middle; venter densely pilose.

"Length, $15^{1}/_{2}$-$19^{1}/_{2}$ mm.; breadth, $5^{2}/_{3}$-$7^{1}/_{4}$ mm.

"Fourteen specimens. Very like *A. subpiceous* Stal, but usually much darker in color, and with the two spines at the apex of the terminal genital segment of the male much more elongate. These spines are longer than in any other of the species of the genus known to me; they are stout at the base and taper toward the tip. In general shape of the terminal segment the present species agrees with *A. subpiceous*, both differing from *A. tristis* in this respect.

The specimens belonging to the Vienna Museum were sent to me as *A. moestus* Stal; the one in the Stockholm Museum was separated as a distinct species."

Localities. Arizona, Mexico.

Apiomerus immundus Bergroth.

Bergroth, Bul. Soc. Ent. Fr. for 1898:307.

Inasmuch as the original description of Bergroth is not available, I shall quote Champion's descriptive notes on this species.

"Sent in plenty from Teapa. Very like *A. subpiceous* Stal, and similarly colored; but smaller and less elongate, the membrane in light-colored specimens usually with scattered darker spots.

"The males have the two spines at the apex of the last genital segment rather short, upwardly curved, moderately divergent, and widely separated at the base, and the apical margin of this segment is subangulate on each side opposite the points of insertion of the claspers; the latter are comparatively short. The genital spines of the male are shorter, less divergent, and more widely separated at the base in the same sex of *A. subpiceous*."

Localities. California, Mexico.

Apiomerus repletus Uhler.

Uhler, Bul. U. S. Geol. Surv., I:329; 1876.

"Black, robust, densely invested with brownish black, erect pubescence. Head and surface of pronotum polished; eyes brown; antennæ brownish piceous, excepting the basal joint, which is deep black. Lateral margins and humeral angles of the pronotum densely beset with stiff bristles; the anterior lobe longitudinally, deeply, and widely scooped out, each side with high, oblique ridges, defined by deep furrows. Hemelytra velvety; the dense pile short, black. On the disk of each corium is a crimson-red, large, triangular spot. Abdomen with dense, erect, moderately short pile; the connexivum, both above and below, almost bald, polished, only the base pubescent, the incisures pale yellow; anal lobes large, lamellate, circular, pale yellow, the margin thickened.

"Length, 21 mm.; width of pronotum, 7 mm."

Locality. Calfornia.

Apiomerus crassipes (Fabricius).

Fabricius, Syst. Rhyng., 273; 1803. *Reduvius crassipes.*

"Hairy fuscous, thorax and margin of abdomen ferrugineous, legs thickened.

"Habitat in California.

"Of medium size. Head hairy, fuscous, unmarked. Thorax villous, fuscous, lateral margin and very slender posterior margin red. Wings black. Breast black spotted on either side, margin of abdomen red. Legs short, thickened, hairy, black with the base a little red."

Inasmuch as Say, who described the following closely related species, *spissipes*, includes a description of this species as well, his description should be valuable and is included here:

"Specific character. Blackish; thorax and abdomen margined with reddish; feet thick.

"Description. Body villous; posterior lobe bituberculate: thorax margined all round with red; anterior lobe with a triangular central indentation; scutel with a red band beyond middle: hemelytra with a reddish humerus; coriaceous portion with two or three obsolete reddish points at tip; membranaceous portion much deeper black; tergum with red triangular spots on the incisures at the lateral margin; pectus with a red spot above the insertion of each foot, and coxæ red; venter margined each side with red.

"Obs. This species was collected by Bose, in California, and was described from his collection by Fabricius. I found the specimens in Arkansaw."

Biology. An account of the habits of this species has been given by Uhler (1884) in the Standard Natural History. He says that it lays its eggs on twigs and bark of the common pine trees.

"These hatch during the early summer, and the young may be seen roaming over the trees in search of plant lice and young caterpillars, which they pierce and suck to death, often holding them out on the tip of the rostrum, while keeping them from getting away by pressing down with the fore feet. The adult insect may be found in the trees as early as March, and numbers may be beaten therefrom during the summer and autumn. This species inhabits most of the thinly distributed pine belts, from lower Canada to southern Florida, and varies much in the width of the red markings of the thorax, wing covers, and abdomen."

Heidemann (1911) describes the egg of this insect as follows:

"Egg, 1.8 mm., oval-elongate; color dark brown; the extension of the chorion at upper egg-pole composed of longitudinal fine scales connecting with each other, yellowish around the rim and white at the edge; the cap rather low, crowned with white scales, of which those on the inside circumference are brown."

A figure accompanies this description.

Localities. Probably universally distributed over the United States and southern Canada; Mexico.

Apiomerus spissipes (Say).

(Pl. XII.)

Say, Jl. Acad. Nat. Sci. Phila., IV:328; 1825. Compl. Wr., II:250. *Reduvius spissipes.*

"Thorax and hemelytra light reddish brown, edged behind with white; venter black, incisures whitish; feet thick.

"Inhabits Arkansas.

"Head black, posterior lobe with two tubercles; thorax light reddish brown; anterior lobe with dilated, black, or arcuated lines, of which some are confluent; posterior lobe hardly more elevated than the preceding, with a black posterior submargin and a white posterior margin; scutel black, margined with white, and tipped by a few hairs: hemelytra, coriaceous portion light reddish brown, with a narrow, whitish posterior margin, membranaceous portion black or dark fuscous; feet thickened, black, hairy; coxæ bright red; abdomen black, margin and band on each segment white.

"Length, thirteen-twentieths of an inch.

"The feet resemble those of *R. crassipes* Fabr., but it is a very distinct species."

Champion gives the following descriptive notes concerning this species:

"These specimens are extremely like some of the varieties of *A. pictipes*, and they are only separable therefrom by the very different form of the external genital armature of the males. They have the venter entirely black, or, rarely, with traces of transverse dirty yellowish lines at the sides; the connexivum in some of them is entirely black, or has the outer margin very narrowly pale; the pronotum rufous, with two broad transverse black fasciæ, which are sometimes united along the middle of the disk; the corium rufous or reddish ochreous with the apical margin narrowly ochreous. The males have the apex of the terminal genital segment broadly produced in the center, and armed on each side with a moderately long, divergent, upwardly curved spine, which is distinctly hooked at the tip (the armature resembling that of *A. subpiceous* and its allies, and very different from that of *A. pictipes*); the claspers are comparatively short, very abruptly bent inwards a little beyond the middle, and strongly curved at the apex. The females have the outer apical angles of the first genital segment deflexed and dilated into a subtriangular concave plate (this being much larger than in the same sex of *A. flaviventris* and *A. pictipes*); the terminal genital segment is strongly transverse."

Biology. Mr. A. C. Morgan (1907) studied the biology of this insect as a possibly important beneficial predacious enemy of the cotton boll weevil, and has contributed most of what is known concerning its biology. Among the points of its life history which he takes up are copulation, oviposition, characters of egg, food, cannibalism, length of life history, natural enemies, distribution, and value as a predacious enemy of the cotton boll weevil. The following account is taken from his work.

Morgan observed copulation of this species on May 23, 1925, and describes it as follows: "During the process the female assumes the normal position while the male clings to one side of her, holding on with the fore and hind legs." The act lasted for four hours in one case and for three hours in another case.

Eggs were laid in masses of forty to sixty on the under side of a leaf near the top of the plant, placed side by side so that the eggs in the center of the mass are hexagonal. They were collected in this position from *Helianthus* sp., and *Ambrosia* sp. He describes the egg as follows:

"The egg is cylindrical, finely punctured, and varies in color from a bright yellow when first deposited to a light brown just before hatching. The collar is shining white. The dimensions of the egg are as follows: Width at narrowest part—just below collar—0.5 mm.; greatest width, 0.64 mm.; length of the collar, 0.26 mm.; total length, 1.77 mm. The width of the collar varies from slightly less to slightly more than the greatest width."

The period of incubation varied from 12 to 16 days in May, to 10 to 12 days in midsummer, to 14 to 16 days in the fall.

Morgan reports that the insect fed upon a wide variety of insects in the laboratory, including Orthoptera, Hemiptera, Lepidoptera, Diptera, and Hymenoptera, but preferred Coleoptera and Diptera. He says:

"In general the reduviids lie in wait in an alert attitude for the approach of an insect and then spring upon it, but frequently they take the initiative and fly or run toward an insect. The insect fed upon is not left until all the juices are sucked from its body. Sometimes this takes only half an hour, at other times the reduviid feeds for more than two hours. Boll weevils fed upon by *Apiomerus spissipes* are often as dry and crush as easily between the fingers as do pinned specimens. The first puncture of the beak of *spissipes* is generally fatal. In the case of boll weevils, upon which *spissipes* frequently fed, the weevil made only a few spasmodic movements after the first insertion of its captor's beak, and then ceased to move. The power of the bite of this insect was well illustrated upon the writer while collecting specimens. One adult inserted his bill in the end of the thumb. The pain at first was not so great as that of the sting of a bee or wasp, but in a few minutes it was much greater than the writer has ever experienced from any hymenopteron's sting. It continued unabated for over an hour, and the spot was tender to the touch for over two weeks."

Morgan gives in some detail the food of individual adult and nymphal *spissipes*. The food of the adult included the cotton boll weevil, though this was apparently unsatisfactory food for them, the pepper weevil, flies, ladybirds, bees and twelve-spotted cucumber beetles. The insect refused the Colorado potato beetle and its larvæ, however, and also the sharpshooter, *Homalodisca triquetra* Fabr. He considered the diet unsatisfactory, however, since he was unable to keep the insect alive for any length of time. A third-instar nymph ate fifty pepper weevils and three cotton boll weevils during the period from October 16 to November 8, but died during the winter. Morgan had great difficulty in keeping the newly hatched individuals alive, but finally succeeded to a certain extent by offering them a head of *Ambrosia* broken open, which contained a variety of insects, including *Triphleps insidiosus,* a weevil of the genus *Apion,* thrips, and larvæ and pupæ of a gall midge.

His records on the length of the stages and the length of the total life cycle are inadequate since he had so much difficulty in keeping the insects alive. He gives 4 to 7 days as the length of time between copulation and oviposition; 10 to 16 as the period of incubation; 12 days or much longer as the period between the second and third molts. He says that there can be but a fragment of a second generation in the field. He also speaks of the fact that while the adults are very common in the field, and may be observed frequently in copulation in June and July, later searches for the nymphs reveal only a very small number.

One natural enemy has been found, an egg parasite belonging to the genus *Hadronotus.* The parasitized egg mass had 12 per cent of the eggs parasitized.

Morgan does not consider this insect as a beneficial one, in fact, he says that it may be positively harmful since it feeds to such an extent upon ladybirds. He sums up his findings as follows:

> "Lastly, the great mortality of the young and consequent paucity of adults, the unspecialized food habits, the failure to feed to any appreciable extent upon harmful insects, and the practical disappearance of the species from the vicinity of cultivated fields during a part of the summer would unquestionably place *Apiomerus spissipes* among insects of economic insignificance."

The writer has made observations on this insect for two summers, and can add something to what has previously been recorded.

Habitat. The habitat of the adults is unquestionably the foliage and flowers of plants. The normal habitat of the nymphs may possibly be a different one. Morgan assumed that the nymphs lived in the same habitat as did the adults, and sought them there. He remarks that they were not abundant, and concluded that the mortality of the young must be very great. He says:

> "At no time during the year of 1905 could the young be found in any numbers. Although adults could be observed frequently in copulation in June and July at Gurley, later observations failed to disclose more than a few young."

Inasmuch as the writer has found several nymphs, in several different collecting localities in Kansas, on the ground under rocks, and inasmuch as he has never found them on foliage, it seems logical to suggest, at least, that Morgan may have been looking for the nymphs in the wrong place.

Food. The writer has had the same experience that Morgan records in finding that the adults will attack a large variety of insects.

Also, the results agree in showing that the assassin bugs prefer Coleoptera and Diptera. I found that weevils in particular were eaten readily by the adults and larger nymphs. The clover-leaf weevil, *Phytonomous posticus*, was especially favored, and house flies were easily caught and consumed. Other insects fed upon were grasshoppers, leaf hoppers, and stink bugs. The writer did not have the same difficulty in keeping the adults alive that Morgan had. The diet offered the bugs seemed to be perfectly satisfactory to them. The only field observation made on feeding was a case where an adult was taken in the act of feeding on a bee. The bug was on the head of a flower, and had taken his position there evidently for the purpose of intercepting the insects visiting the flower.

The nymphs have been fed on a wide variety of insects, including small beetles, such as tiny flea beetles and weevils, small Miridæ, both nymphs and adults, small leaf hoppers, and various other small insects swept from grassy and weedy fields. Later it was found that they would feed on house flies, and as these were more easily obtained they were then substituted. Some of the nymphs have been brought from the second to the fifth nymphal instar on a diet of house flies alone. The flies were caught with a net at a near-by stable and crushed slightly before being introduced.

Mating. Mating has been observed a number of times. The male mounts from behind and holds on by means of all legs and the beak placed at the juncture of the head and prothorax. The genital organs of the male are extruded, and he attempts to establish connection, first on one side, then on the other, eventually establishing connection. Several of the males were observed, after having become coupled, to let go with the beak and the first two pairs of legs, remaining attached only by the hind legs and the genital organs. The body of the male forms an angle with that of the female. The insects may remain coupled in this manner for several hours, and they may mate several times during their lives. Whether several matings are necessary for the fertilization of all of the eggs or not I cannot say.

Seasonal Life History. While Morgan does not draw any definite conclusions as to the details of the seasonal life history, yet he presents some material which is useful in determining the normal seasonal life history. He evidently found adults practically all summer, since he gives the incubation period for May, midsummer and fall. He mentions, however, that adults are found most commonly in the field during June and July. The writer has taken fifth-instar nymphs in the field in the spring of the year. These change to adults, and are found in this condition in June and July in Kansas, as Morgan reports for Texas. The eggs are now laid, and the rest of the summer is spent in the nymphal condition. Thus the insect normally has a single generation a year, and winters in the fourth or fifth nymphal instar. Reared insects have almost exactly this life history.

Length of Stages. I have carried this insect through the round of its life cycle, from fifth-instar nymph to fifth-instar nymph. In one case a fifth-instar nymph was collected from under a rock on April 20. This insect was confined in a cage with soil included and a rock under which to hide. It was fed June bugs and weevils, and changed to an adult on June 11. With this insect was placed a male which had been collected as an adult. The insects were put in the same cage on June 22, and were observed to mate the next day. On July 10 the female deposited an egg mass of 32 eggs on a rock in the cage, and on July 24 produced another egg mass of 25 eggs. The male died July 20, and the female August 7. On July 26, 16 days after having been laid, the eggs of the first mass produced hatched. Several of the nymphs were isolated for rearing purposes, some in small stender dishes, others in tin boxes with dirt in the bottom. Two individuals from that source are now alive in the laboratory (April 20), and their record of development is as follows:

1. July 10, egg laid; July 26, egg hatched; August 22, molted to second instar; September 2, molted to third instar; October 10, molted to fourth instar; March 2, molted to fifth instar.

2. July 10, egg laid; July 26, egg hatched; August 14, molted to second instar; September 9, molted to third instar; October 20, molted to fourth instar; March 5, molted to fifth instar.

These insects are at the present time (April 20) alive and healthy. They have been given the same treatment except that one has been kept in a tin box with soil in the bottom, while the other has been kept in a glass stender dish. Both have been fed house flies for the greater part of their lives, though they were fed some small flea beetles, leaf hoppers, etc., while first-instar nymphs.

Other records for the length of stages are as follows:

The first instar lasted from eight to sixteen days in five individuals, with an average of thirteen days for the five.

The second instar lasted from fourteen to twenty days in five individuals, with seventeen days as an average for the five.

The third instar lasted from fifteen to thirty-four days in five individuals, with twenty-one days as an average for the five.

Eggs. (Pl. XI, Figs. 1-3; Pl. XII, Fig. 7.) Mr. Morgan gives a very satisfactory description of the eggs, and describes them as being placed on the leaves of *Helianthus* sp. and *Ambrosia* sp. The writer has not been able to find the eggs in such situations, but has found them on rocks in the field. In two cases egg masses have been found. In one case the eggs were attached to the upper surface of a rock which was covered by a superimposed rock, and in another case they were attached to the under surface of a rock which was resting on the earth. In the laboratory the eggs were laid sometimes on bits of rock provided, and sometimes on the sides of the cage.

DESCRIPTION OF INSTARS.

Morgan has not described the immature stages of this insect, with the exception of the egg, so the writer includes here descriptions of the five nymphal instars.

First Instar. (Pl. XII, Fig. 1.) Length of body from 2 mm. in newly hatched individuals to 2.8 mm. in older individuals; length of front femur, .85 mm.; length of first antennal segment, .4 mm.

General color reddish; dorsum of head and thorax rather dark, abdomen banded with dark; plates which mark openings to dorsal stink glands on cephalic margins of abdominal segments four, five and six light; legs yellowish red, eyes more nearly purely red; under surface reddish.

Body rather stout; head a little less than twice as long as width across eyes, somewhat narrower at base, eyes very prominent, apex narrowly rounded; antennæ rather short, four-segmented, second segment shortest, fourth segment slightly swollen; white lines of epicraneal suture visible, lateral arms running caudad from eyes extended obliquely mesad, then turned transversely across head to meet; beak rather long, curved, three-segmented, second segment longer than first and third combined, third segment very short, pointed. Pronotum longer than mesonotum, this longer than metanotum; pronotum narrower cephalad than caudad with suggestion of lobes at cephalolateral angles; legs rather short, first and second pairs modified for grasping, the first pair to a greater degree than the second pair; front femur long, stout; tibia long, curved, stout, and covered with long, stiff, conspicuous bristles, evidently of use in grasping and holding prey; middle legs similar to front legs but noticeably shorter and tibiæ with fewer bristles; hind legs normal, nearly as long as front legs, both femur and tibia more slender than in first two pairs of legs; tarsi of all legs short, two-segmented, first segment very short and inconspicuous. Abdomen short, broad, rounded; plates marking openings of dorsal stink glands visible on median dorsal line along cephalic margins of segments four, five and six; plate on segment four larger than that on segment five, this larger than that on segment six.

Second Instar. (Pl. XII, Fig. 2.) Length of body, 3.8 mm.; length of front femur, 1.19 mm.; length of first antennal segment, .51 mm.

General color much darker than in preceding; reddish tinge still present though obscured by fuscous markings; head and antennæ fuscous with exception of red eyes and white epicraneal suture; top of thorax fuscous with median light line; femora fuscous with reddish tinge; tibiæ lighter reddish with exception of apex of front tibia, which is fuscous; abdomen somewhat mottled.

Of same general shape and structure as preceding instar; dorsal surface of abdomen with many papillæ, each terminating in a hair or bristle.

Third Instar. (Pl. XII, Fig. 3.) Length of body, 5 mm.; length of front femur, 1.63 mm.; length of first antennal segment, .74 mm.

Reddish tinge nearly absent in this instar; replaced by a mottled fuscous and dirty white; head mostly fuscous with very little whitish; eyes with very faint reddish tinge, epicraneal suture light; thorax as in preceding; legs entirely fuscous; abdomen mottled, dorsum of segments five and six darker than the rest, anterior dorsal stink gland opening whitish, posterior two openings reddish.

Similar in structure to preceding; lateral arms of epicraneal suture now extended straight back from eyes, instead of obliquely; fore tibiæ densely hairy, much more so than in preceding instars; wing pads present on caudolateral margins of meso- and metanota, barely discernible in this instar.

Fourth Instar. (Pl. XII, Fig. 4.) Length of body, 7.7 mm.; length of front femur, 2.72 mm.; length of first antennal segment, .99 mm.

General color fuscous, abdomen slightly lighter in color than head and thorax; antennæ and legs fuscous.

Front and middle tibiæ with increased number of hairs; wing pads now increased in size and extended over one-half the length of the second abdominal segment; body more hairy.

Fifth Instar. (Pl. XII, Fig. 5.) Length of body, 11.3 mm.; length of front femur, 3.4 mm.; length of first antennal segment, 1.19 mm.

General color dark with reddish markings; head darker at base, lighter at apex; eyes light in color, antennæ rather light; prothorax dark with reddish median line and lateral margins; wing pads reddish basally and fuscous apically; legs black with exception of coxæ, trochanters and bases of tibiæ, which are marked with reddish; abdomen mottled with fuscous, reddish, and whitish, lateral margin reddish interrupted with black dots; terminal segments solid black; ventral surface fuscous and reddish with black terminal segments.

Body very stout and short; head rather short, narrowed at base, rounded at apex, eyes conspicuous, antennæ short, four-segmented, second segment shortest, beak rather long and straight, three-segmented, second segment longest, third segment very short and sharply pointed. Prothorax subquadrate, narrower cephalad and wider caudad; prosternum with ridged groove between fore coxæ into which tip of beak fits; wing pads larger, extended over cephalic margin of fourth abdominal segment; legs rather short, front and middle legs raptorial, hind legs normal; front femur long and stout, covered on all sides with a thick set brush of stiff, long bristles, of assistance in catching and holding prey; middle legs similar to front legs with femur and tibia shorter and a little more slender, bristles on tibia less conspicuous; hind legs nearly as long as front legs, more slender than either front or middle legs; tarsi of all legs short, two-segmented, first segment very short and inconspicuous. Abdomen very short, broad, rounded, covered with sparse hairs; plates marking openings to dorsal stink glands visible on anterior margins of segments four, five and six.

Localities. Colorado, Arizona, Texas, Kansas, Arkansas, Mexico, Florida.

Apiomerus flaviventris Herrich-Schaeffer.

Herrich-Schaeffer, Wanz. Ins., VIII:77, fig. 847; 1853.

"Black, grey-villous, thorax with anterior margin and a median fascia, the hemelytra and coxæ dark purple; remainder of margin of thorax, scutellum and apical portion of hemelytra, six spots on pectus yellow, the incisures of abdomen narrowly black.

"Very gaily colored, grey-gold, hairy; the fore margin and hind half of the thorax, the inner and outer margins of the wing covers, and also the coxæ turbid red; side and hind margins of the thorax, border of the rounded scutellum, hind margin of the wing covers, six spots on the breast and the belly yolk yellow, the incisures of the latter narrowly black."

Champion gives the following descriptive notes on this species:

"The pronotum is rufous, and usually has one or two transverse black fasciæ, the base being broadly flavous; the apex of the scutellum and the lower part of the propleura are broadly flavous; the corium is rufous, with the apical margin flavous; the connexival segments are flavous, banded with black; the venter (the genital segments excepted) is flavous, with some spots at the sides and the sutures very narrowly black; the legs are rufous, banded with black, there being usually a conspicuous rufous ring near the apices of the intermediate and hind femora; the head, membrane (when closed), and antennæ are black. The males have the apex of the terminal genital segment somewhat broadly produced in the center, and armed on each side with a stout, horizontal, laterally extended, hooked spine; the claspers are long and stout, and strongly curved. The females have the outer apical angles of the first genital (terminal dorsal) segment deflexed at the sides, so as to form a triangular plate, and the last segment large and trapezoidal."

Localities. Florida, Colorado, New Mexico, Texas, Arizona, California, Mexico.

Apiomerus pictipes Herrich-Schaeffer.

Herrich-Schaeffer, Wanz. Ins. VIII:75, fig. 843; 1853.

"Brick-colored, head with antennæ, two bands on the prothorax, apex of the scutellum, the membrane, and marks on the legs black; thorax and posterior margin of scutellum, incisures of abdomen and six marks on the prothorax flavous.

"Very similar to *flaviventris,* smaller, less hairy, the abdomen brown, strongly hairy, with narrow black incisures, the femora with black elongate spots; the tibiæ red only at the base."

Champion gives the following additional notes on this species:

"Some of the Yucatan specimens are only separable from *A. flaviventris* by their slightly smaller size and the broader black bands across the ventral segments. The genital spines and claspers are similarly formed in the males of each species; the females, however, have the sides of the first genital segment more narrowly deflexed than in the corresponding sex of *A. flaviventris.* The large number of specimens received from Yucatan have the corium (except at the apex), and the pronotum more or less (except at the base), dark, and the ventral segments broadly banded with pale flavous. Most of the other Mexican examples, as well as those from Guatemala, etc., resemble Herrich-Schaeffer's figure. The Panama specimens have the corium and the posterior lobe of the pronotum sordid ochreous. The ventral segments vary greatly in color, but in the darkest specimens there are traces at the sides of transverse yellow lines. The six males dissected show not the slightest variation in the form of the genital spines or claspers."

Localities: Colorado, New Mexico, Mexico, Guatemala, Nicaragua, Panama, Colombia.

SUBFAMILY HARPACTORINÆ.

This group was originally designated as the "Groupe Harpactorides," by Amyot and Serville (1843). The members of the subfamily possess the following characteristics: Ocelli present, rather close together, placed on a tubercle on the posterior part of the head; anterior coxæ short; front wings with a quadrangular or discoidal aërole at the proximal angle of the membrane, the latter extending farther proximad than the costal aërole of the membrane; neck somewhat constricted or elongated behind the eyes; anterior and middle legs without spongy fossa; tarsal claws compressed, with tooth at base.

WORLD DISTRIBUTION OF SUBFAMILY.

This is the largest subfamily of the family Reduviidæ, and is composed of over one thousand described species. The subfamily is well represented in all of the faunal realms. The distribution of the subfamily by numbers of species is as follows: Nearctic, 44 species; Neotropical, 269 species; Palæarctic, 90 species; Ethiopian, 301 species; Oriental, 299 species; Australian, 155 species.

HABITS OF SUBFAMILY.

The members of this subfamily seem to live for the most part on plant structures. They may be found on leaves, twigs and trunks of trees, in grass, and on flowers, in which places they attack the numerous plant-feeding insects which frequent such places. A number of the species are well known; among these are *Zelus exsanguis* (Stal), *Arilus cristatus* (Linnæus), and *Sinea diadema* (Fabricius). Several of them have been reported as definitely beneficial insects, because of their predacious habits.

CLASSIFICATION OF SUBFAMILY.

The genera of this subfamily represented by species found in North America north of Mexico may be separated by the following key:

KEY TO GENERA OF SUBFAMILY HARPACTORINÆ.

1. Sides of mesosternum without a tubercle or fold in front.............. 2
   Sides of mesosternum with a tubercle or fold in front at the hind angles of the prosternum 10
2. Fore femora as long or longer than hind femora; segment one of beak scarcely, or not at all longer than one-half the length of the second segment ....*Zelus* Fabricius, p. 168
   Fore femora shorter than hind femora, though sometimes very little shorter; first segment of beak much longer than one-half the length of the second 3

3. First segment of beak shorter than second segment 4
   First segment of beak as long as or longer than second segment 5
4. Scutellum short, broad, with obtuse apex, and without somewhat foliaceous apical lobe .... *Rhynocoris* Hahn, p. 182
   Scutellum longer, with somewhat foliaceous apical lobe, *Pselliopus* Bergroth, p. 185
5. Lateral angles of pronotum obtuse, not spinose ...... *Fitchia* Stal, p. 199
   Lateral angles of pronotum spinose or tuberculate 6
6. Apex of femur bispinose .... *Doldina* Stal, p. 202
   Apex of femur without spines, or with two very short ones 7
7. Pronotum armed with spines on the disk 8
   Pronotum unarmed on the disk 9
8. Juga when prominent obtuse at apex; eyes full width of head; fore femora not incrassate; pronotum with four spines on posterior lobe, *Repipta* Stal, p. 197
   Juga distinctly prominent at apex and often acute or subacute; fore femora distinctly incrassate; hemelytra usually not reaching apex of abdomen .... *Rocconota* Stal, p. 200
9. Apical angles of penultimate segment of abdomen armed with a prominent spine; antennæ about three-fourths as long as the body; fifth and sixth segments of abdomen not greatly dilated, *Atrachelus* Amyot and Serville, p. 202
   Apical angles of penultimate segment of abdomen unarmed; femora thickened, body rather stout; segment one of antennæ shorter than head and pronotum together .... *Castolus* Stal, p. 196
10. Fore femora thickened, spinose, densely granulated 11
    Fore femora unarmed, rarely a little thickened, a little granulated 12
11. Fore tibiæ with three pairs of ventral spines, *Sinea* Amyot and Serville, p. 216
    Fore tibiæ unarmed .... *Acholla* Stal, p. 211
12. Pronotum produced caudad over scutellum with a high mesal tuberculate ridge .... *Arilus* Burmeister, p. 205
    Caudal lobe of pronotum six sided, not elevated nor produced caudad, *Heza* Amyot and Serville, p. 204

Genus ZELUS.

This genus was orginally described by Fabricius (1803) as follows:

"Rostrum short and arched. Antennæ 'secaseæ,' inserted at the apex of the head at the base of the beak.

"Body elongate, filiform, frequently bordered with spines, agile, head elongate, exserted, narrowed posteriorly: with two vertical spines, elevated, eyes large, globose, prominent, inserted on median margin, antennæ longer than the body; segments elongate, apex of head inserted, thorax elevated, gibbous, anterior lobe small, distinct, scutellum triangular, acute, elytra incumbent, the length of the abdomen, almost entirely membranous, abdomen extended, slender; margin of abdomen slightly elevated, acute, all legs very long and slender, cylindrical."

Stal (1872) characterizes the genus as follows:

"Legs long or rather long, anterior femora equal in length to posterior, or longer than them; first segment of beak much shorter than second, anteocular part of the head shorter or subequal in length to the latter; first segment of antennæ equal in length or longer than head and thorax together. Apex of abdomen not enlarged."

WORLD DISTRIBUTION OF GENUS.

This genus is entirely American, and contains about sixty described species. Ten species have been recorded for the Nearctic realm, and fifty-five for the Neotropical, several being found in both realms.

CLASSIFICATION OF GENUS.

The species of this genus to be found in North America north of Mexico may be separated by the following key:

1. Lateral angles and disk of pronotum unarmed.......................... 2
   Lateral angles, or both disk and lateral angles of pronotum armed with teeth or spines 4
2. Upper surface of body marked with black, legs and antennæ black; head with two longitudinal black stripes on the postocular portion. *bilobus* Say, p. 169
   Entire body, antennæ, rostrum and legs, pallid....................... 3
3. Legs speckled or annulate with black..........*pictipes* Champion, p. 170
   Legs entirely pale...............................*cervicalis* Stal, p. 171
4. Lateral angles of pronotum armed with a spine or tooth; disk unarmed, 5
   Lateral angles of pronotum armed with a spine, the disk with two spines 7
5. Pronotum sulcate down the center, from apex to middle of posterior lobe ....*renardii* Kolenati, p. 178
   Pronotum with anterior lobe only sulcate........................... 6
6. Lateral angles of pronotum armed with a rather stout acute spine, the posterior lobe rugulose.......................*exsanguis* (Stal), p. 171
   Lateral angles of pronotum armed with a short tooth; posterior lobe almost smooth ....*lævicollis* Champion, p. 177
7. First and third segments of antennæ subequal in length, *occiduus* Bueno, p. 181
   First segment of antennæ distinctly, though slightly longer than third... 8
8. Both lobes of pronotum concolorous..........*angustatus* Hussey, p. 182
   Front lobe of pronotum piceous; hind lobe paler...................... 9
9. Brownish yellow in color...........................*audax* Banks, p. 181
   Darker in color, fuscofulvous or fulvotestaceous......*socius* Uhler, p. 179

Zelus bilobus Say.

Say, Insects La.:12; 1832. Compl. Wr., I:306.

"Yellowish; thoracic spot, feet and base and tip of hemelytra black.

"Inhabits Georgia and Louisiana.

"Body yellowish, more or less tinged with fulvous; elongated; head elongated; immaculate; antennæ —; rostrum piceous on the second and third joints; thorax bilobate; anterior lobe convex, with a longitudinal impressed line; posterior portion with a black disk; hemelytra black, with a yellowish band on the tip of the corium, and humerous yellowish; feet black, long; postpectus with a blackish spot over the intermediate feet; coxæ and trochanters yellowish.

"Length over seven-tenths of an inch.

"This insect was sent me by Oemler, of Savannah, and by Mr. Barabino, of Louisiana.

"It is a little like *taurus* Fabr., but is much larger and unarmed."

Biology. Blatchley reports taking this insect by beating herbs and shrubs along roadsides and in open pine woods; and from beneath loose bark of dead oaks.

Localities. North Carolina, South Carolina, Georgia, Florida, Louisiana, Texas.

Zelus pictipes Champion.

Champion, Biol. Cent. Am., Heter., II:255, pl. 15, fig. 14; 1899.

"Elongate, narrow, slender, dull, clothed with fine pallid pubescence and scattered erect hairs; stramineous, the head more or less blackish above, with a pale stripe on each side anteriorly and a pale median line posteriorly; the anterior lobe of the pronotum nigro-fuscous or black, with six small pale spots (four in a transverse row behind and two on the disk in front of these), the posterior lobe fusco-testaceous, with the sides and basal margin pale; the scutellum and elytra fuscous or fusco-testaceous, the nervures and outer margins of the corium stramineous; the dorsal surface of the abdomen, the connexival margins excepted, infuscate or sanguineous; the femora and tibiæ speckled or annulated throughout with black; the antennæ with joints 1 and 2 fuscous and the rest testaceous, sometimes entirely testaceous. Head about as long as pronotum, very gradually narrowing behind the eyes, the postocular portion longer than the anteocular portion; antennæ very slender, as long as the body, joint 1 longer than the head and pronotum united. Pronotum longer than broad, depressed along the middle, the anterior lobe with a median sulcus, the hind angles tumid and rounded, the base feebly emarginate in the center and with a narrow reflexed margin, the anterior angles tuberculiform. Elytra reaching beyond the apex of the abdomen, the latter narrow. Legs long and slender, sparsely pilose, the anterior femora as long as the hind femora.

"♂ Third antennal joint thickened to beyond the middle, and the terminal genital segment armed at the apex with a long, upwardly curved, hooked spine.

"Length, 11-13 mm.; breadth, 2-2½ mm. (♂ ♀).

"This insect is closely allied to *Z. cervicalis* Stal, but it has the legs annulated with black (as in the species of the genus *Milyas*), the legs less elongate, etc. The second joint of the rostrum is elongate. The head is very little narrowed towards the base, with the postocular portion longer than usual. The six small spots on the anterior lobe of the pronotum are glabrous and well defined."

Biology. Champion gives a brief note concerning the nymph of this species. He says: "The larva has a long black spine at the sides of each abdominal segment."

Localities. Arizona, Mexico, Guatemala.

Zelus cervicalis Stal.

Stal, Enum. Hemip., II:90; 1872.

"Narrow, pale testaceous, scarcely pilose, thorax, scutellum and hemelytra infuscated, lateral margin of thorax and hemelytra pale; dorsum of abdomen tinged with sanguineous; lateral lines on the anteocular part of the head between the antennæ and leading to the eyes, the postocular part above, also lateral ventral spots, two or three on single segments black; a longitudinal line running through the middle and lateral anterior lines of the postocular black part of the head testaceo-flavescent. ♂. ♀. Length, 10-14 mm.; width 1¾-2 mm.

"Head, when viewed from the side, of uniform thickness, postocular part viewed from above gradually more slender behind, longer than anteocular portion. Antennæ with first segment subequal in length to head and thorax together. Tubercles at apical angles of thorax very distinct. Legs slender, anterior femora lightly thickened, equal in length to the posterior."

Biology. Occurs on weeds and tall grasses (Blatchley).

Localities. Southern United States from Virginia south and west to California, including Texas and Arizona; Mexico.

Zelus exsanguis (Stal).

(Pl. XIII.)

Stal, Stet. Ent. Zeit., XXIII:452; 1862. *Diplodus exsanguis.*

"Pale subsordid stramineous; narrow vitta on neck region of head on either side behind the eyes fuscescent, frequently obsolete; antennæ black, first segment, apex excepted, second segment from the base to well beyond the middle and also the third segment at the base flavo-testaceous; hemelytra sometimes very obsoletely infuscate, veins pale; veins of the membrane and of the corium beyond the middle infuscate. ♂. ♀. Length, 15½ mm.; width, 3 mm."

The following description of *Zelus luridus* Stal, later considered as synonymous with *exsanguis*, is given by the same author.

"Similar to *Zelus exsanguis*, thorax narrower; sordid stramineous; lateral angles of posterior lobe of prothorax subinfuscate, armed with a moderately long black spine, posterior angles rounded; clavus and membrane at base lightly infuscate; basal segment of antenna equal in length to, or longer than the head and thorax together. ♂. ♀. Length, 16-17 mm.; width, 3 mm. Carolina."

Biology. There are various references to the biology of this insect under varying combinations of the generic names *Zelus*, *Diplodus* and *Darbanus* with the specific names *exsanguis*, *luridus*, *georgiæ* and *palliatus*.

Uhler, in his "Notices of the Hemiptera Heteroptera in the Collection of the Late T. W. Harris, M. D.," comments as follows upon the species:

"The description given by Stal applies to the faded female. When alive the insect is apple green with bright-red eyes. The male is almost black on the hemelytra. Specimens of the first-named sex become more or less fuscescent after death, and such is the type described by Stal. I regret that before meeting with the above description I had sent specimens to various correspondents in this country and Europe, labeled *Evagoras viridis* Uhler. The latter name is the one that I had given it in my MS., and of course it must fall before the published one of Doctor Stal.

"In the collection is a cluster of the eggs, arranged in a single tier, forming a globular pellet, from which a larva has partly emerged. The species ranges from Canada to Florida, and west to Texas, and is perhaps represented in California by a variety."

Van Duzee (1894) in his "List of the Hemiptera of Buffalo and Vicinity," gives the following brief note on this insect under the name *Diplodus luridus:* "Not uncommon on small trees in May and June. They reach maturity about June 1."

A. H. Kirkland studied this insect in connection with his work on the predacious enemies of the gipsy moth (1896). He described the eggs more fully than did Uhler in the above description, and gave other notes and descriptions. His description of the egg is quoted. (Pl. XI, Figs. 4-6; Pl. XIII, Fig. 7:)

"Length, 1.9 mm.; width at base, .4 mm.; at top, .3 mm.; somewhat curved, widest and rounded at base, truncate at the top. The eggs forming the outer layer are of a burnt sienna color, those on the inside being of a pale amber. The upper end of the eggs is of a pale-yellowish color, and bears immediately within the circumference a narrow, circular, dark-brown band, while at the center there is a small dark-brown dot. The areas covered by the circle and dot are depressed."

Mr. Kirkland also describes the adult male and female insects, and the first, second and last nymphal instars.

Heidemann (1911), in his work on the eggs of the Heteroptera, gives a brief description of the egg:

"The sticky secretion the insect uses for protecting the eggs covers sometimes also the cap, leaving only in the center a small opening; chorial processes close together, club-shaped."

Bueno (1923) says of this species: "This is the common species (of the genus), which may be beaten from almost any hardwood tree."

Several others have referred briefly to the habits of this insect, but add nothing to what has been quoted above.

The writer has found this species to be very common in the wooded areas around Lawrence, Kan., and has made field observations, as well as conducted rearing experiments with it, and can add something to what has been published previously concerning this insect.

Habitat. This species is apparently a shade lover, living on the leaves of trees and woodland shrubbery for the most part. Its normal place of resting or feeding is on a tree leaf, where its green color, common to both nymphs and adults, makes it inconspicuous. There seems to be no preference in species of tree inhabited. Bueno says "hardwood" trees. The writer has found it most commonly on hickory, pawpaw and basswood, though not confined to these by any means.

Food. This species unquestionably feeds on small insects, probably of a number of kinds. Kirkland (1896) reported it as an enemy of the gypsy moth caterpillars. It was found in one instance on basswood trees very thickly infested with Tingidæ, which served in that instance as its food. In the laboratory it feeds very readily on any small insects offered it, such as house flies, small leaf hoppers, Miridæ, etc.

Seasonal Life History. This insect spends the winter as a nymph, curled up in a leaf on the ground in some protected place. Both fourth- and fifth-instar nymphs have been collected in such situations during the winter. A careful search in the leaves at the base of a large tree, or in a depression in the ground, will reveal their presence a good many times. The writer has taken as many as thirteen curled up in one sycamore leaf. With the coming of warm weather they leave this retreat and are then to be found upon the new leaves of the bushes and trees. Van Duzee reports that they become adult about June 1 in the vicinity of Buffalo, N. Y. This is true for Kansas, also, although some adults have been found as early as the middle of May. Oviposition may begin in the middle of June and may last well into August. One field observation on record notes the fact that a number of egg masses were taken in the field on June 21, and that a female was observed in the act of oviposition on that date. After a short egg stage the nymphs appear and require the rest of the summer to become the hibernating fourth- or fifth-instar individuals. There is but a single generation a year.

Mating. Mating has been observed and is similar to the process in the other species of the family. In this case the beak again seems to be very important, and is applied at the juncture of the head with the prothorax to give an additional purchase. The exact length of time occupied was not determined, though it was over an hour in some cases.

Oviposition. Oviposition was observed in one instance when a female in the field was observed to finish the deposition of an egg mass upon which she had evidently been working for some time. As has been mentioned, the eggs are cylindrical, laid in a compact mass with each egg resting upon its broadened base, and covered by a large amount of a sticky material which holds it in place and protects it. In the operation of depositing an egg, the female took great care to first cover the sides of the eggs against which the unlaid egg was to lie, and the portion of the leaf on which the base was to rest, with a cementlike material which comes from certain glands at the tip of the abdomen. The abdomen was moved up and down continually, smearing the surfaces mentioned thoroughly. Finally the egg appeared, base first, and was placed in position easily. The preparation for the egg took much longer than the actual deposition. The entire act took from two to three minutes for each egg, in several cases where it was timed. At this rate of speed it would take a female an hour and a half to deposit an egg mass of forty eggs, which is not an unusual number.

It was attempted, by laboratory rearing, to determine how many egg masses and how many individual eggs a single female would lay during her life. The most prolific female gave the following results. This female was paired with a male on May 24, caged, and fed regularly on house flies. Her egg masses appeared as follows: June 11, 45 eggs; June 18, 45 eggs; June 22, 35 eggs; June 27, 45 eggs; July 1, 45 eggs; July 6, 38 eggs; July 12, 42 eggs; July 20, 34 eggs; July 27, 36 eggs; August 8, 40 eggs; August 12, 39 eggs; dead. This female, then, produced eggs over a period of two months from June 11 to August 12. During the two months she deposited eleven egg masses, and a total of 444 eggs. The periods of time between the appearance of egg masses varied from four to nine days, and averaged six days.

Habits of Nymphs. The nymphs, and adults also, have the peculiar habit of, when disturbed, raising the head and the apex of the abdomen, folding the legs and antennæ, and then letting go their hold and rolling to the ground if possible. In movement they are sluggish, apparently waiting for their prey to come to them rather than seeking it by running around over the foliage. The adults are capable of flight, and may be seen in flight occasionally on the warmer days. However, their wings do not seem to be essential to their life. No records of their having been taken at lights are available.

Length of Stages. The writer has not carried this insect through the complete course of its life history in the laboratory. The individuals hatching from the eggs have, however, been carried through several of their molts, and the length of the early stages can be given.

The egg stage lasted from ten to thirteen days.

The first instar lasted ten and eleven days in four individuals reared. It is quite likely that it may take much longer in the field under unfavorable conditions.

The second instar varied from nine to twenty-one days in the four individuals reared, this probably being the normal range.

The third instar lasted from twenty-four to thirty-seven days, and the only insect reared through the fourth instar required twenty-one days. This last-mentioned insect, at least, was ready for hibernation at that time.

DESCRIPTION OF INSTARS.

The eggs are described in the quotations given above. The five nymphal instars have been described by the writer, and these descriptions are included here:

First Instar. (Pl. XIII, Fig. 1.) Length of body from 2.4 mm. in newly hatched individuals to 3.8 mm. in older individuals; length of front femur, 1.7 mm.; length of first antennal segment, 2.1 mm.

General color whitish when first hatched, greenish white later. Head light, eyes red, antennæ light banded with dark, first and second segments light banded with dark, third segment mostly light, fourth segment almost entirely light; lateral margins of pro-, meso- and metanota dark; legs light, banded and spotted with dark; abdomen light, three terminal segments each with a pair of dark dots on dorsal surface; lower surface of body entirely light.

Body long and slender; head elongate, constricted at juncture with prothorax to form a neck, from which point it swells to a wide region caudad of eyes, somewhat narrower before eyes, sides parallel to antenniferous tubercles, then tapers to rounded apex; eyes rounded, prominent; antennæ very long, slender, filiform, four-segmented, first segment longest, fourth next in length, third next shortest and second segment the shortest. Pronotum longer than mesonotum, which in turn is longer than metanotum; legs very long, slender, front legs only very slightly thickened, femora longer than those of other legs, front tibiæ long and slender and covered with fine, long, sticky hairs which other tibiæ do not have; middle legs shortest; hind legs nearly as long as fore legs. Tarsi of all legs very short, two-segmented, first segment very short and inconspicuous. Abdomen elongate, slightly swollen, tapering and rather pointed at caudal end; openings to dorsal stink glands not visible in this instar.

Second Instar. (Pl. XIII, Fig. 2.) Length of body from 4.8 mm. to 5.8 mm.; length of front femur, 2.3 mm.; length of first antennal segment, 2.5 mm.

General color greenish, head margined with fuscous, eyes red, antennæ as in preceding instar with dark markings less distinct. Thorax and legs as in preceding instar; abdomen greenish, fuscous dots on terminal segments missing, tinged with reddish on dorsal surface near caudal end.

Shape and structure similar to preceding; pronotum narrowed cephalad, with lobes at cephalolateral angles, and widened caudad; openings to dorsal stink glands on anterior margins of abdominal segments four, five and six now faintly visible.

Third Instar. (Pl. XIII, Fig. 3.) Length of body, 8.2 mm.; length of front femur, 3.2 mm.; length of first antennal segment, 3.4 mm.

Color much as in preceding; darker margins of pro-, meso- and metanota now less conspicuous, reddish coloring on upper surface of abdomen more conspicuous; dark markings of antennæ and legs much less conspicuous.

Wing pads appear in this instar, arising from the caudal margins of meso- and metanota, very small in this instar; those of metathorax extended but a short distance over first abdominal segment. Abdomen slightly swollen, tapered caudad.

Fourth Instar. (Pl. XIII, Fig. 4.) Length of body, 9.1 mm. to 9.6 mm.; length of front femur, 4.1 mm.; length of first antennal segment, 3.8 mm.

General color greenish as in preceding instars; fuscous markings of legs and antennæ, as well as darkened margins of thoracic segments, now absent.

Wing pads increased in size, partially overlapped, those of the mesothorax covering about the basal half of those of the metathorax, extended over greater length of first abdominal segment; metathoracic pads slightly larger than mesothoracic pads; both rather elongate, slender, pointed at apex.

Fifth Instar. (Pl. XIII, Fig. 5.) Length of body, 12.5 mm.; length of front femur, 4.8 mm.; length of first antennal segment, 4.4 mm.

General color greenish marked with red and yellow. Head green to greenish yellow, eyes red, antennæ greenish, beak greenish, slightly darkened at apex. Prothorax greenish with indistinct, light, median line, wing pads greenish with traces of red and yellow; legs green excepting apices of tibæ and tarsi, which are brownish. Abdomen chiefly green with a median yellow line running down dorsum, and median, red, transverse vittæ on dorsum at juncture of segments; lateral margins tinged with red.

Body elongate; head elongate, slightly narrowed at juncture with prothorax, from which point it widens to eyes, cephalad of eyes the sides are parallel to point of attachment of antennæ, cephalad of this point head tapers to rather rounded apex; eyes conspicuous, rounded; epicraneal suture runs between eyes; antennæ very long, slender, filiform, four-segmented, first segment longest, third segment next in length, second and fourth segments shortest and subequal; beak rather long, slender, three-segmented, second segment longest, third segment short, tapering, pointed. Prothorax subquadrate, narrowed cephalad, cephalolateral angles with rounded lobes, prosternum with ridged groove. Meso- and metathorax about equal in width to prothorax; wing pads conspicuous, overlapping, reaching well over base of third abdominal segment. Legs very long and slender, first and last pairs longer than second pair; first pair fitted for grasping, femora a little thickened, tibiæ covered with a large number of sticky, thickly-set hairs; other legs normal walking legs. Abdomen only slightly swollen, tapering to apex; openings to dorsal stink glands visible, though rather inconspicuous, along cephalic margins of abdominal segments four, five and six.

Localities. Probably universally distributed over the greater part of the United States and southern Canada. Reported also from Mexico and Guatemala; Kansas.

Zelus lævicollis Champion.

Champion, Biol. Centr. Am., Heter. II:260, pl. 15, fig. 24; 1899.

"Elongate, narrow, moderately robust, shining, sparsely pubescent, stramineous; the head with the postocular portion black above, a line on each side extending from the eyes to the ocelli, and also one down the middle, stramineous, the anterior portion mottled with brownish; the pronotum dilute fuscous, with the lateral and basal margins, and two transverse rows of small spots on the anterior lobe, stramineous; the elytra fuscous, with the costal and median nervures of the corium, as well as the portion of the latter adjoining the base of the membrane, stramineous, the membrane smoky (antennæ broken off). Head elongate, gradually narrowing behind the eyes, the basal portion stout and cylindrical. Pronotum a little longer than the head; the anterior angles armed with a short stout tooth, the lateral angles with a very short tooth; the anterior lobe sulcate down the middle, with sinuous lines of pubescence between the smooth bare spots; the posterior lobe flattened on the disk and with indications of two anteriorly converging carinæ in front, apparently smooth, but with a close minute punctation showing through from beneath. Scutellum blunt and thickened at the apex. Legs sparsely pilose, moderately elongate; the anterior femora as long as, but much stouter than the hind femora; the hind tibiæ simple.

"Length, 13½ mm.; breadth of pronotum, 2⅘ mm.

"One example. This species is nearest allied to *Z. exsanguis*, var. ***luridus*** Stal., but it differs from it in having the posterior lobe of the pronotum almost smooth, with the lateral angles armed with a very short tooth, and the legs less elongate. From *Z. janus* (♀), which it resembles in arrangement of the pubescence on the anterior lobe of the pronotum, it may be separated by the simpler posterior tibiæ, the much smaller size, narrower shape, etc."

Localities. Texas, Mexico, Kansas.

Zelus renardii Kolenati.

Kolenati, Melet. Ent., VI:42, pl. 3, fig. 2; 1857.

"Reddish or livid, setose, antennæ with segment one sanguineous, legs setose, femora at the apex and tibiæ at the base intense sanguineous, rest of femur yellowish, tibiæ reddish, apex of tarsi fuscous, anterior part of prothorax quadrituberculate and bispinose, posterior part rough, head on either side widely marked with black, hemelytra roughened, membrane rugose, at the apex of the hemelytra the color is brick red or somewhat reddish, abdomen entirely pale yellow.

"Length, 5½ lin. Width of anterior part of thorax, ⅔, of posterior part of thorax 1⅗ lin. Width of anterior portion of abdomen 1¼, of posterior portion 1⅔ lin.

"Habitat in California."

Biology. The writer has several references to brief accounts of the habits of this insect.

Morrill recorded this species as an enemy of the conchuela, *Pentatoma ligata* Say (1910), and found it to be the only predacious hemipteron which would attack this insect. He says:

"This reduviid is common in the cotton fields in both Texas and Mexico, and the nymphs not only voraciously attack one another, but any other insect that crosses their path. Nymphs of the reduviid readily attack nymphs of the conchuela, and one specimen of the former was reared to maturity with its diet limited to nymphs of the Pentatomidæ. Many other specimens of Reduviidæ are commonly found in the cotton fields and doubtless may be relied upon to destroy a small percentage of the nymphs of the injurious Pentatomidæ."

Another worker, Horton (1918*a*), has reported that the young nymphs of this species are very common on orange trees in California and have been observed to feed on the larvæ of the citrus thrips. However, only the first- and second-instar nymphs are valuable in this work. Horton (1918*b*) also records this species as one of the natural enemies of the citrus mealy bug.

Localities. California, Texas, Mexico, Kansas.

Zelus socius Uhler.

(Pl. XIV. Figs. 1, 2, 5.)

Uhler, Hayden's Surv. Terr., Rept. for 1871:420. 1872.

"Pale fusco-fulvous, or fulvotestaceous, sparsely and slenderly pubescent. Form and aspect of *Diplodus luridus* Stal. Upper side of head black; the upper cheeks, a slender line along the middle, a shorter one on the impressed line extending from the antennæ to the ocelli, a third broader line running from the middle of the eye posteriorly, and the under side of the head pale fulvous or testaceous; the tylus and a streak on the upper line of the lower cheeks blackish; the surface both above and below and the rostrum with minute, grayish pubescence; eyes brown; antennæ dull fulvous, fuscous on the upper side and at the base and tip of the first two joints; the second joint about one-third the length of the basal one; third much stouter than the second, fully twice as long as it, tapering toward the tip. Rostrum reaching to the anterior coxæ, testaceous at base, becoming darker until finally piceous at tip. Pronotum clothed with dense, minute, hoary pubescence; the anterior lobe blackish, with its lateral carina pale fulvous; posterior angles each with a moderately short, smooth subconical, piceous tooth, and the carinæ each side terminated behind with a similar tooth; pectus and coxæ shining black; the sides usually with a broad, irregular, fulvous stripe along the middle and posterior pleuræ. Legs yellow, very hairy; all the femora a little tumid near the tip, sprinkled with fuscous; tip of the tibiæ and whole of tarsi, including the nails, blackish piceous. Scutellum piceous, having a V-shaped elevation, which is rufous or yellow; the submargin broadly grooved; the margins and tip yellow. Hemelytra smoke-brown; the principal elevated nervures, the costal margin, and cuneus pale testaceous; membrane pale brown, paler at tip; the nervures dark brown. Tergum rufous, or rufo-flavous; the connexivum yellow, having blackish, subquadrate interruptions; the posterior segment margined behind with blackish; venter minutely scabrous, black, the middle line and sides broadly fulvous; its connexivum yellow, with a black, large spot at the apex of each segment.

"Length to tip of abdomen, 10-12 mm.; width across the humeri, 2-2½ mm.

"Brought from the region of the Snake river, Idaho. It inhabits, also, Kansas, Dakota and Arizona."

Biology. Practically nothing has been recorded on the biology of this species. The writer has had some limited experience in rearing the insect.

On July 8, 1925, I received from the University of Kansas biological survey field force several nymphs of this species, taken at Norton county, Kansas, on grass and other low-growing plants between two railroad embankments. Only one of the insects survived the trip, and this was caged and fed house flies. It fed freely, in the same manner as does *Zelus exsanguis,* and eight days later, July 16, became an adult, female sex. Inasmuch as no male was available I despaired of obtaining eggs from this individual. However, on August 4 an egg mass was produced, apparently normal for this species. The egg mass was different from that of *Z. exsanguis* in that it was elongate, with not more than three or four eggs placed side by side in a transverse row, instead of being a compact mass, four- or five-sided, as is the mass of *exsanguis.* (Pl. XIV, Fig. 5.) The individual eggs, however, were very similar to those of *exsanguis,* differing only in minor details. The amount of cement used to attach the eggs and to protect them was less in the case of *socius* than in *exsanguis.* On August 15 this insect died, and the eggs failed to hatch before winter, as was expected, since it was known that they were not fertilized. Several of the fifth-instar nymphs which were sent still were of good form, though dead, when they arrived, and a figure of one of these, accompanied by a description, is included here.

Fifth Instar. (Pl. XIV, Fig. 1.) Length of body, 11-12 mm.; length of front femur, 5 mm.; length of first antennal segment, 5 mm.

General color greenish with darker markings on head and thorax and fuscous markings on abdomen. Apices of wing pads darker than bases.

General shape very elongate with long slender legs and antennæ; head elongate, widest immediately behind eyes, slightly narrowed at junction with thorax, rather pointed at apex; eyes protrude but little from sides of head; antennæ elongate, first segment longest, third next in length, second and fourth short, subequal; rostrum long and slender, first and third segments short, subequal, second segment longer than first and third together. Prothorax narrowed cephalad, wider caudad; anterior angles evenly rounded. Wing pads long and slender, the mesothoracic pads overlie the metathoracic pads and both reach beyond the middle of the third abdominal segment. Legs long and slender; front and hind femora subequal in length, hind tibia exceeds fore tibia in length; middle femur and tibia shorter; front legs raptorial with femur slightly though distinctly enlarged, and both femur and tibia covered with numerous sticky hairs; tarsi of all legs small, the first segment extremely small; claws toothed at base. Abdomen slender, the posterior angles of the abdominal segments marked with fuscous; openings to dorsal stink glands present at anterior margins of segments four, five and six along median line; rather inconspicuous; guarded on either side by the small, dark, seta-bearing elevation.

Localities. Florida, Illinois, Kansas, Dakota, Colorado, Utah, New Mexico, Arizona, California, Idaho, Indiana, New Jersey, North Carolina.

Zelus audax Banks.

Banks, Ent. News, XXI:325; 1910.

"Brownish yellow; head with broad black stripe behind each eye, leaving a narrow, median, yellow line, also blackish in front and between eyes; anterior lobe of pronotum black each side and on the lateral margin, posterior part of the posterior lobe blackish; abdomen reddish above, black on sides at tips of segments. Venter pale, a black spot behind coxa I and also a smaller spot in front, a spot each side at base of each ventral segment, larger near the base of the abdomen; coxæ mostly dark; a broad band beyond middle, and one before tip of each femur; also two or three fainter bands on the tibiæ; second joint of antennæ with broad band near middle, and the tip dark, rest of antennæ mostly dark, sometimes pale at base of third joint. Head long and slender, ocelli more than two diameters apart, no tubercles over base of antennæ; anterior lobe of the pronotum with a deep median groove; posterior lobe with middle and lateral depressions, the ridges terminating behind in four large, subequal conical tubercles, the lateral ones at the humeri. Wings extend beyond tip of abdomen; body slender. Length, 12 mm.

"Related to *Zelus* (*Pindus*) *socius,* but not as dark, and legs differently marked.

"From Sea Cliff, N. Y., in cedar trees; also Falls Church, Va."

Localities. Ontario, Maine, New York, Virginia.

Zelus occiduus Bueno.

Bueno, Ent. News, XXIV:22; 1913.

"Belongs in the subgenus *Pindus* of Stal, which is characterized by the possession of four black spines on the thorax, two lateral, and two on the disk.

"Differs from *Zelus* (*Pindus*) *socius* Uhler in having the first and third joints of the antennæ subequal, the first a little over three times as long as the second, and the third somewhat less than the second. Proportion of antennal joints: 1st : 2d : 3d :: 50 : 16 : 44. Third joint in male scarcely stouter than second and of even diameter throughout; not tapering.

"Rostrum reaching to anterior coxæ; joint two five times as long as one and more than six times as long as three. Proportions: 1st joint : 2d joint : 3d joint :: 4 : 20 : 3.

"Hemelytra with the main corial vein whitish.

"Legs slender, femora thickened and slightly darker toward the distal end; femora of first pair of legs thickest and longest; of second pair thinnest and shortest; hind femora intermediate in thinness and length.

"Proportions: Anterior femora : middle : posterior : : 5.1 mm.-5.6 mm. : 3.6 mm.-4 mm. : 5 mm.-5.4 mm.

"Head, length : 2.6-2.5 mm.; prothorax, 2.4-2.1 mm.; scutellum, 1.2-1 mm.; abdomen, length from tip of scutel : 6.8-6.4 mm.; total length, 13-12 mm.; greatest breadth (abdomen) 2.6-2.4 mm.; length : breadth : : 5 : 1."

Locality. California.

Zelus angustatus Hussey.

Hussey, Journ. N. Y. Ent. Soc., XXXIII, p. 66; 1925.

The following description is that given by Blatchley:

"Elongate, subparallel. Brownish yellow, more or less tinged with fuscous, sparsely clothed above, thickly beneath, with white scalelike hairs; veins of corium and margins of connexivum dull yellow; head and outer half of corium fuscous brown; membrane whitish hyaline, feebly iridescent, the veins dull yellow; legs brownish yellow, thickly pilose. Antennal joints 1 and 2 and base of 3 brownish yellow, remainder paler; joint 1 nearly three times as long as head, two and one-half times as long as 2, 3 nearly twice the length of 2, 4 two-thirds as long as 3. Head about as long as pronotum, hind lobe freely and gradually narrowed from eyes to base, transverse interocular groove feebly impressed, median longitudinal carina very fine. Pronotum one-fourth longer than wide at base, hind lobe one-half longer than front one, its spines rather short and blunt. Length, 14 mm."

Locality. Florida.

Genus RHYNOCORIS.

This genus, originally described by Hahn, is described as follows by Amyot and Serville as *Harpactor:*

"Body large, rather compact. Head with a prolongation in the form of a blunt cone in front of the eyes and between the antennæ, with an ordinarily short neck. Eyes rather small and prominent, with a transverse furrow behind them. Ocelli placed on a gibbosity which follows the furrow, and are rather far apart. Antennæ rather long, with four segments, not counting a rudimentary basal segment which is distinct from the antenniferous tubercle which precedes it; first segment the longest; the second ordinarily the shortest; the fourth and the fifth (evidently should be third and fourth) sometimes of equal and sometimes of unequal length. Beak arched, slender, cylindrical, reaching the middle of the prosternum; second segment longer than the first; the third short. Prothorax trapezoidal, lightly inflated; its anterior swelling unequal and more or less large; scarcely a longitudinal furrow on the posterior half; posterior angles blunt; the posterior margin indented in the middle and sinuate. Scutellum rather small. Elytra as long as the abdomen, coriaceous part large; the membrane with the usual three large cells, with a peculiar twisting of the veins, and an almost metallic sheen to the tissue. Abdomen oval, margins narrow, a little elevated, boatlike, passing the elytra on each side. Legs rather short, all of about equal length; anterior femora ordinarily a little swollen."

WORLD DISTRIBUTION OF GENUS.

This genus, usually listed under its synonym, *Harpactor*, is composed of about ninety species so far described. Of these the Nearctic realm contains one species peculiar to it, and a second species typically Palæarctic. The other species of the genus are distributed as follows: Palæarctic, 31 species; Ethiopian, 45 species; Oriental, 16 species; Australian, 1 species.

Rhynocoris ventralis (Say).

Say, Heter. N. Harm., 31; 1832. Fitch Rep., 800. Comp. Wr., I:355. *Reduvius ventralis.*

"Brown black; posterior margin of the elytra, and abdomen sanguineous, the latter with lateral black spots and lateral vittæ beneath.

"Inhabits Missouri.

"Body brown black, somewhat hairy; thorax transversely impressed before the middle; anterior portion unequal; posterior portion margined each side and behind narrowly with sanguineous: hemelytra with a rufous corium; abdomen sanguineous, with large marginal quadrate black spots above and beneath and dilated lateral black ventral vittæ; coxæ sanguineous; not remarkably distinguished.

"Length about two-fifths of an inch.

"The feet are not remarkably dilated as in *crassipes* Fabr.; the species is also described to have 'elytra fusca basi parum rufa,' 'corpus nigrum pectore utrimque punctis, abdomine margine rubris,' 'pedes incrassati,' etc. I owe it to the kindness of Nuttall."

Several varieties of this species have been described. The first, *americanus*, was described by Bergroth as *Harpactor americanus*, as follows:

"Head hairy, a little shining, black, a spot between the ocelli, a lateral vitta running from the ocelli to the anterior angles of the eyes, anteocular part at least at the sides, and the throat red; anteocular and postocular part of the same length; rostrum red, piceous at apex, first joint hardly longer than the anteocular part of the head, second joint distinctly longer than the first; first joint of the antennæ as long as the head, blackish, broadly annulated with rufous in the middle, or sometimes entirely red except apex, second joint considerably shorter than the first, entirely fuscous or rufous with apex black (remaining joints wanting). Pronotum a little longer than the head, smooth, hairy, subnitid, anterior angles bluntly tuberculate, lateral angles rounded, scarcely tuberculate at the sides of the longitudinal furrow; color of pronotum black, the lateral angles, the postero-lateral margin and the basal margin of the hind lobe red, sometimes also a short red streak on the lateral margin of the fore lobe; in fresh specimens some narrow greyish sericeous bands on the disk of the fore lobe. Breast black, the middle of antepectus and the acetabula red, with the clavus sometimes blackish, membrane shining, more or less infuscated. Abdomen entirely red in the male, but in the female there is a quadrate black spot at the basal angles of the abdominal segments; spiracles seated very little before the middle of the segments. Legs red, femora, tibiæ and tarsi infuscated at apex, a subbasal ring to the tibiæ and sometimes a spot or ring on the middle of the femora fuscous.

"Length, 10-10.8 mm."

Bergroth adds a few interesting notes:

"This is the first American species of the genus *Harpactor,* as characterized by Stal in Enum, Hem. IV, p. 13, under the name *Reduvius.* It must be noted, however, that the Siberian *H. leucospilus* Stal is distributed to Sitka in the East. In Europe the genus is represented by several species. *H. americanus* is a northern, or mountain species, inhabiting Shasta county, and was communicated to us many years ago by its discoverer, Mr. James Behrens. I have in vain waited to see this conspicuous insect described in one of the numerous writings of Professor Uhler."

Van Duzee says of this variety: "Variety *americanus* Bergroth is very close to the typical *ventralis*, but has the red a little more extended." Van Duzee describes in addition two other varieties of this species:

Rhynocoris ventralis var. *femoralis* Van Duzee.

Van Duzee, Trans. San Diego Soc. Nat. Hist., II:13; 1914.

"This variety differs from the typical *ventralis* in being soiled with testaceous where that is red, although it may become fulvous on the legs and antennæ or even tinged with sanguineous. The antennæ are of an obscure testaceous; the legs are black with a quadrate spot on the lower surface of the femora, and the tibiæ, except at the base, pallid. The coriaceous portion of the corium is a clear testaceous.

"Described from three females taken on the dry granite hillsides at Lakeside in May and at Alpine in June."

Rhynocoris ventralis var. *annulipes* Van Duzee.

Van Duzee, Trans. San Diego Soc. Nat. Hist., II:13; 1914.

"Another variety from Felton, California, in my collection is very near *femoralis*, having the same testaceous color but in this the anterior lobe of the pronotum and the legs are soiled testaceous, the latter with a subapical annulus on the hind femora black. The single female specimen was taken by Dr. J. C. Bradley in the foothills of the Santa Cruz mountains in March, 1907. It may be called var. *annulipes*. The typical *ventralis* seems to be more common in Colorado and Utah, although I have one example taken at Pasadena, Cal., by Mr. Fordyce Grinnell in July."

Localities. Maine, Massachusets, Missouri, Nebraska, North Dakota, Saskatchewan, Colorado, Utah, California, Kansas, Indiana, Illinois.

Rhynocoris leucospilus (Stal).

Stal, Of. Vet. Akad. Forh., XVI:203; 1859. *Reduvius leucospilus.*

"Black, pilose, small spots on the posterior part of head above, and a vitta narrowed to the rear on the lower side, marginal triangular spots on abdomen, the breast around the coxæ, the disk of the mesosternum, the narrow border of the basal ventral segment yellowish white. ♂ ♀ Length, 12 mm.; width, 3 mm. Habitat, Siberia."

Distribution. Palæarctic, being typically a Siberian species, but reported from Sitka, Alaska, and hence included here.

Genus PSELLIOPUS Bergroth.

This genus is characterized by having the apex of the scutellum depressed, more or less distinctly foliaceous, sometimes strongly dilated; the lateral angles of the prothorax armed with a spine; the first segment of the beak distinctly longer than the anteocular part of the head.

BIOLOGY.

The members of this genus, so far as the writer's acquaintance with them is concerned, live on the foliage and stems of plants both as nymphs and adults, and also attach their eggs to such supports.

WORLD DISTRIBUTION.

This genus is entirely American in distribution. Of the fourteen species which are included in it, ten have been described from Central America. Of these, three species, and three other species peculiar to the region, have been recorded from the United States. A single additional species has been recorded from Brazil.

CLASSIFICATION.

The species of this genus which occur within our limits may be distinguished by the following key, recently arranged by Mr. H. G. Barber (1924):

KEY TO U. S. SPECIES OF PSELLIOPUS.

(Taken from H. G. Barber.)

1. Femora speckled and annulate with fuscous, tibiæ annulate throughout. Anterior lobe of pronotum furnished with rather long, acute spines; posterior lobe with scattered small, black tubercles; the two anterior pronotal spines rather slender, directed forward, *spinicollis* Champ, p. 193

   Femora only annulate with fuscous. Anterior and posterior lobes of pronotum either unarmed or provided with tubercles; the two anterior pronotal spines stout, directed obliquely forward 2

2 Anterior lobe of pronotum quite setose, furnished with 10-12 prominent rounded tubercles; posterior lobe with numerous small setose tubercles or granules. Tibiæ annulate toward base only. Connexival fascia widely expanded within.................... *latifasciatus* Barber, p. 195

   Anterior and posterior lobes of the pronotum smooth, unarmed......... 3

3. Process of the genital segment of the male sulcate or divided at apex. Head, anterior lobe of pronotum, pleuræ and venter strongly fasciate with fuscous; posterior lobe of pronotum commonly reddish; anterior median longitudinal sulcus extended past middle of posterior lobe as a shallow groove; posterior margin before scutellum very feebly sinuate, nearly straight; humeral tooth well developed...*zebra* Stal, p. 193

   Process of the genital segment of the male entire. Deep median, longitudinal groove of the anterior lobe of the pronotum, not at all or only very faintly indicated on the posterior lobe.................... 4

4. Lateral angles of the pronotum unarmed, either nodose or rounded; posterior margin before scutellum strongly bisinuate. Genital process stout, not much produced...................*inermis* Champion, p. 194

   Lateral angles of the pronotum provided with either a subacute black tubercle or a spine; posterior margin more feebly bisinuate........ 5

5. Lateral angles of pronotum provided with an obvious, subacute spine which projects beyond humeral angles. Anterior lobe of pronotum strongly trifasciate with black; posterior margin before scutellum quite evidently bisinuate. Genital process of male rather stout and blunt, not spinose ....*cinctus* Fabr., p. 186

   Lateral angles of pronotum provided with a short, stout, usually acute, black tubercle which does not project beyond the humeral angles. Anterior lobe of pronotum nonfasciate; posterior margin before scutellum quite or very nearly straight. Genital segment of male armed with a rather long, erect, spinose process..*barberi* Davis, p. 190

Pselliopus cinctus (Fabricius).

(Pl. XV.)

Fabricius, Genera Ins., 302; 1776. *Reduvius cinctus.*

Inasmuch as Fabricius' description does not distinguish between this species and the following it is not quoted here. The species may be identified positively by Barber's key to the species, and by Davis' comparison of *cinctus* and *barberi* which is quoted in reference to the following species.

Biology. There are several references to the habits of this insect to be found in our literature. Some of these may actually refer to *barberi,* because of the confusion of the two species until recently.

Uhler, in the Standard Natural History, gives the following account of the species:

"It is quite common, and may be taken singly or in pairs upon a great variety of bushes and trees, from early summer until late in autumn. The eggs are often glued to the bark of pine trees, covered by a waterproof gum, which effectually excludes the rain, dries and hardens, and does not incommode the young larvæ when they push up the lidlike ends to make their way out. Its color is a wax, or orange yellow in all stages of its existence, and it is made quite conspicuous by the black bands which cross its legs and antennæ."

The following quotation from Webster concerns the beneficial habits of this insect as a natural enemy of the chinch bug:

"Perhaps the worst insect enemies of the chinch bug are to be found among its comparatively near relatives—the insidious flower bug (*Triphleps insidiosus* Say), and *Milyas cinctus* Fabr., the latter being reported by Thomas as the most efficient insect enemy of the pest, while Riley found that the former also attacked it."

Chittenden reports this insect as one of the natural enemies of the Colorado potato beetle, *Leptinotarsa decimlineata*, and Hungerford found that one species of this genus, probably *cinctus* or *barberi*, was the natural enemy of *Sciara* adults.

McAtee reports the finding of sixty specimens of this species in winter quarters together under the bark of a tulip tree.

The writer has attempted to sum up what has been found out concerning this species and to add from his own observations.

Habitat. During the warm months this species is to be found on the leaves and stems of plants, for the most part forest plants, as far as the writer's observations are concerned, although since the species is reported as a natural enemy of the chinch bug and Colorado potato beetle, it must occur in open fields also.

Food. The above quotations will give some idea of the food of the species. In general it may be said to feed on any small insects available to it. It has fed in the laboratory on house flies, leaf hoppers, Miridæ nymphs and adults, and small caterpillars, and will undoubtedly accept other insects.

Feeding habits. This species is one that normally waits for its food to come to it. Its fore legs are not particularly thickened, but it does secrete a sticky material which is to be found on the femora and tibiæ, as well as on other parts of the body, and this undoubtedly aids it in holding its prey.

Seasonal Life History. McAtee reports the hibernation of this insect as an adult. Although the writer has not found this species in hibernation, he has reared it through a part of its life history, and the indications from this rearing are that adult hibernation is the normal thing. The adults emerge from hibernating quarters in spring and are soon ready to oviposite. With the single female which the writer had in captivity, oviposition began, as far as observations were concerned, on June 19. This insect was not captured until June 17, however, and probably had oviposited in the field before being captured. After a short egg stage, the nymphs appear and may be found in the field for the rest of the summer, becoming adult only in late summer and early fall. There is but a single generation a year.

Oviposition. Uhler reports the eggs being laid on the bark of pine trees and covered by a waterproof gum. The writer has not found the eggs in the field, but has obtained them from a female confined in the laboratory. The eggs are laid singly, resting at an angle on the broad curve at the lower end of the egg, and attached to their support by a small amount of cement. In the laboratory they were found attached to the cheesecloth and wire screening of the cage. The female observed produced eighty-two eggs during her period of captivity, from two to nine eggs being taken from her container on most days, though on some days no eggs were laid.

Length of Stages. Only one individual was carried through the complete life history from adult to adult. The record of this individual is as follows: Egg laid July 7; egg hatched July 18, 11 days; first molt August 1, 14 days; second molt August 14, 13 days; third molt August 23, 9 days; fourth molt September 1, 9 days; fifth molt changing to adult September 20, 19 days.

Other records indicate an egg stage lasting from 9 to 13 days; the first instar lasting from 9 to 14 days in eight individuals; the second instar lasting from 6 to 12 days in four individuals; and a third instar lasting 10 days in the only individual, aside from that mentioned above, that passed through that instar.

DESCRIPTION OF INSTARS.

The early stages only of this insect are figured and described. Unfortunately the writer did not save material of the fifth instar, since he had collected some fifth-instar nymphs which he thought were of this species. However, these were the closely related *barberi,* and hence must be described as such. Descriptions of the egg and of the first four nymphal instars, however, are given and illustrated.

Egg. (Pl. XV, Fig. 6.) Length, 2 mm.; greatest width, 1 mm.; least width, just below the extension of the chorion, .4 mm.; length of extension of chorion, .2 mm.

Color brown, excepting the extension of the chorion, this whitish. Somewhat kidney-shaped, wider at base, one side convex, broadly rounded, the other side almost straight though slightly concave; narrowed in region of cap. Cap with a central rodlike structure, this extended above the tubelike extension of the chorion. From the base of rodlike structure rises a reticulated membrane, this radiating outward and upward to meet the sides of the tubelike extension of the chorion.

First Instar. (Pl. XV, Fig. 1.) Length of body, when newly hatched 2.2 mm., when older 2.7 mm.; length of front femur, 1 mm.; length of first antennal segment, 1.3 mm.

General color orange yellow with black markings. Eyes black, tinged with red; anterior part of head with dark markings; antennæ, first segment dark, twice banded with light, second segment dark with median light band, third segment entirely dark, fourth segment entirely light; beak dark at base, at juncture of first and second segments, and slightly darker at apex; postocular portion of head unmarked; upper surface of thorax uniform orange yellow; femora of all legs four-banded, the basal band sometimes incomplete, the apical band broad; basal half of tibiæ three times banded with fuscous; tarsi dark at apex; abdomen uniformly orange yellow with exception of two pairs of dark apical spines.

Upper surface of body with stiff, erect setæ; head distinctly swollen behind the eyes; antennæ with first segment longest, fourth next in length, second and third shorter, subequal. Beak with second segment longer than first, apical segment shortest. Legs of moderate length, fore and hind femora of nearly equal length, fore femora scarcely thickened, unarmed; tarsi two-segmented, second segment much the longer, claws toothed. Abdomen rounded evenly; seventh and eighth abdominal segments each bear a pair of black spines, each surmounted by a seta; openings to dorsal stink glands present at anterior margins of segments 4, 5 and 6, very inconspicuous.

Second Instar. (Pl. XV, Fig. 2.) Length of body, 4 mm.; length of front femur, 1.5 mm.; length of first antennal segment, 1.6 mm.

General color as in preceding instar. First antennal segment with two bands and apex light in color; femora five-banded, instead of four-banded as in preceding.

Similar in structure to preceding. Segments 3-8 of abdomen with conspicuous spines on dorsum, one pair to each segment; those on segments 3-6 orange yellow in color, those on segments 7-8 black, pair of segment 7 longest; smaller spines along lateral margins of posterior abdominal segments. ~~(Pl. XV, Fig. 3.)~~

Third Instar. (Pl. XV, Fig. 3.) Length, 5.5 mm.; length of front femur, 1.7 mm.; length of first antennal segment, 2 mm.

Third antennal segment now with base dark, apex light; two pairs of dark lateral spines near caudal end of abdomen.

Setæ on upper surface of head and thorax more conspicuous;

wing pads present, dorsal in position, very small, first pair extended but short distance over second pair, and second pair extended over first segment of abdomen hardly at all. Dorsal spines on abdomen as in preceding instars, though more conspicuous; lateral spines more conspicuous, smaller towards base of abdomen, longer caudally, segments 6 and 7 bear two pairs each, a darker anterior pair and a lighter caudal pair.

Fourth Instar. (Pl. XV, Fig. 4.) Length of body, 7 mm.; length of front femur, 2.3 mm.; length of first antennal segment, 2.5 mm.

Similar to preceding in color; dorsal spines on abdominal segments 4-6 now black tipped.

Third antennal segment now longer than either second or fourth; wing pads longer, extend to base of second abdominal segment; dorsum of abdomen with spines as before; lateral spines more conspicuous on segments 5, 6 and 7, where the anterior pair dark, the posterior pair light.

Localities. Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Virginia, North Carolina, Georgia, Florida, Ohio, Illinois, Colorado, Wyoming, Oklahoma, Texas, Kansas, Indiana.

Pselliopus barberi Davis.

(Pl. XIV, Figs. 3, 4.)

Davis, Psyche, XIX:20-21; 1912.

"The description of *cinctus* by Frabicius will cover both species, but we may consider it to be the darker and somewhat smaller form.

"*Color.* Anterior lobe of pronotum with black markings usually absent or reduced to two faint oblique streaks at anterior portion. Posterior lobe marked as in *cinctus.* Scutellum with no prominent black markings, which are either absent entirely or reduced to a small spot or to two faint oblique bands at extreme anterior part between the two whitish pruinose spots. Corium unmarked with black; orange yellow. Connexivum banded with black as in *cinctus.* Venter with black markings arranged much the same, but considerable variation exists in both species. Markings of the legs, rostrum and antennæ are similar, but the head has less amount of black maculation in *barberi.*

"*Structural differences.* In *cinctus* the short, black-tipped, acute spine, before the rounded humeral angle projects beyond the humeri and is directed slightly backward, while in *barberi* the black-tipped spine preceding the humeral angle is shorter, more obtuse and directed more laterally. It never extends beyond the humeral angle. Basal margin of the pronotum in front of the scutellum is feebly bisinuate in *cinctus*, while in *barberi* it is straight across. Scutellum of *barberi* is not so foliaceous and flat as in *cinctus* and a well-defined ridge or keel runs backward from the transverse crescentic ridge.

Apex of last genital segment of male in *barberi* armed with a long very pointed spine, which is directed obliquely forward and somewhat concealed. The inner genital lobes on either side of this are not produced in *barberi* or in *cinctus* as in *zebra*. In *zebra* the apex of the last genital segment of male is produced in the middle and armed with a sulcate-pointed spine."

Biology. Inasmuch as this species has, until recently, been confused with *cinctus*, it is quite likely that observations made upon its habits have been ascribed to *cinctus*. Davis, in the notes accompanying his description of the species, describes finding mating adults on September 26, 1911, in Prince George county, Maryland. This species is more common than *cinctus* in Kansas, and the writer has had the opportunity of making observations on it several times.

Habitat. The same as for *cinctus*. This species is taken frequently on sycamore.

Food. Apparently a variety of small insects as in *cinctus*. The writer has fed confined adults house flies with very satisfactory results.

Seasonal Life History. These insects winter as adults, as has been reported for the preceding species. They have been found most commonly under leaves at the bases of sycamore trees. There they may occasionally be found in large numbers, usually in a curled sycamore leaf, or occasionally in a roll of sycamore bark. The death rate among hibernating individuals seems to be rather high. In one case I found over twenty dead individuals together at the base of a sycamore, and in numerous other cases occasional dead individuals have been found. From the fact that Davis found mating individuals in September, it might be argued that the eggs are laid in the fall and the winter spent in the egg stage. This, however, does not seem to be the case, since hibernating adults may be found very commonly, and these, when confined and fed in the spring, very readily produce eggs. In short, then, it may be said that the seasonal life history is practically the same as for the preceding species, as would be expected.

Mating. Davis reports observing mating in the fall. The writer has collected hibernating individuals of both sexes, paired the individuals, and then observed mating in the warm days of early spring. While mating the male is directly on top of the female, holding to her with all legs. The front femora extend straight out on a continuation of the line of the body, the tibiæ bend down at right angles, and the tarsi rest on the head of the female, just behind the bases of the antennæ. Mating may last for several hours, or for less than an hour.

Oviposition. The eggs of this species are laid in rather loose clusters of from two or three to as many as fifteen or more eggs. In the laboratory they were placed on the cheesecloth of the cage in which the adults were confined, and in the field are probably deposited on leaves or stems.

The period of incubation, the length of the stages and the number of eggs laid by a single female individual have not been determined for this species. The descriptions of the egg and of the fifth-instar nymph follow:

Description of Egg. Length, 1.7 mm.; greatest width, 1.67 mm.; least width, just below extension of chorion, 1 mm.; length of extension of chorion, .17 mm. Body of egg chestnut brown, extension of chorion whitish. Cylindrical, slightly curved, not so broad as in *cinctus*, narrowed at cap; extension of chorion tubelike, reticulate, of smaller circumference at base and apex, somewhat expanded in middle; cap set within extension of chorion, top of cap with whitish flocculent, almost fungouslike covering, not extended above extension of chorion.

This egg may be distinguished easily from that of *cinctus* by its shape, which is more slender; by the structure of the cap, which bears a central rodlike structure in *cinctus*, absent in *barberi;* by the fact that the eggs are laid singly in *cinctus* and in groups of several eggs in *barberi;* and by the fact that the egg rests with its main axis at an angle with the surface on which it is placed in *cinctus*, but is upright in *barberi*.

Description of Fifth-instar Nymph. (Pl. XIV, Fig. 3.) Length of body, 9-10 mm.; length of front femur, 3.2 mm.; length of first antennal segment, 3.2 mm.

Color yellowish orange and black; eyes, region of transverse suture, a V on anteocular part, and median cephalic lobe of anteocular part of head black; first antennal segment black, thrice banded with white, second segment black with light median band; third segment with the basal fifth black, the apical four-fifths light. Upper surface of thorax uniformily yellowish orange; legs banded, femora light, five times banded with black, tibiæ banded with black three times before the middle, and with longitudinal black vittæ on apical half. Surface of abdomen yellowish orange except at apex, apex black; abdomen with solid black and orange and black spines.

Head swollen behind the eyes, bearing setæ; antennæ, first segment longest, third next in length, second and fourth subequal. Anterior angles of pronotum produced into acute tubercles, upper surface of thorax and wing pads clothed with short hairs; legs of moderate length, fore femora not distinctly thickened; wing pads extended beyond middle of third abdominal segment; abdomen rounded, very spiny. Segments 3-8 each with a pair of conspicuous dorsal spines, those on segments 3-6 light at base, dark at apex; those on segments 7 and 8 entirely dark; segments 3-7 also bear on each side two lateral spines, the anterior of these black, the posterior light. Openings to dorsal stink glands at cephalic margins of segments 4, 5 and 6, very inconspicuous.

Localities. Maryland, Virginia, Missouri, Kansas, Texas, Ohio, Indiana, North Carolina.

Pselliopus zebra (Stal).

Stal, Stett. Ent. Zeit., XXIII:448; 1862. *Milyas zebra.*

"Pale stramineous, upper surface of head, antennæ, spots on the anterior lobe of the prothorax and prosternum, two annuli on beak and numerous annuli on legs, fasciæ on connexiva, narrow ventral incisures or bands, and dilations near the lateral margins black; four annuli on the basal segment and one on the second segment of the antennæ, spots between the antennæ and eyes, and also two spots on the head between the eyes pale stramineous; hemelytra smoky stramineous; apex of scutellum foliaceous, produced; posterior lobe of thorax more or less testaceous, lateral angles emarginate, before the emarginations lightly produced toothlike; in the males this tooth and six stripes between the posterior lateral margins, the hind one shortened, black; posterior angles of the thorax produced, obtusely lobate. ♂ ♀. Length, 10-13 mm.; width, 2-3 mm.

"Head behind the eyes very obsoletely, scarcely perceivably tuberculate."

Localities. Arizona, California, Mexico, Central America.

Pselliopus spinicollis (Champion).

Champion, Biol. Centr. Amer., Heter., II:245, pl. 15, fig. 2; 1899. *Milyas spinicollis.*

"♀. Broad, obovate, finely pubescent and also clothed with long erect hairs; stramineous, the anterior lobe of the pronotum and the base of the scutellum reddish, the dorsal surface of the abdomen tinged with sanguineous; the head in great part black above, with ocular portion stramineous; the pronotum with the inner spines on the anterior lobe black, and the posterior lobe, the basal margin excepted, slightly infuscate, with the tubercles and the lateral teeth infuscated or black; the elytra dilute fuscous; the connexivum broadly banded with black, the mesosternum and the sides of the ventral segment 1-3 also black; the antennæ with joints 1 and 2 black, 1 quadriannulated with stramineous, 2 with a stramineous median ring, 3 and 4 obscure ferrugineous; the basal joint of the rostrum and the tibiæ narrowly annulated, the femora speckled and annulated, with black. Head much shorter than the pronotum, armed above with two small conical tubercles on each side before the eyes; antennæ moderately long, slender, joint 1 about one-half longer than 2, 2 and 3 subequal, 4 shorter than 3. Pronotum moderately constricted at the sides; the anterior lobe armed with six short spines on each side of the median groove and with a rather long spine at the anterior angles; the posterior lobe studded with scattered conical setiferous tubercles, the base feebly bisinuate in the middle and with a narrow reflexed margin at the sides, the lateral angles armed with a short, stout, blunt, backwardly directed tooth. Scutellum with the apex rounded and foliaceous. Connexivum broad, rounded externally. Venter smooth. Legs rather short.

"Length, 9¾ mm; breadth of the pronotum 2⅘, of the abdomen 3⅔ mm.

"One example. Allied to *M. punctipes* but much broader; the pronotum with twelve short spines (instead or eight very long ones) on the anterior lobe, a short, blunt, posteriorly directed tooth at the lateral angles, and the basal margins narrowly reflexed; the scutellum more broadly foliaceous at the apex; the third antennal joint not longer than the second. The tibiæ are annulated with black to the apex."

Localities. Idaho, Arizona, California, Mexico.

Pselliopus inermis (Champion).

Champion, Biol. Centr. Amer., Heter., II:246, pl. 15, fig. 4; 1899. *Milyas inermis.*

"Rather broad, moderately elongate, sparsely pilose; stramineous, the abdomen and legs with a reddish tinge in fresh examples; the head black above, with a small spot between the ocelli, an oblique mark on each side before the eyes, and the anterior portion in part, stramineous; the pronotum with the anterior lobe variegated with black leaving a spot at the sides, two vittæ on the disc, and the anterior angles pale, the posterior lobe, the basal margin excepted, slightly infuscate, the hind angles with a small black spot; the scutellum blackish at the sides below the base; the elytra fuscous or fusco-testaceous; the connexivum banded with black; the ventral sutures very narrowly, and some small spots on the pleura, black; the antennæ with joints 1 and 2 black, 1 triannulated with stramineous, 2 with a stramineous median ring, 3 and 4 ferrugineous; the femora narrowly, and the basal halves of the tibiæ and the basal joint of the rostrum more broadly, annulated with black. Head moderately broad; antennæ with joint 1 about twice as long as 2, 2 and 4 subequal, 3 much longer than 2. Pronotum smooth, the anterior lobe sulcate down the middle and with a short stout tooth at the anterior angles, the lateral angles tuberculate or nodose; the base strongly bisinuate in the middle and also deeply sinuate at the sides, the margin rather broad and reflexed. Scutellum with the apex rounded and strongly foliaceous. Connexivum rather broad. Legs moderately elongate.

"♂. Terminal genital segment armed with a stout tooth of variable length, the genital lobes long and very slender.

"Length, 11½-13 mm.; breadth of the abdomen, 4-4¼ mm. (♂ ♀)

"Var. The head above, a small spot between the ocelli excepted, the pronotum and pleura in great part, and the sides of the venter broadly, a row of spots excepted, black, the corium solid ochreous. (♀)

"Eight examples of the typical form and one of the variety. Easily separable from all other species of the genus by the simply tuberculate or nodose lateral angles of the pronotum, the pronotum with its basal margin strongly bisinuate in the middle.

"Allied to the North American *M. cinctus* (Fabr.), but with the tooth at the lateral angles of the pronotum very short or obsolete, the base of the latter strongly bisinuate opposite the scutellum, etc."

Localities. Arizona, Mexico.

Pselliopus latifasciatus Barber.

Barber, Proc. Ent. Soc. Wash., XXVI:211-212; 1924.

"Form rather broad. Sordid stramineous. Anterior lobe of head, with tylus, fascia running forward from between two small rounded black tubercles to the base of each antenna, a small spot between the eye and base of each antenna, posterior lobe with a broad lateral fascia running back from the eyes and connected near base of head with two broad somewhat crescentic fascia which run forward between the ocelli to connect at the transverse stricture, black; a somewhat quadrangular stramineous spot between the ocelli. Antennæ colored as in *cinctus* with the second and fourth segments about equal in length. Pronotum, except for a short median longitudinal black fascia anteriorly, unicolorous, sometimes tinted with orange; scutellum sordid stramineous, with the Y-shaped callosed carina paler and with a whitish pruinose spot at base on either side; corium darker, somewhat ferrugino-fuscous; connexivum with narrow edge, except at incisures, the transverse fasciæ outwardly narrow widely expanded within, ferrugino-fuscous; legs stramineous, not spotted but banded with black, the femora with six rings, the tibiæ with three rings before the middle; sternum and venter not fasciate, the latter with a small round black spot on segments two to six, situated midway between spiracles and middle of venter. Head, antennæ and rostrum of the same character as in *cinctus,* the first-named, however, not so abruptly contracted to form the collum which appears somewhat shorter. Pronotum much more setose than in *cinctus;* anterior angle with a prominent, bluntly rounded tubercle directed obliquely forward and set with a seta; posterior angle armed with a prominent horizontal subacute tooth or spine which is directed backwards on a line with the outer margin, sometimes infuscated at tip; anterior lobe with ten to twelve prominently elevated, rounded tubercles, each set with a long seta; posterior lobe on the elevated disk granulate or provided with numerous scattered low tubercles beset with setæ; the disk not so sharply delimited laterally as in *cinctus;* posterior margin before the scutellum weakly bisinuate. Scutellum a little more widely foliaceous than in *cinctus.* Corium with a rather dense coating of fine appressed hairs. Membrane brownish hyaline. Connexivum rather widely expanded and reflexed; extreme edge fuscous except just before incisures which are somewhat callosed; the transverse fusco-ferrugineous fascia narrow where it joins the margin just back of the incisures, widely expanded within. Terminal genital segment of male entire, slightly produced at apex in a short, stout, rather obtuse process, the posterior margins either side of process plainly callosed; the projecting genital lobes nearly straight, scarcely clubbed at apex, outwardly black.

"Length, male 11 mm.; width of abdomen, 4.5 mm.

"This species is most closely related to *tuberculatus* Champion, from which it differs much in coloration. The femora are not spotted but only annulate with fuscous. In some specimens the anterior lobe of pronotum is tinted with orange and the connexivum beneath is occasionally transversely fasciate with fuscous."

Localities. Louisiana, Virgina, Maryland, Colorado, Texas.

Genus CASTOLUS.

This genus was described originally by Stal as follows:

"Head somewhat shorter than antennæ, tuberculate behind the antennæ. Rostrum with segments one and two subequal in length. Antennæ with segment one the length of the thorax. Thorax long, constricted behind the middle, anterior lobe small, posterior margin of hind portion truncate before scutellum, lateral angles obtuse, subprominent. Membrane with two aëroles, the anterior twice as large as the posterior. Legs medium, anterior longer than intermediate, femora lightly incrassate.

"Related to genus *Harpactor*."

WORLD DISTRIBUTION OF GENUS.

This is a Neotropical genus of nine described species. One species has been found only in Arizona, and another, while typically Neotropical, has also been reported from that state.

CLASSIFICATION OF GENUS.

The two species of this genus which have been found within the limits of the United States may be separated in the following manner:

1. A distinct black-tipped tubercle over base of each antenna; smaller, length 13 mm. .... *ferox* (Banks).

   Tubercle not as above; larger than preceding, female 17 mm. in length, *subinermis* (Stal).

Castolus subinermis (Stal).

Stal, Stet. Ent. Zeit., XXIII:447; 1862. *Repipta subinermis.*

"Livid, head with two vittæ between the eyes, occasionally running together, annuli on antennæ and legs, posterior lobe of thorax, except the posterior margin, and the posterior lateral region, incisures and a vitta on either side in the lateral ventral region and the hemelytra fuscous, apex of corium pallid; membrane fusco-hyaline. ♀. Length, 17 mm.; width, 4 mm.

"Short spines on head. Thorax with basal margin of posterior lobe straight, posterior angles scarcely protruded, obtuse, lateral angles emarginate, before the emarginations lightly produced, spinelike." Description from *Hemiptera Mexicana.*

Localities. Arizona, Mexico.

Castolus ferox (Banks).

Banks, Ent. News, XXI:325; 1910. *Zelus ferox.*

"Pale yellow; sides of head in front and behind the eyes dark; anterior lobe of pronotum with black on sides, and a narrow incurved stripe each side nearly connected to each other behind middle; posterior lobe broadly dark on sides, black at humeri; basal part of wings black; dorsum of abdomen reddish; below the prosternum is a black spot in front of each coxa I; all femora with a band beyond middle, and one toward tip dark, sometimes a faint band near base of tibia, and sometimes the hind and middle femora have a band before middle. Head short (shorter than in *Z. exsanguis*) with a distinct black-tipped tubercle over base of each antenna; ocelli not two diameters apart; a broad deep furrow on middle of pronotum, fading out toward hind margin, humeri acute, upturned, but scarcely produced; a faint tubercle each side nearer hind edge of pronotum; pronotum and basal part of wings with many fine, short, yellowish hairs; wings extended beyond tip of the abdomen. Length, 13 mm."

Locality. Arizona.

Genus REPIPTA.

This genus was described originally by Stal as follows:

"Body elongate. Head oblong, bispinose before. Rostrum with segment one a little longer than two. Antennæ very long, segment three in male thickened. Thorax lightly constricted before the middle, posterior lobe quadrispinose, base truncate. Hemelytra extending beyond abdomen. Abdomen unarmed. Legs long, slender. Apex of femur unarmed, anterior femora lightly thickened. Tarsi with the last two segments of about equal length."

Champion gives the following notes on this genus:

"Some of these insects are superficially very like *Zelus*, but they may be easily separated therefrom by the comparatively short second joint of the rostrum. The third joint of the antennæ is, in most of the species, more or less thickened in the males, this being especially noticeable in *R. fuscipes*."

WORLD DISTRIBUTION OF GENUS.

This genus is composed of fourteen described species, and is typically Neotropical in distribution. Of the fourteen, three species have been recorded from the United States.

CLASSIFICATION OF GENUS.

The three species of this genus to be found in the United States may be separated by the following key:

1. Body moderately elongate, not very slender, not uniformly colored above 2
   Body narrow and elongate, obscurely colored above.....*mucosa* Champion.
2. Legs black, the femora sometimes pale at the base; the posterior lobe of the pronotum in great part black or with two black vittæ, *taurus* (Fabricius).

Legs pale; the posterior lobe of the pronotum immaculate or with two faint vittæ ....*flavicans* (Amyot and Serville).

Repipta taurus (Fabricius).

Fabricius, Syst. Rhyng., 291; 1803. *Zelus taurus.*

"Sanguineous, antennæ, elytra and legs black, head with two spines, thorax with four.

"Habitat in Carolina."

Stal gives a somewhat fuller description than the above original description:

"Dilute sanguineous, venter, except for margins, dirty ivory colored; spines on head, tubercles of neck, two lateral vittæ of varying width on the posterior lobe of the thorax, near the anterior lobe, the hemelytra, narrow ventral fascia, and legs black; coxæ and base of femora sanguineous; costal margin of hemelytra pale, membrane pale infuscate.

" ♂. ♀. Length, 11 mm.; width, 2¼ mm."

The above description from *Hemiptera Mexicana.*

Champion gives the following descriptive notes:

"In this species the antennæ, the posterior lobe of the pronotum (the basal margin excepted), the clavus, the corium (the costal margin excepted), and legs are black or blackish. In light-colored specimens the dark coloration on the posterior lobe of the pronotum is reduced to two vittæ, and the femora are pale at the base. The outer margin of the corium is usually pale. The spines on the head and pronotum are very long. The males have the third joint of the antennæ thickened for two-thirds of its length, and the terminal genital segment armed with a very short tooth at the apex."

Biology. Blatchley reports that it is common on low vegetation in early spring in Florida, and that it hibernates beneath bark, in bunches of Spanish moss and beneath chunks along the margins of ponds.

Localities. Pennsylvania, Carolina, Florida, Colorado, Texas, Mexico, Guatemala, Yucatan.

Repipta mucosa Champion.

Champion, Biol. Cent. Am., Heter., II:271, pl. 16, fig. 17; 1899.

"Moderately elongate, narrow, slender, dull, finely pubescent and also with a few scattered erect hairs, the pleura and the basal margin of the pronotum clothed with an agglutinated whitish tomentum; rufo- or griseo-fuscous above, paler beneath, the sides of the venter and the dorsal surface of the abdomen sanguineous in fresh specimens, the connexival margins pale; the antennæ blackish or fuscous, the first joint usually with a pale ring towards the apex, the third joint flavous at the base; the legs stramineous or testaceous, the apices of the femora and the bases of the tibiæ obscurely annulated with fuscous. Head about as long as pronotum, tumid behind the eyes, and considerably narrowed posteriorly, armed with two moderately long acute spines, the eyes a little prominent; antennæ very slender, longer than the body, the third joint in the male thickened at the base. Pronotum armed with two long slender spines on the disk of the posterior lobe and with a similar spine at each of the lateral angles; the posterior lobe flattened along the middle of the disk; the anterior angles tuberculiform, transverse. Scutellum flattened at the apex. Elytra slightly longer than the abdomen, the discoidal area short. Abdomen unarmed at the sides. Legs pilose, slender, the anterior femora thickened towards the base, the hind femora (when extended backwards) reaching very little beyond fourth abdominal segment.

"Length, 8-10 mm.; breadth, $1\frac{1}{2}$-2 mm. (♂ ♀).

"A common insect in Chirqui (Champion). Allied to *R. gracilis*, but much smaller and less elongate, the legs relatively much shorter, the posterior lobe of the pronotum smoother, the first joint of the rostrum not much longer than the second, the discoidal area of the elytra short. *R. mucosa* is also very much like *Z. nugax* and other small species of that genus, but it is easily separable therefrom by the short second joint of the rostrum."

Localities. Texas, Panama.

Repipta flavicans (Amyot and Serville).

Amyot and Serville, Hemip., 374; 1843. *Zelus flavicans.*

"Very close to *lineatus,* but of an indefinite yellowish and uniform brown lines. Eyes black. The base of the elytra rather brown; the two spines on the posterior disk of the prothorax very long and inclined to the rear. Legs and antennæ yellowish. Male."

Champion discusses this species as follows:

"This insect is certainly nothing more than a variety of the variable *R. taurus,* from which it differs in having the legs pale and the pronotum, at most, faintly streaked with black or fuscous. From Teapa southwards it is much commoner than the dark-legged *R. taurus;* the latter does not appear to extend to the South-American continent, and it is therefore perhaps more convenient to treat the two forms as distinct."

Localities. Texas, Mexico, Guatemala, Costa Rica, Panama, South America.

Genus FITCHIA.

This genus was originally described by Stal as follows:

"Body elongate. Head elongate, subequal in length to the thorax, behind the eyes noticeably narrowed, anterior part with two short spines. Segment one of antennæ somewhat shorter than head and thorax. Rostrum with first segment a little longer than second. Thorax noticeably narrowed behind, lightly impressed behind the middle, base sinuate, unarmed. Hemelytra rather short, incomplete. Abdomen oblong, margin somewhat flattened. Legs rather long, anterior femora thickened, anterior tibiæ equal in length to femora."

WORLD DISTRIBUTION OF GENUS.

This genus is composed of two described species, and both of these, so far as present records are concerned, are confined to the United States.

CLASSIFICATION OF GENUS.

The two species may be separated as follows:

1. Pronotum armed on the posterior lobe with two short spines on the disk and with a spine at each of the lateral angles............*spinosula* Stal.
   Pronotum unarmed ....*aptera* Stal.

Fitchia aptera Stal.

Stal, Of. Vet. Akad. Forh., XVI:371; 1859.

"Testaceo-flavescent, thorax rugulose behind the middle; scutellum fuscous; a wide dorsal vitta and also a narrower one on each side of the venter of the abdomen black. ♀. Length, 15 mm.; width, 2½ mm. America borealis."

Biology. Taken from beneath boards (Blatchley).

Localities. Maine, Massachusetts, New York, New Jersey, Pennsylvania, South Carolina, Illinois, Kansas, Colorado, Utah, Oklahoma, Texas.

Fitchia spinosula Stal.

Stal, Enum. Hemip., II:79; 1872.

"Pale, grayish flavescent, with grayish pile; with three ventral vittæ, most narrow medially, extended laterally through the sides of the mesosternum, black; posterior lobe of the thorax quadrispinose; membrane gray, veins fuscous. ♀. Length, 12 mm.; width, 2⅓ mm.

"Similar to the preceding (*aptera*), in size somewhat narrower and in all parts of the body somewhat longer, posterior lobe of the thorax with two short spines on the posterior disk and armed at lateral angles with a spine turned upwards and a little inwards, and the area of the membrane distinctly narrower."

Biology. Taken from bases of clumps of grass (Blatchley).

Localities. Georgia, Florida, Texas, Colorado, Indiana.

Genus ROCCONOTA.

This genus was originally described by Stal as follows:

"Body elongate. Head oblong, thorax short, anterior part bispinose, or bituberculate; apex of genæ at forward end somewhat acutely produced. Rostrum with first segment somewhat longer than second. Antennæ long, segment one subequal in length or somewhat longer than head and thorax together, the second segment less than half as long as this. Thorax lightly constricted, posterior lobe with four spines or tubercles. Apex of scutellum rather acute. Hemelytra somewhat longer than apex of abdomen. Abdomen hardly as wide as hemelytra, segments one to three on either side subspinose.

Legs long, anterior femora equal in length to posterior, thickened; apical segment of tarsi a little longer than the preceding."

Champion gives the following descriptive notes on this genus:

"It is doubtful if this Tropical-American genus can be retained as distinct from *Repipta* Stal. The species here referrd to *Rocconota* have the anterior femora more or less incrassate, the third antennal joints slender in both sexes, the abdomen with one or more of the basal segments armed with a spine at the outer apical angles, the head and posterior lobe of the pronotum armed with long spines or tubercles, the outer area of the membrane nearly or quite as long as the inner."

WORLD DISTRIBUTION OF GENUS.

This is a Neotropical genus of ten described species, only one of which extends in range into the United States.

Rocconota annulicornis (Stal).

Stal, Enum. Hemip., II:77; 1872. *Heza annulicornis.*

"Pale testaceo-flavescent, with grey pile, head sometimes fuscous; two or three annuli on the first segment, a very wide annulus on the second segment, and the base of the third segment of the antenna pale; apex of femur dark; spines at base of thorax fuscous; margin of abdomen pallescent, segments of the border of the abdomen before the middle and the apical margin, except in the dorsal part, fuscous or testaceous. ♂. ♀. Length, 15-16 mm.; width of hemelytra, 3-3½ mm.

"The size of *H. multiannulata*, scarcely different from this species. First segment of antennæ somewhat longer than head and thorax together. Head a little shorter or subequal in length to thorax, the anterior part armed with two medium-sized spines. Thorax with two wrinkled creases, somewhat extended in posterior lobe, interrupted, this lobe with four spines, twice as long as the spines on the head. Costal region sometimes much darkened. Membrane and wings pale dirty wine-colored or dirty hyaline. Mesopleura marked on lateral margins with alboserieeous spot or spots. Sixth segment of abdomen on either side slightly but noticeably flattened, apex rounded.

"In the example from Texas the spines on the head and thorax are shorter than in the female specimen from Mexico, head likewise appearing a little shorter."

Champion makes the following comment on this species:

"There is no trace of a tubercle or plica on the mesopleuron in front, the insect cannot therefore belong to *Heza*. *R. annulicornis* is closely allied to *R. tuberculigera*, but differs from it in having the first connexival segment armed with a spine at the apex, and the pronotal spines are flavous at the apex. The basal joints of the antennæ are more or less distinctly annulated with brownish or fuscous, as are also the femora towards the apex and the tibiæ at the base. The under surface is very finely and closely pubescent, as well as sparsely pilose, the longer hairs arising from small bare spots.

"The males have an upwardly curved spine at the apex of the last genital segment, and the third antennal joint slender."

Localities. New Jersey, Texas, Mexico, Guatemala, Alabama, Florida, North Carolina, Maryland.

Genus ATRACHELUS.

This genus was described originally by Amyot and Serville as follows:

"Body rather rugulose and hairy. Head a little narrowed behind, without the neck being slender and elongate. Antennæ with their next to last segment hardly twice as long as the second, in the two sexes; notably thickened, a little flattened and hairy in the males. Prothorax with a tubercle on each side at its anterior margin, more or less projecting in the females, spiny in the males. The other characters are those of *Zelus*."

WORLD DISTRIBUTION.

This is a Neotropical genus of three described species, one of which extends northward in its range into the United States.

Atrachelus cinereus (Fabricius).

Fabricius, Ent. Syst. Suppl., 347; 1843. *Reduvius cinereus.*

"Cinereus, thorax with four spines, margin of abdomen spined.

"Habitat in Carolina.

"Small. Head with a number of acute, elevated, cinereus spines. Thorax cinereus with four acute spines. Elytra cinereus, unmarked. Wings hyaline. Abdomen cinereus, margins spined. Legs slender, unarmed, cinereus."

Champion gives the following descriptive notes on this species:

"In both sexes of this species the connexival segments 1-5 are angularly dilated or spinose at their outer apical angles, there being considerable variation in this respect. The third antennal joint of the males is also much more thickened in some examples than in others. The abdomen is subparallel in the males, rounded at the sides in the females."

Biology. Taken from foliage of oak and from tall grasses by Blatchley.

Localities. Pennsylvania, North Carolina, South Carolina, Florida, Texas, Mexico, Guatemala.

Genus DOLDINA.

Described originally by Stal as follows:

"Body elongate. Head cylindrical, behind the eyes to the rear noticeably more slender, bispinose anteriorly. Beak with segment one equal in length to the second and third together. Thorax lightly constricted, noticeably narrowed before, width about one-half the length, posterior lobe quadrispinose. Apex of scutellum subproduced. Abdomen with segments 1-3 with the apex on either side armed with spines. Legs long, slender, apex of femur bispinose, anterior femora slightly thickened, anterior tibiæ subequal in length to femora; second segment of tarsus equal in length to apical segment."

WORLD DISTRIBUTION.

This genus is composed of five described species, one of which is confined to North America north of Mexico, another found in the southern United States and Central America, and the rest distinctly Neotropical.

CLASSIFICATION OF GENUS.

Our two species of this genus may be separated in the following manner:

1. Posterior lobe of pronotum unarmed .... *prætermissa* Bergroth.
   Posterior lobe of pronotum armed at humeral angles with a short, acute spine .... *interjungens* Bergroth.

Doldina prætermissa Bergroth.

Bergroth, Ent. News, XXIV:264; 1913.

"Testaceous, shortly pilose above, more longly so on the upper side of the head and on the first two antennal joints, on the under side of the body, along the abdominal margin, and on the legs, head more or less infuscated on the sides, upper side of postocular part sometimes with two narrow ferrugineous vittæ behind the ocelli, venter sometimes with a sublateral brown vitta. Head shorter than pronotum, first joint of antennæ slightly passing apex of scutellum, second joint as long as postocular part of head and eyes together. Pronotum rather more than one-half longer than the width between the humeral angles, anterior lobe smooth, in fresh specimens with some subreticulated pubescent lines, posterior lobe unarmed, finely and thickly rugulosely punctate with five shallow and rather narrow longitudinal furrows, the middle furrow being more distinct. Abdomen with a short spine at the apical angles of the first and second segments. Posterior femora reaching or nearly reaching the base of the sixth ventral segment. Length, ♀, 16-17 mm.

"Allied to *D. lauta* Stal, but is somewhat smaller and the posterior lobe of the pronotum is somewhat differently sculptured with the median furrow narrower and less deep."

Localities. Florida, British Honduras.

Doldina interjungens Bergroth.

Bergroth, Ent. News, XXIV:263; 1913.

"Testaceous, rather sparingly clothed with a white pilosity which is shorter on the upper side and thicker on the apical part of the prosternum and the adjacent part of the head, abdomen piceous-testaceous with the lateral border pale testaceous. Head shorter than pronotum, first antennal joint passing apex of scutellum, second joint a little shorter than the head. Pronotum half as long again as the humeral breadth, the posterior lobe very finely and thickly punctured, the longitudinal median impression rather broad, the intrahumeral impression evanescent anteriorly, humeral angles armed with a short acute spine, disk unarmed. Scutellum slightly recurved at apex. Hemelytra (♀) not reaching middle of last dorsal segment, the prolonged exterior apical part of the corium almost hyaline at and before the apical angle, membrane subhyaline, its exterior basal cell passing apical angle of corium. Abdomen shortly spined at base of sixth abdominal segment. Length, ♀, 19 mm.

"This very distinct species is described from a single specimen in de la Torre Bueno's collection. It is exactly intermediate in structure between the subgenera *Doldina* and *Hygromystes*, agreeing with the former in the unarmed disk of the posterior pronotal lobe, with the latter in the spinose humeral angles."

Biology. Taken from tall dead grass along borders of ponds, lakes, and sloughs by Blatchley.

Localities. Maryland, North Carolina, Florida.

Genus HEZA.

This genus was characterized originally by Amyot and Serville as follows:

"Antennæ having very pointed teeth, very pronounced and erected immediately behind the base of each of these. Beak having its first two segments of about equal length. Prothorax furnished with four tubercles, of which two are on the anterior lobe and two on the posterior lobe; posterior angles armed with a pointed spine, with a tooth behind it and at its base. Elytra not extending beyond the apex of the abdomen. Anterior femora lightly thickened. The other characters are those of Euagoras."

WORLD DISTRIBUTION OF GENUS.

This genus is essentially Neotropical. Seventeen species have been described as belonging to it, and of these only one is to be found within our limits.

Heza similis Stal.

Stal, Of. Vet. Akad. Forh., XVI:199; 1859.

"Fusco-testaceous, greyish sericeous, upper surface with small albosericeous macula infrequently scattered; posterior legs olivaceous green, femora and apex of posterior tibiæ with some red. ♂. Length, 18 mm.; width, 3 mm. Habitat, Colombia.

"Very similar to *H. macilenta*, spines on head and posterior lobe of thorax shorter. Spines on head and anterior lobe of thorax short, subconical, some acute, fuscous, others obtuse, pallid; spines on the posterior lobe of the thorax slightly shorter than the median lateral spines."

Champion gives the following descriptive notes concerning this species:

"Our specimens vary from 15 to 24 mm. in length. Some of them are of an olivaceous or greenish color. In fresh examples the pronotum, scutellum, and corium are set with scattered points of whitish tomentum. The third antennal joint is slender in both sexes. *H. similis* is very like *Rocconota rufotestacea* and other species of that genus, but it is easily distinguishable from them by the plica on the mesopleura."

Biology. Van Duzee reports taking a specimen from an oak tree.

Localities. California, Mexico, Guatemala, Nicaragua, Panama, Colombia.

Genus ARILUS.

This genus was described originally by Burmeister as follows:

"This genus also resembles in superficial characters the preceding (*Notocyrtus*), though the long-extended form of the head distinguishes it, particularly the narrowing of the head behind the eyes into the neck. The antennæ have the same structure; the first and third segments are sometimes equal, sometimes unequal, the first is particularly large, the much smaller second segment agrees with the fourth in length. The third is commonly larger than the second, seldom equal to it. The long, free, strong beak shows a different structure in its various segments. The pronotum is very broad, extended into a thorn at the humeral angles, on the disk covered mostly with beading, or a comb present. The wing covers at the base are strongly hairy. Abdomen broader than the wings, oval, often lobed on the sides; narrower in the males, hardly broader than the wings. Legs long, lightly haired, the fore femur a little thicker, the tarsi very small."

Champion gives the following notes on this genus:

"An American genus including several very closely allied species of large size, remarkable on account of the greatly developed and peculiarly formed posterior lobe of the pronotum, this latter being more or less cristate down the middle and set with a row of smooth, shining black tubercles, and at the base there are two stout spines."

BIOLOGY.

Champion says of this genus: "They prey upon small insects which live upon trees and bushes, and are able to inflict a very painful wound."

This seems to be true of our species, at least, numerous references to which may be found. Our common species, *Arilus cristatus* (Linnæus), is discussed in full later, and it is probable that the other species of the genus have similar habits.

WORLD DISTRIBUTION OF GENUS.

This is a Neotropical genus of seven described species, only one of which may be found north of the Mexican border.

Arilus cristatus (Linnæus).

(Pl. XVII.)

Linnæus, Cent. Ins. Rar., 16; 1763. *Cimex cristatus.*

Described by Linnæus in *Systema Naturæ* as follows:

"Black; upper wings ferrugineous: snout antennæ and shanks yellow; scutel crested serrate. Inhabits America. Scutel very large, toothed on the edge, the crest erect and 12-toothed: thorax small, spinose before."

Uhler describes the insect as follows in the Standard Natural History:

"It is of mouse-grey color, closely invested with short grey hair, and has the knobs of the head, cogwheel crest on the prothorax, eyes and angles black, with the legs and antennæ tinged with chestnut reddish. The female often measures more than an inch and a quarter in length, while the male is much smaller."

Champion gives the following descriptive notes:

"*A. cristatus* differs from the South-American and Antillean *A. carinatus* Forst., in having fewer tubercles on the crest of the pronotum (12-14 in *A. carinatus*, 8-10 in *A. cristatus*) and the margins not distinctly dilated behind the posterolateral angles. The margins of the abdomen are sinuate in both sexes."

Biology. There are numerous references to various phases of the biology of this insect to be found in the literature. Its large size, conspicuous appearance, and abundance have attracted attention.

Say (1832) redescribes the insect as *Reduvius novenarious,* and gives the following notes on its habits:

"This large and fine species is not uncommon in various parts of the Union, at least from Pennsylvania to the southern boundary. Its puncture is very painful, benumbing the vicinity of the wounded part for a considerable time."

Glover, in his Manuscript Notes on the Hemiptera, gives quite a complete account of the habits and life history of the insect (1876).

"Eggs to the number of 79 to 130 deposited in a hexagonal mass, cemented together with a thick brown viscid substance, each egg when separated from the mass presenting the appearance of a somewhat square flask, standing on its own bottom. This mass of eggs is placed on the bark of the tree, a fence rail, under the eaves of outbuildings or wherever the female chances to be at the time of oviposition. The larvæ when young, are blood red with black marks, and do not resemble the adult insect at all excepting somewhat in form and habits. The larvæ, pupæ and perfect insects all feed on other insects they can overcome, not even sparing their own brethren. When very young, they destroy great numbers of plant lice (Aphides), and when older they prey upon caterpillars, or indeed upon any insect they can overpower. They kill their prey by inserting their proboscis into it and which emits a most powerful poisonous fluid into the wound. The victim thus pierced dies in a very short time; they then leisurely suck all the juices out and drop the empty skin. The perfect wheel bug is a large and very singular looking insect of very slow and deliberate motions when undisturbed and stealing up to its prey. It is of a gray color and has a high semicircular ridge or projection on the crest of its thorax, armed with nine perfectly arranged teeth, or coglike protuberances, like very short spokes or cogs of a wheel hence the vulgar name of 'wheel bug.' The young shed their skin several times before attaining their full size. As this insect is constantly employed from the moment it hatches in searching for and destroying noxious insects, it may be considered a friend to the horticulturist and farmer. A dozen or so of the insects placed near the nest of some of those caterpillars, so destructive to our fruit and forest trees, will destroy almost every caterpillar in it in a short time, as they are exceedingly voracious, and each insect will kill and destroy several caterpillars daily. Great care must be taken, however, when handling the adult insects, as they are very apt to sting, or rather insert their strong curved beak into the naked flesh, and the poisonous fluid ejected, when the wound is inflicted, is extremely powerful, and is much more painful than the sting of a wasp or hornet. One of these insects having stung the writer, the pain lasted for several hours and was only alleviated by applications of ammonia. Several days afterwards the flesh immediately surrounding the puncture was so much poisoned that it sloughed off, leaving a small hole in the thumb injured."

Uhler gives the following discussion, in the Standard Natural History (1884), which gives an idea of the seasonal life history:

"Both sexes are formidable blood-sucking insects, able to conquer their neighbors of whatever order, and not at all backward in punishing man for sitting next their favorite trees. Like the foregoing, they glue their eggs to the bark of linden and other trees in our southern parks and gardens, extruding at the same time a gummy cement which keeps the eggs in condition throughout the bad weather of winter until the return of warm weather in the spring."

Chittenden (1905) reported that this insect is one of the natural enemies of the adult of the southern corn root worm, *Diabrotica 12-punctata*.

Girault (1906) made a very complete study of the number of eggs deposited in a mass by this insect. Out of twenty egg masses which he counted, the largest number of eggs to a mass was 172, the smallest number 42, and the average number 128. His remarks concerning this species follow:

"The egg masses were collected at Annapolis, Md., in a small peach orchard, where they have been unusually abundant for the past three or four years. In other orchards, in the immediate vicinity, none could be found, nor on trees other than fruit trees, except rarely. The insect apparently shows quite a preference for peach, as a place to deposit its eggs, and it seems to have a tendency to exist in isolated colonies."

Chittenden (1916) lists this species as one of the natural enemies of the cabbage worm.

Garman (1916) gives a discussion of the habits of this insect and its work as an enemy of the locust borer, *Cyllene robiniæ*. This discussion follows:

"A large puncturing insect, the wheel bug, has proved a very effective check on the adult beetles, and where it is sufficiently common destroys them in large numbers. This insect is one of the most formidable of its kind. It is a member of the order Hemiptera, a group containing such pests as the notorious chinch bug, the squash bug, the bedbug and the kissing bug. It reaches a length of 1.28 inch, is provided with a stout beak, and gets its common name wheel bug from a toothed and arched crest on the back just behind the head Individuals have been observed on the flowers of goldenrod destroying the locust borer adults, and also on the trunks of the locust trees, where they may be observed with the beetles impaled on their beaks. Near McKee, in Woodford county, I found an example with a beetle still struggling on its beak. With the wound it inflicts, the bug injects a clear fluid that probably has a paralyzing effect. On one occasion an example taken from a goldenrod, managed while I was engaged momentarily with something else, to prod my finger, causing a sharp pain and subsequent inflammation and swelling, the results being somewhat like that of a bee sting.

"The females when captured sometimes emit at the hind end of the body a forked, orange-colored, glandular organ with a pungent scent like that of a gland of a celery worm. It is probably protective. The bottle-shaped eggs of this bug are placed in clumps on the twigs, and remain in this condition over winter. They are laid in September.

"These wheel bugs are doing a great deal of good in some localities, and should be recognized and protected where this is practicable by those interested in the growing of locusts."

The wheel bug is again mentioned as an enemy of the locust borer by Sanborn and Painter (1916).

Britton (1917) mentions the wheel bug as a natural enemy of the fall webworm, *Hyphantrea cunea*.

G. W. Barber (1919) gives still another account of a personal experience with the bite of this insect:

"On September 22, 1919, the writer was collecting along the banks of the Potomac river at Williamsport, Md. Adults of *Arilus cristatus*, the wheel bug, were very numerous, engaged in feeding on a large variety of insects and in mating.

"A considerable number of these adults were picked up for life-history studies, a male of which sunk its proboscis into the forefinger of the writer's right hand. The wound was at once very painful and remained so for ten days, at first appearing red, and then the portion adjoining the wound more nearly, becoming hardened and quite white. On the 26th it was necessary to lance the wound and let out considerable bad blood and pus, and the finger was not normal until about the third of October."

Later notes given by Barber (1920) are as follows:

"During the months of September and October, 1917, the wheel bug *Arilus cristatus* Linn. was very numerous on flowers, especially goldenrod, along the

Potomac river near Williamsport, Md. Fifty specimens could easily be taken in the space of an hour—the females somewhat more numerous than the males.

"On September 30 it was noticed that the adults were especially active in copulation, although they were observed thus engaged several weeks previous and somewhat later than this date.

"Females oviposited readily and usually deposited all of their eggs at one laying and in one mass. For sixteen females that oviposited in captivity, the largest number of eggs was 182, the smallest 60, and the average was 130.6. The exact number of individual eggs per female was 118, 60, 132, 141, 137, 152, 90, 126, 169, 97, 171, 182, 103, 148, 136 and 126.

"Eggs were deposited in rearing cages on the cover of salve boxes and on the sides or top of screen cages. Masses were found in the field only on the trunks and lower limbs of trees.

"Adults were found feeding on honey bees and grasshoppers in the field. In cages they readily attacked and devoured katydids, adult Meloidæ, adults of *Cyllene robiniæ,* Arctiid larvæ, Pentatomid adults, and several unknown lepidopterous larvæ. In addition, females were found to be very fond of devouring the males soon after copulation was complete."

There exist several other accounts of some feature of the life history or habits of this insect which add nothing to the above. The writer has made a number of observations on this insect which, however, merely confirm, and in most cases add nothing to what has been quoted above. Although the writer has not reared the insect through the complete life history, he is convinced that it has five nymphal instars. The repugnatorial glands at the extremity of the abdomen of the adults are very interesting and will bear further study.

DESCRIPTION OF INSTARS.

Descriptions of the eggs, and of four of the five nymphal instars have been prepared by the writer.

Egg. (Pl. XVI, Fig. 1; Pl. XVII, Fig 6.) Total length, 3.7 mm.; length to extension of chorion, 3.2 mm.; width, 1.3 mm.; diameter of extension of chorion from a little less than the greatest width to a little more.

Color brown, darker toward upper end, extension of chorion whitish, central area of cap dark brown, appendages of rim of cap buff.

Shape subcylindrical, rounded at lower end, somewhat narrowed at upper end; from upper end produced a membranous, reticulated extension of the chorion, somewhat flaring; central disk of cap very slightly raised, from the outer rim produced two sets of filamentous appendages, one set turned outward over the extension of the chorion, the other turned inward over the central area of the cap.

First Instar. (Pl. XVII, Fig. 1.) Length of body when newly hatched, 3.5 mm.; when older, 4 mm.; length of front femur, 1.3 mm.; length of first antennal segment, 1.3 mm.

Head, thorax, antennæ, excepting last segment, beak and legs fuscous to piceous; abdomen reddish. Apical segment of antennæ yellowish red; eyes tinged with reddish; epicraneal suture and a longitudinal line on postocular part of head continued on thorax light.

Body sparsely hairy; head swollen behind the eyes, narrowed to neck, postocular part much longer than anteocular part; first antennal segment longest, second shortest, first subequal to second and third together, third and fourth subequal; rostrum with first and second segments subequal, third segment short; head as long as three thoracic segments together; pronotum subequal in length to meso- and metanota together; legs long, rather slender, sparsely hairy, fore femora longest, only slightly thickened, hind tibiæ longest; fore tibiæ with a preapical spur above; all tarsi two-segmented with apical segment much longer than basal, claws toothed. Abdomen somewhat swollen, evenly rounded, openings to dorsal stink glands located at anterior margins of segments four, five and six; spiracles visible laterally, located in small, dark plates.

Third Instar. (Pl. XVII, Fig. 2.) Length of body, 7 to 10 mm.; length of front femur, 4 mm.; length of first antennal segment, 4.2 mm.

General distribution of color as in first instar. Apical half of third segment of antennæ, as well as all of fourth segment of antennæ, reddish yellow. Abdomen with row of conspicuous dark plates along middorsal line, the first three at openings to dorsal stink glands, broader than long; the fourth much longer than broad; the fifth and sixth very close together, sometimes united to form a dark, apical plate; some specimens with a similar row of midventral dark plates.

Similar in structure to first instar with following exception: Head much less swollen behind the eyes; second segment of antennæ proportionally shorter, fourth segment much shorter than third segment. Wing pads present, dorsal in position, mesothoracic pads extended backwards for about half the length of the metanotum, metathoracic pads extended backwards hardly at all. Abdomen very much swollen, especially ventrally.

Fourth Instar. (Pl. XVII, Fig. 3.) Length of body, 13 to 15 mm.; length of front femur, 5.5 mm.; length of first antennal segment, 5.5 mm.

First segment of antennæ with a broad postmedian annulus, the apical two-thirds of the third segment and all of the fourth segment reddish yellow; rest of antennæ black; rostrum reddish yellow; tibia with a broad preapical band of reddish yellow, occupying less than half the length of the first, about half the second, and more than half of the length of the third tibia. Abdomen predominantly reddish, with middorsal and midventral rows of black plates, numerous scattered black flecks, and scattered whitish markings.

Head more elongate; first segment of beak distinctly longer than second, hind femora as long as or longer than fore femora; wing pads longer, first pair but little shorter than second pair, extended over second pair, both extended to base of second abdominal segment.

Fifth Instar. (Pl. XVII. Fig. 4.) Length of body, 19 to 23 mm.; length of front femur, 8 mm.; length of first antennal segment, 8 mm.

General appearance much more sombre than preceding. Antennæ reddish yellow except black base and apex of second segment and base of third segment; upper surface of head and thorax with cover of greyish pile. Tibiæ reddish brown except at bases and apices. Abdomen much duller in color than preceding, dirty whitish with numerous black flecks and occasional reddish markings; black middorsal and midventral plates as in preceding instar.

Third antennal segment longer, subequal to first. Wing pads much longer, of equal length, second pair entirely hidden by first pair, both extended to or beyond middle of third abdominal segment; abdomen proportionately longer and less swollen than in the preceding instars.

Localities. New Jersey, Pennsylvania, Delaware, Maryland, District of Columbia, North Carolina, South Carolina, Florida, Oklahoma, Texas, New Mexico, Mexico, Guatemala, Kansas.

Genus ACHOLLA.

This genus was described originally by Stal as follows:

"Body rather long. Head subcylindrical, spinose. Rostrum with first and second segments subequal in length. Thorax lightly constricted a little before the middle. Anterior femora thickened, below on either side with a few spines, unarmed above. Anterior tibiæ unarmed.

"Similar to the genus *Sinea.*"

The insects belonging to this genus are, indeed, very similar to those belonging to the genus *Sinca*, from which they may be distinguished easily by the unarmed condition of the front tibiæ, the tibiæ in *Sinca* being armed with three rows of very conspicuous ventral spines.

BIOLOGY.

If we may judge from our common species of this genus, *multispinosa* (De Geer), the members of this group normally inhabit trees. All stages of the species mentioned, and probably of the other species of the genus as well, are passed on the leaves and twigs of forest trees. The habits of the species mentioned above are quite well known and will be discussed later.

WORLD DISTRIBUTION OF GENUS.

There are three species described as belonging to this genus, all American, and none reported south of Central America. Of these, one has not been recorded from south of the Mexican border, and the other two have been found both in the United States and southward in Mexico and Central America.

CLASSIFICATION OF GENUS.

The three species of the genus may be separated by the following key:

1. Head longer, spiniform elevations on head and anterior lobe of pronotum prominent .... *multispinosa* (De Geer), p. 212
   Head shorter, spiniform elevations not so prominent 2
2. Postocular portion of head tumid, tubercles on anterior lobe of prothorax raised .... *ampliata* Stal, p. 216
   Postocular portion of head not so tumid, tubercles on pronotum not so raised .... *tabida* (Stal), p. 216

Acholla multispinosa (De Geer).

(Pl. XVIII.)

De Geer, Memories, III:348, pl. 35, fig. 10; 1773. *Cimex multispinosa* (part).

"Oblong, fuscous, rostrum short and arched, head and thorax with many spines, and with anterior femora thickened and bearing many spines.

"This bug has been found in Pennsylvania by M. Acrelius. It is elongate and rather large; the venter is convex below, but its upper surface is very concave so that its margins are very much elevated and form a deep trough, in the cavity of which the hemelytra and rather large wings are placed. The antennæ, which are a little shorter than the body, are setaceous and are divided into four segments.

"Its color is a uniform brownish grey, more or less darkened in different places, and the first segment of the antennæ, counting from the head, and the legs, are spotted with dark brown.

"The head, which is elongate and rather large, is furnished above with many small points, short and spined. The beak is curved and bent below the head, of which it has the same length, and rests with its point in a little groove, which may be seen on the under side of the prothorax. The prothorax, which is rugose, is divided into two convex parts, of which the first is entirely covered, above and towards the neck, with a large number of short spines, similar to those on the head; but the other part has only on each side a single short angular point. The two anterior femora, which are thicker and longer than the others, are furnished below with numerous points, rather long and in the form of spines, of which there are more in some individuals than in others."

Stal (1862) describes this species following Wolff's terminology, as *sexspinosus*. This description is given here to supplement the above:

"Dilute cinnamon, darkly infuscated above, annuli on antennæ and legs and anterior femora below fuscous; venter infuscate, with scattered pale markings; head slightly shorter than prothorax, before the eyes on either side with a series of three rather large spines, some very small spines interposed, behind the eyes armed with some minute spines; neck scarcely or obsoletely spinose; anterior lobe of prothorax with scattered small tubercles and obtuse spines, posterior lobe rugulose-punctate, lateral angles acutely produced; apex of scutellum subfoliaceous, rather obtuse; abdomen on either side somewhat flat.

"♀. Length, 14 mm.; width, 3¼ mm. Wisconsin."

Biology. Comparatively little has been written about the biology of this species, although it appears to be rather common.

Felt (1924) has reported this species to be of beneficial habits. Walden has photographed an egg mass of the insect, which photograph appears in the "Hemiptera of Connecticut" (1923), but the eggs have not been described. The writer has made some observations on the insect which may be valuable.

Habitat. This species inhabits the twigs and leaves of trees. It has been reported from fruit trees, and I have found one rather large colony on the trees of a walnut grove, and have found other scattered specimens on oak. The adults, immature stages, and eggs have been taken from such a habitat.

Food. Apparently all kinds of small tree-inhabiting insects are acceptable to this insect as food. In captivity it fed on anything offered it, including house flies, leaf hoppers, Miridæ, etc. It seemed to be very similar to the *Sinea* group in feeding habits.

Seasonal Life History. This insect spends the winter in the egg stage on the twigs of trees. In this respect it is similar to *Arilus cristatus* (Linnæus). These two species, with *Emesaya brevipennis* (Say), are the only species of Reduviidæ so far reported as winter-ing in the egg stage, though it is possible that *Zelus socius* Uhler spends the winter in the egg stage also. The eggs hatch out in early spring, during April in Kansas, and the nymphs require the greater part of the remainder of summer to become full grown, adults being found in August and September. There is but a single generation a season.

Eggs. The eggs are laid in compact masses, with from 33 to 40 eggs in a mass. The eggs are placed with the base attached to the supporting twig, and closely pressed one to another. The female usually selects for oviposition a place on the twig protected by a projecting bud or small side twig. A cement holds the eggs in place and protects them somewhat. It is not known how many masses a single female will lay during her adult life. One female under observation in the laboratory laid two masses, though it is likely that in the field several more would be laid normally.

Mating. Mating has been observed, and is similar to mating in *Sinea diadema* (Fabricus).

Length of Stages. The writer has not reared this insect through all the stages of its life history, and has only a small amount of material on this subject.

DESCRIPTION OF INSTARS.

Only the third, fourth and fifth nymphal instars and the eggs of this species have been obtained. These are described and figured.

Eggs. (Pl. XVI. Fig. 2; Pl. XVIII, Fig. 6.) Length, 2.1 mm.; width, .7 mm.; diameter of extension of chorion a little greater than width of egg. Color dark brown, with extension of chorion lighter. Shape elongate-oval, narrowed at top; extension of chorion produced from top of egg, horizontal, reticulate, with crenulate margins; cap composed of an outer, finely and evenly reticulate circular margin, a raised crater, lighter than the rest of the cap, and an inner, darker, flat, central disk. Raised crater composed of scales which incline toward center of egg.

Third Instar. (Pl. XVIII, Fig. 1.) Length of body, 5-6 mm.; length of front femur, 2 mm.; length of first antennal segment, 1.5 mm.

General color greyish brown; first antennal segment with two lighter annulations; front femur with a dark median annulus; mid and hind femora with dark preapical annuli. Dorsal surface of head and thorax slightly darker than dorsal surface of abdomen;

three dark plates on dorsal surface of abdomen at bases of segments four, five and six conspicuous.

Anteocular part of head armed above with three pairs of spines, those nearest eyes longest; postocular portion with two pairs of larger spines and many smaller ones; antennæ with segment one longest, two shortest, four longer than three. Beak with first and second segments subequal, third shorter. Pronotum with one pair of very prominent spines on disk, and many other smaller dorsal and lateral spines; mesonotum also with one pair of prominent spines. Fore femora longer than and thicker than others, and spinose; with two large preapical dorsal spines, two rows of ventral spines of five spines each, and other smaller spines. Fore tibiæ unarmed except for very minute toothlike structures; tarsi of all legs two-segmented, first segment very small, claws toothed. Wing pads present, dorsal in position, first pair extended backwards for about half the length of the metanotum, second pair extended back hardly at all. Abdomen wider and deeper than thorax, swollen in full-fed individuals, lateral margins of segments produced into small, spinelike extensions; plates at anterior margins of segments four, five and six marking openings of dorsal stink glands, guarded on each side by a spine, the posterior two pairs of spines longer than the first pair.

Fourth Instar. (Pl. XVIII, Fig. 2.) Length of body, 7.2 mm.; length of front femur, 2.5 mm.; length of first antennal segment, 2 mm. Color as in preceding instar; ventral surface of fore femur a little darker, two annuli on mid and hind tibiæ, instead of one, as in preceding.

An increase in the number of spines on the upper surface of head and thorax; longer spines in position described in preceding instar. Wing pads larger, first pair over second pair, both extended to base of second abdominal segment, margins minutely spinose.

Fifth Instar. (Pl. XVIII, Fig. 3.) Length of body, 9-11.5 mm.; length of front femur, 3.2-3.8 mm.; length of first antennal segment, 2.5-3 mm.

Much variation in color; from light greyish brown to darker chestnut brown; distribution of color much as in preceding instar; wing pads quite conspicuously darker, corium distinctly darker than membrane.

Similar to preceding in structure; spines on thorax shorter and those on mesothorax obsolescent. Fore femora thickened and spined as before, with spines proportionately smaller. Wing pads longer, slender, of equal length; extended to anterior margin of fourth abdominal segment; lateral margins of abdomen undulate, the produced portions truncate in segments four, five and six, more acute in other segments.

Localities. Ontario, Maine, Massachusetts, New York, New Jersey, Pennsylvania, North Carolina, Illinois, Wisconsin, Iowa, Nebraska, Kansas, Colorado, Arizona, Michigan, Indiana.

Acholla ampliata Stal.

Stal, Enum. Hemip., II:72; 1872.

"Similar and very closely related to the preceding (*multispinosa*), differs in that the head is somewhat shorter, the postocular part is thicker anteriorly, the thorax is wider, the tubercles on the anterior lobe a little higher, and the abdomen somewhat wider. ♀. Length, 14 mm.; width of hemelytra, 3½ mm. Habitat, Mexico, Oaxaca."

Localities. New Mexico, Arizona, Mexico.

Acholla tabida (Stal).

Stal, Stet. Ent. Zeit., XXIII:446; 1862. *Ascra tabida.*

"Pale cinnamon color; head before the middle armed with a series of spines, the anterior two spines larger, inclined forwards; anterior lobe of thorax behind the middle with three longitudinal impressions, posterior lobe rather convex, lateral angles projecting, suberect; abdomen rhomboidal, somewhat wider than hemelytra, disk of venter on either side with a series of minute fuscous spots; anterior femora below armed behind the middle on either side with two spines.

"♀. Length, 12 mm.; width, 3 mm."

Champion's notes on this species follow:

"*A. tabida* also is very like *A. multispinosa* (De G.); but it has a less elongate head, and the spiniform elevations on the head and anterior lobe of the pronotum are not nearly so prominent. The males have a narrow abdomen."

Localities. California, Mexico, Guatemala.

Genus SINEA Amyot and Serville.

Originally described by Amyot and Serville as follows:

"Head and thorax bristling above, especially forward, with extremely sharp spiny points; posterior angles of prothorax projecting a little, but sharp; the posterior disk more or less tuberculate. Scutellum not or hardly tuberculate. Elytra very nearly the length of the abdomen. Abdomen ordinarily almost linear, sometimes very much dilated and almost rhomboidal in the females. Legs of about the same size; anterior femora ordinarily larger than the others, and in this case, strongly toothed below. The other characters those of *Euagoras*."

Caudell, who monographed this genus of 1901, makes the following observations concerning the genus:

"The species of the genus *Sinea* vary much both in size and color. In general they are somber-colored and in cabinet specimens they vary many shades, from light cinnamon to almost black. If a specimen is killed soon after transformation the integument will not have become fully hardened and as a result the color is liable to be pale. The width of the abdomen varies considerably, especially in the female, where it is often distended with eggs. In short, both size and coloration are so variable as to be usually unreliable as specific characters.

"This genus is recognized by the species having the anterior legs with a dorsal spine on the femora and spines below on both the femora and tibiæ."

BIOLOGY.

The members of this genus whose habits are known spend all the stages of their life history on plants, feeding on small insects. Some are known to be forest dwellers, and others inhabitants of open, sunny fields.

WORLD DISTRIBUTION.

Caudell includes twelve species in his monograph of this genus. Of the twelve, ten are to be found within our limits and of the ten four are recorded only from North America north of Mexico, the others being shared with Mexico and Central America. The two remaining species are exclusively Neotropical according to present records.

CLASSIFICATION OF GENUS.

The species of this genus to be found within our limits may be separated by the following key, adapted from Caudell.

Key to Species of Genus Sinea to be Found in North America North of Mexico.

1. Anterior prothoracic lobe armed on the disk with spines.............. 2
   Anterior prothoracic lobe armed on the disk only with tubercles, sometimes acuminate but usually blunt.............................. 5
2. Posterior prothoracic lobe armed on the disk with sharp spines, *complexa* Caudell, p. 225
   Posterior prothoracic lobe unarmed on the disk...................... 3
3. Gibbosities on the disk of the posterior prothoracic lobe surmounted by a small tubercle. Sides of female abdomen very prominently undulate .... *undulata* Uhler, p. 224
   Gibbosities on the disk of the posterior prothoracic lobe not surmounted by a small tubercle.................................. 4
4. Margins of the female abdomen prominently undulate, the undulations usually subangulate. Male abdomen varying from almost entire to quite prominently undulate. Length, 12-14 mm., *diadema* (Fabricius), p. 218

Margins of female abdomen usually inconspicuously undulate, sometimes more pronounced but rarely so prominent as in *diadema*; the undulations generally rounded. Abdomen of the male entire, or very slightly rounded. Length, 11-13 mm..........*confusa* Caudell, p. 224

5. A pale fascia at the lateral extremity of each abdominal segment. Membrane of the hemelytra with a longitudinal dusky mark extending to the apex. Anteocular spines generally short and somewhat blunt ....*rileyi* Montandon, p. 233

The lateral extremity of the fourth abdominal segment without a pale fascia. Membrane of the hemelytra generally without a longitudinal dusky mark extending to apex. Anteocular spines variable......... 6

6. Anteocular spines sharp and well defined, the pair next the eyes usually longer than the terminal pair.................................... 7

Anteocular spines blunt, short, usually mere tubercles, the pair next the eyes not distinctly longer than the terminal pair, *defecta* Stal, p. 234

7. Disk of the posterior prothoracic lobe bigibbous. Lateral margins of the abdomen, especially of the female, undulate, scarcely so in the males 8

Disk of the posterior prothoracic lobe transversely convex, not distinctly bigibbous. Lateral margins of the abdomen not undulate in either sex 9

8. Abdomen of both sexes abruptly widened behind...*coronata* Stal, p. 225

Abdomen of neither sex abruptly widened behind....*confusa* var., p. 224

9. Abdomen of the male with margins subparallel, of the female widened to the apex of the fourth segment...............*raptoria* Stal, p. 226

Abdomen of both sexes directly widened to the apex of the fourth segment, but narrower in the male than in the female................ 10

10. Abdominal segment four and the basal half of segments five and six generally of the same color as the rest of the abdomen above, or slightly darker. First pair of anteocular spines usually twice as long as terminal pair. Usually less than 12 mm. in length, *sanguisuga* Stal, p. 226

Abdominal segment four and the basal half of segments five and six generally much darker than the rest of the abdomen. First pair of anteocular spines longer than the terminal pair, but seldom twice as long. Usually more than 12 mm. in length, *spinipes* Herrich-Schaeffer, p. 227

Sinea diadema (Fabricius).

(Pl. XIX.)

Fabricius, Genera Insectorum: 302; 1776. *Reduvius diadema.*

Fabricius' original description of this species is hardly adequate, so the description given by Caudell in his monograph of the genus *Sinea* is included instead:

"Length, 12-14 mm. Anterior prothoracic lobe armed on the disk with long spines. Posterior prothoracic lobe unarmed, bigibbous on the disk. Margins of the female abdomen prominently undulate. Abdomen of the male varying from almost entire to quite prominently undulate.

"This is our most common and best-known species and is readily separable from all others, except *coronata*, *undulata*, and *confusa*, by the distinctly undulated margins of the female abdomen. The spined anterior prothoracic lobe clearly separates it from *coronata*, but from *confusa* it can be distinguished only by comparative differences, aided perhaps in some cases by the habitat. It differs from *undulata* only in minute details."

Biology. There have appeared a number of accounts of the habits of this insect, several of them calling attention to its beneficial habits as a predacious insect. A brief account of the more important of these is given here.

Ashmead (1895) discussed this insect under the common name, "Crowned Soldier Bug." He found that it was important as an enemy of plant lice, cotton worms, and other insects in cotton fields, and described the eggs and first-instar nymphs.

Chittenden (1907) reported the insect as an enemy of the Colorado potato beetle, and later (1919) as an enemy of the striped cucumber beetle.

Morgan (1907), while working on *Apiomerus spissipes* (Say) as a possibly important enemy of the cotton boll weevil, used this insect in some of his feeding experiments for purposes of comparison, and found that it consumed larger numbers of pepper weevils and cotton boll weevils than did *Apiomerus spissipes* (Say).

R. L. Webster (1912) reported this insect as one of the natural enemies of the pear slug.

Parker (1916) discusses the feeding habits and economic importance of this insect. He describes in a very interesting manner the feeding of a small nymph.

G. W. Barber (1923) discusses the habits of this insect, giving descriptions and figures of eggs and young nymphs.

The writer has issued a paper (1924) on the life history of this insect, from which a great deal of the following material on the biology of this insect is taken.

Habitat. This insect seems to prefer definitely open, sunny fields as a home. It may be found on leaves, stems and flowers of plants, usually waiting for some insect which will serve as food to come within reaching distance. While it is not so definitely associated with flowers as is the ambush bug, belonging to the family Phymatidæ, nevertheless, at certain seasons of the year in particular, it is to be found in large numbers in flower heads. The writer has found it very commonly on daisy heads in early June, and also on goldenrod in the fall.

Food. A wide variety of insects have been recorded as serving as food for this insect. Among the economic species might be mentioned cotton aphids, cotton worms, cotton boll weevil, pepper weevil, Colorado potato beetles, striped cucumber beetles, pear slugs, small caterpillars, tarnished plant bugs, and many other insects. It is probable that it will accept any small insect that is not particularly repulsive. Cannibalism occurs to a certain extent, but probably is not important in the life economy of the insect.

Seasonal Life History. Sinea diadema winters as an adult, as do so many other Hemiptera. Adults have been taken in late November in the winter rosette of common mullein, *Verbascum thapsus.*

There are two generations a season of this insect. The writer proved this by collecting fifth-instar nymphs in June, rearing them through to the adult, mating them, obtaining eggs from them, and then rearing the resulting nymphs through to adults again the same summer. Collecting in the field produced results indicating two generations also. This is the only species of reduviid that we know of for which two generations have been proven.

Eggs. The eggs are laid in double rows on stems or leaves of plants, or on other objects, in groups of from 5 to 22, the usual number being from 8 to 12. They are attached by means of a cement. The largest total number of eggs laid by a single female in the laboratory was 412; these were laid over a period of two months. The eggs have been figured by Heidemann (1911) and Barber (1923), and described by Ashmead (1895), Heidemann and Barber.

When the egg leaves the body of the female the fringelike collar is folded up with the scales erect as in the bud of a flower, and forms a buttonlike knob on the top of the egg. Upon drying, however, the collar expands and takes a horizontal position as described later. This process of expansion, at least under the heat of a microscope lamp, required less than a minute.

Hatching. In from ten to fourteen days after being laid the eggs hatch. Stages in incubation and appearance of eye spots cannot be determined because of the opaque shell.

In hatching, the insect tilts the cap off and emerges slowly, requiring about two minutes for the operation. The young insect appears to be folded once upon itself and the top of the thorax appears first. The membrane of the postnatal molt is broken through and the body and appendages slowly freed. The legs, antennæ and beak are folded up together and are extricated by repeated pulls, first on the hind legs, then the middle legs, then on the front legs and finally the antennæ. At each pull a slight advantage is gained. When nearly cleared, the appendages are bowed out to the sides and a little additional leverage gained in this way. The short middle legs are freed first, the hind legs next, and the long front legs and antennæ last. When the appendages are all free the insect remains for a short time attached to the shell by the tip of the abdomen only, apparently waiting for the legs to become hard enough for use. Then it catches hold with its legs, easily frees the abdomen from the postnatal membrane, and stalks off. The cap of the egg frequently catches on one of the spines of the thorax and adds something to the already grotesque appearance.

Feeding of Nymphs. After hatching, the nymphs were isolated in stender dishes, given a bit of stick to rest on, and fed daily. The smaller nymphs were fed plant lice, tender leaf-hopper nymphs and very small caterpillars. Older nymphs were fed adult leaf hoppers, larger caterpillars, mirids, house flies, and various other insects. It was observed that ants and ladybird beetles were not attacked if there were other insects present that could be fed on. The nymphs, and adults as well, were cannibalistic to a certain degree, but seemed to prefer other species when they could get them.

Length of Stages. The egg stage lasted from 10 to 14 days, with 12 days as the average and usual length of egg stage.

The first stage lasted from 5 to 8 days in the insects reared, 7 days being the average length of time computed from 34 individuals.

The second stage lasted from 4 to 9 days, with 7 days as an average for 19 individuals.

The third stage lasted from 4 to 8 days, with 6½ days as an average for 13 individuals.

The fourth stage lasted from 6 to 16 days, with 9 days as the average computed from 9 individuals.

The fifth stage lasted from 8 to 15 days, with 12 days as an average for 7 individuals.

The complete life history from adult to adult may be passed through in less than two months, and this of course gives ample time for the two generations a season.

DESCRIPTION OF INSTARS.

The description of the egg given below is that prepared by G. W. Barber. The newly hatched nymphs have been described by Ashmead (1895) and Barber (1923), but as these descriptions do not fit older individuals in the first stage in all particulars, they have been modified. Former descriptions of the older instars have not been found and are included here.

Egg. (Pl. XVI, Figs. 3-5; Pl. XIX, Figs. 1-3.)

"Length, 1.3 mm.; width, .6 mm.; diameter of extension of chorion, .8 mm. Color brown, minutely granulated, somewhat shining; central area of cap brown; outer rim brown with minute, regular, white reticulations; extension of chorion white with dark lines, brown towards the inner edge; shape subelliptical, narrowed towards the cap; central area of cap raised, conelike, bluntly rounded at the tip, composed of several scales that fail to meet at the tip; outer rim of the cap flat with minute, regular reticulations; extension of the chorion on the same plane with the outer rim of the cap in new-laid eggs, after hatching or drying bending upwards or downwards, squamous, minutely so towards the inner border, gradually coarser outwards, edge sinuate; chorial processes numerous, elongate, club-shaped, within the extension of the chorion."

First Instar. (Pl. XIX, Fig. 4.) Length of body, 1.8 mm. in newly hatched individuals to 2.5 mm. in older individuals; length of front femur, .9 mm.; length of first antennal segment, .7 mm.

General color dark; head, base of antennæ, dorsum of thorax, front femur and tibia, and middorsal region of abdomen black; remainder of antennæ, front tarsi, and entire middle and hind legs brownish; lateral margins of dorsum of abdomen dirty white, especially anteriorly, eyes red. Location of spines as follows: Head, none; prothorax, one erect pair on dorsum, and anterolateral angles pointed; mesothorax, one erect pair on dorsum; abdomen, none; front femur, two ventral rows, one dorsal row, and a single preapical spine on the inner side; front tibia, two ventral rows. Openings to dorsal stink glands located in anterior portion of abdominal segments four, five and six, location marked by dark plates, unarmed in this instar.

Second Instar. (Pl. XIX, Fig. 5.) Length of body, 2.9 mm. to 3.6 mm.; length of front femur, 1.2 mm.; length of first antennal segment, 1.1 mm.

General color dark, though slightly lighter than in the preceding instar, distribution of color as in preceding instar. Location of spines as follows: Head, two large pairs and several smaller pairs; pronotum, one large pair and several smaller pairs, sides spiny; mesonotum, one large pair; metanotum, none; abdomen, one pair on each of the dark plates on abdominal segments three, four and five, and an additional pair in a corresponding position on segment six; femur and tibia as in preceding instar. Openings to dorsal stink glands located in anterior portion of segments four, five and six, location marked by plates on the posterior border of the segment preceding the opening, each plate being armed with a pair of erect spines.

Third Instar. (Pl. XIX, Fig. 6.) Length of body, 4.7 mm. to 5.1 mm.; length of front femur, 1.9 mm.; length of first antennal segment, 1.5 mm.

General color much lighter than in preceding instar, tawny, mottled, fairly uniform, with head, bases of antennæ, top of thorax, front femora and three plates on dorsum of abdomen slightly darker than the other parts. Location of spines as follows: Head, three pairs of large spines and several smaller ones cephalad of transverse suture; one pair of large spines and several smaller ones caudad of transverse suture; pronotum, two pairs of large spines, the anterior one of which is branched at the base, and many smaller spines on top and sides; mesothorax, one large pair present on dorsum and several smaller spines on pleuræ; abdomen, spines present as in the preceding instar with the addition of small spines on the dorsal surface and at the lateral edges of the abdominal segments. Wing pads present in this instar, extended only to first abdominal segment. Openings to dorsal stink glands as in preceding instar.

Fourth Instar. (Pl. XIX, Fig. 7.) Length of body, 6.7 mm. to 7.7 mm.; length of front femur, 2 mm.; length of first antennal segment, 2 mm.

General color tawny to darker, mottled. Location of spines as follows: Head, three pairs of large spines and several smaller ones cephalad of transverse suture, three pairs of large spines and several smaller ones caudad of transverse suture; prothorax, very spiny, with many large spines on dorsum, and smaller spines on both dorsum and pleuræ; mesothorax, one large pair on dorsum and several smaller spines on pleuræ; metathorax as in preceding instar; abdomen, as in preceding instar with an increase in the number of spines on the dorsal surface; front femur, as in preceding instars except that basal spines in dorsal row are becoming obsolete, the apical spine alone now being well developed. Wing pads now extended over second abdominal segment.

Fifth Instar. (Pl. XIX, Fig. 8.) Length of body, 8.8 mm. to 10.4 mm.; length of front femur, 4 mm.; length of first antennal segment, 3.3 mm.

General color light tawny, mottled. Location of spines as follows: Head, as in the preceding instar but spines longer; prothorax, spines very numerous, long, conspicuous, present both on dorsum and pleuræ; mesothorax, one large pair, one slightly smaller pair, and several very small pairs present on the dorsum and many others on the pleuræ; metathorax, many spines on the pleuræ; abdomen, as in preceding instar with an increase in the number of spines on dorsal surface. Wing pads now extended over third abdominal segment.

Localities. Reported from Quebec south to Florida and west to California. Probably quite uniformly distributed over the United States and southern Canada.

Sinea undulata Uhler.

Uhler, Proc. Cal. Acad. Sci., Ser. 2, IV:282; 1894.

"Brownish-cinereous, pale gray, pubescent, similar to *S. diadema* Fabr., but wider, with a shorter neck and femora, with the spines more numerous and crowded together on the front division of the head, with the carinate lines of the middle of the pronotum prominent and sharply defined, and the knobs each side of the base elevated, and surmounted by a little tubercle; three double series of spinelike, black tubercles on the anterior lobe of the pronotum. Venter with a series of oblique, white spots on each side near the border more prominent and placed further back than in *S. diadema;* the inner margin of the corium white.

"Length to tip of venter, 14-15 mm. Width of pronotum, 3 mm.

"This appears to be a common species in southern California and in Lower California. Specimens were collected at San Jose del Cabo, and at the Calmalli mines by Mr. C. D. Haines."

The following notes on this species are given by Caudell:

"This species, which will probably prove to be a variety or aberration of *diadema,* is quite a characteristic-appearing insect. The type has been seen and it seems to agree perfectly with the description. None of the many specimens of *Sinea* examined by me were referable to this species."

Localities. California and Lower California.

Sinea confusa Caudell.

Caudell, Jour. New York Ent. Soc., IX:6; 1901.

"Length, 10-13 mm. Prothoracic lobes as in *diadema.* Abdomen of the female generally inconspicuously undulate, sometimes more pronounced but never as prominent as in the typical *diadema.* The undulations usually rounded. Abdomen of the male entire, or very slightly undulate.

"This species has hitherto been confounded with *diadema.* The two species do approach each other very closely, but the extremes are conspicuously distinct. *Confusa* has also been confounded with *undulata,* but it is difficult to see how that could occur. The author's description of *undulata,* it seems, would preclude such a possibility.

"Of this species I have seen specimens from California, Arizona and Texas in the United States, and from various localities in Mexico and Central America. Its habitat will aid to an extent in separating it from *diadema.*

Specimens sent from Mexico by Mr. Champion have the abdomen of the females very slightly undulate, while those of the males are practically entire."

Localities. Texas, Arizona, California, Mexico, Central America.

Sinca coronata Stal.

Stal, Stet. Ent. Zeit., XXIII:444; 1862.

"Dark cinnamon; head before the eyes with six large spines, behind with two very large spines, some other very small spines interspersed; anterior lobe of thorax with scattered acute protuberances. ♀. Length, 15 mm.; width, 3 mm.

"Head granulate, before the eyes on either side armed with a series of distinct spines, interposed with other small spines, posterior spines longest; neck scarcely spinose. Antennæ pale, first segment dark annulated before apex. Anterior lobe of prothorax rather thickly scattered with small acute grains or tubercles, posterior lobe punctate, disk with two large tubercles, these obtuse, moderately elevated, lateral angles rather acute. Apex of scutellum rounded, attenuate. Segments four, five and six of abdomen flat on either side."

The following description is given by Caudell:

"Length, 13-15 mm. Anterior prothoracic lobe without spines on the disk, furnished only with conical tubercles. Posterior lobe unarmed, bigibbous on the disk. Abdomen of both sexes abrubtly widened behind.

"This characteristic species is readily distinguished from all others by the abrubtly widened abdomen in both sexes, as illustrated. *Diadema* is its nearest ally, and from it it is distinguished at a glance by the anterior prothoracic lobe being without spines on the disk."

Localities. Texas, California, Mexico, Guatemala.

Sinca complexa Caudell.

Caudell, Can. Ent., XXXII:67; 1900.

"Length, 8-11 mm. Anterior prothoracic lobe distinctly spined. Posterior lobe with well-defined spines on the disk, which is transversely convex, not bigibbous. Abdomen with well-rounded sides, margins entire. Anterior femora with the last two ventral spines of the inner row out of alignment, the terminal one the more so, being subdorsally located.

"This well-marked little species is at a glance recognized from all the other species, *integra* alone excepted, by the posterior prothoracic lobe being distinctly spined on the disk. The peculiar armature of the anterior femora serves to separate it from *integra*."

Biology. Van Duzee reports taking this species from San Diego county, California, during April and May, and that it is apparently rare.

Localities. Colorado, Utah, Arizona, California.

Sinea raptoria Stal.

Stal, Stet. Ent. Zeit., XXIII:444; 1862.

"Dark cinnamon; annulus before middle of basal antennal segment and posterior femora, as also the tibiæ towards apex pale; anterior lobe of prothorax armed with minute rather acute tubercles, posterior lobe with lateral angles acute, turned backwards; abdomen of female rhomboidal, apical angles of segments one, two, three, five and six pale-colored. Female. Length, 9½ mm.; width, 2 mm.

"Very closely related to *S. sanguisuga*, abdomen a little more flat, lateral angles of posterior lobe of prothorax turned backwards, not turned outwards."

Champion gives the following valuable notes on this species:

"The male of *S. raptoria* was unknown to Stal. It is very like that of *S. caudata*, but the apex of the abdomen is subtruncate and not produced. In this sex the abdomen is long and narrow, subparallel to the apex of the fifth segment and narrowing thence to the apex, the outer apical angles of the fourth segment being more or less prominent. The connexival margins are minutely denticulate in both sexes. The third spine of the double series on the anteocular portion of the head is very elongate. The females are only separable from those of *S. defecta* by this last-mentioned character; but the males of these two species are very different. The anterior lobe of the pronotum is set with very short subconical tubercles. In our numerous Mexican and Guatemalan specimens the spiniform lateral angles of the pronotum are directed backwards a little, while in the long series of both sexes from Chiriqui they are directed outwards, but this difference is not constant."

Caudell gives the following description and notes:

"Length, 8-11 mm. Anterior prothoracic lobe armed with short conical tubercles. Posterior lobe unarmed, convex on the disk. Abdomen entire, not caudate, subtruncate at apex.

"This species is closely related to *caudata* and *sanguisuga*, but may be separated from them by characters given in the table. The males are necessary for a correct determination."

Localities. Arizona, California, Mexico, Guatemala, Panama, Colombia.

Sinea sanguisuga Stal.

Stal, Stet. Ent. Zeit., XXIII:444; 1862.

"Fuscous or blackish; annulus before the middle of the basal segment of the antenna, sometimes also an annulus on the posterior femur and on the median tibia pale; anterior lobe of prothorax granulate, lateral angles of posterior lobe acute, produced outwards. ♀. Length, 10-11 mm.; width, 2 mm.

"Head before the eyes with a series of six spines, the two posterior spines longest, behind the eyes; also on the neck on either side some small spines and near the eyes two larger spines. Anterior thoracic lobe armed with minute tubercles; lateral angles of posterior lobe acute, produced outwardly. Abdomen of female rhomboidal, medially on either side obtuse-angled and flat, lateral macula at apex of segments two, three and five dirty pale."

Champion gives the following notes:

"*S. sanguisuga* agrees with *S. defecta* in having the abdomen somewhat similarly shaped in both sexes, but considerably narrower in the males than in the females: it is widened to the apex of the fourth segment and narrowed thence to the tip, the outer apical angles of the fourth segment, and those of the fifth also, in the males, being sometimes prominent or subdentiform. The connexival margins are crenulate or finely denticulate. I am unable to find any certain character by which to distinguish some of the females before me from those of *S. raptoria*."

The following description and notes are given by Caudell:

"Length, 10-13 mm. First pair of anteocular spines usually twice as long as the third pair. Thorax as in *raptoria*. Abdomen entire, outer angles of the fourth segment sometimes prominent or subdentiform, especially in the male, where sometimes the fifth segment is also slightly prominent. Segments four and basal half of segments five and six usually of the same color as the rest of the abdomen, sometimes slightly darker.

"Some difficulty may be experienced in separating it from *spinipes* as the differences here are but relative. The abdomens of the males are usually sharply angulated on the fourth segment, sometimes also on the fifth."

Biology. Blatchley reports that this species occurs in late autumn on flowers of goldenrod, and in the spring on weeds in Florida.

Localities. Texas, Mexico, Guatemala, Florida, Indiana.

Sinea spinipes (Herrich-Schaeffer).

(Pl. XX.)

Herrich-Schaeffer, Wanz. Ins., VIII:82, fig. 851; 1848. *Harpactor spinipes.*

"Brownish grey, femora nodulose, anterior femora thickened, with apex and anterior part thickened."

Caudell's description of the species is fuller and more satisfactory than the above, and is therefore included.

"Length, 12-15 mm. First pair of anteocular spines seldom twice as long as third pair. Thorax as in *sanguisuga*. Abdomen entire. The fourth and basal half of segments five and six of the abdomen generally conspicuously darker than the rest of the body, usually more constant in the females."

Biology. A biological note concerning this species has been recorded by Caffrey and Barber (1919). They have observed that the nymphs of this insect feed upon the nymphs of the grain bug, *Chlorochroa sayi* Stal, in the field. The writer has made observations on and rearings of this species during two summers and can add something to what is known concerning it.

Habitat. This species seems to be more of a shade lover than is *Sinea diadema.* Instead of being found in open fields and meadows it is usually taken in woodlands, on the twigs and leaves of forest trees. In Kansas it has been taken from hickory, walnut, pawpaw, various oaks and elm, and it is probable that it may be found on any species of forest tree.

Food. A wide variety of insects is accepted by this insect in the laboratory, and it is probable that it feeds on any of the smaller insects that are to be found on the leaves and branches of trees. Adults feed very readily of fall webworm larvæ and various other caterpillars, and small flies, bees and beetles are also accepted. Young nymphs accepted first-instar walnut *Datanas*, and fall webworm larvæ about one-half inch long. They are apparently very fierce and attack caterpillars much larger than themselves, actually riding the caterpillars, with their beaks inserted, if necessary. In one case observed it took a first-instar *Sinea spinipes* nymph twenty-five minutes to quiet a half-inch webworm. During most of this time the small assassin bug was riding on the caterpillar with its beak inserted. In another instance it took from two to five minutes for first-instar nymphs to quiet very small, practically newly hatched walnut *Datana* larvæ. In addition to these insects, the nymphs will feed on leaf hoppers, small flies, nymphs of the tarnished plant bug, and undoubtedly many other small insects. It should not be forgotten, furthermore, that Caffrey and Barber have reported the insect as a natural enemy of the grain bug, *Chlorochroa sayi.*

Seasonal Life History. From the evidence at hand it seems clear that *Sinea spinipes* spends the winter as an adult. One specimen in my collection was collected on February 25, 1925, under leaves in woodland, evidently in hibernating quarters. The fact that only adults are to be found when the insect first emerges in the spring supports this conclusion also.

This insect, unlike *Sinea diadema,* has but a single generation a year. Adults emerge from hibernating quarters early in the spring, deposit eggs as early as late April and early May, and the members of this generation may become adult by early July. However, the overwintering adults may continue oviposition until early August, and consequently some of their offspring do not become adults until quite late in the season.

Eggs. The eggs are deposited on leaves, or possibly twigs, in a double row, similar to the egg mass of *Sinea diadema.* There are some distinct differences, however. The eggs of *spinipes* incline more from the vertical than do those of *diadema,* and consequently the tops are not in such close juxtaposition. There is less adhesive material used in the case of *spinipes,* while in the case of *diadema* the cement used to attach the eggs to their support is rather conspicuous.

The number of eggs to a mass varies considerably, from seven to fifteen being the usual number, though there may be a few more or less than these numbers. It is not the usual thing for the eggs to be deposited singly, however.

The total number of eggs deposited by a single female has not been determined to the writer's satisfaction. The greatest number of eggs deposited by any female in the laboratory was 163. These eggs were laid over a period from June 21 to July 28, and included sixteen separate masses. It is probable that this female had deposited some eggs before she was captured on the earlier date, as other individuals which have been captured earlier have deposited eggs freely. One individual which was taken in late April deposited eggs, but unfortunately died soon after.

The act of oviposition has been witnessed. It is similar to that recorded for *diadema.* As in *diadema* the ornamented cap of the egg is folded up when the egg leaves the body of the female, and unfolds and becomes rigid during a short drying period.

Specimens of this egg are present in the United States National Museum collection of hemipterous eggs, but, so far as the writer has been able to find out, have never been described. Therefore a description is included later with the descriptions of the nymphal instars of the insect. In general it may be said that they are similar to those of *diadema,* but with some very distinct differences.

Hatching has been observed, and is similar to the process in *diadema.* The head, thorax, antennæ and legs are red in the newly hatched insect, and the abdomen pale yellow, but the normal colors soon appear.

Nymphal Habits. The nymphs have the habit of taking a position on a leaf, usually somewhat curled, and waiting for prey to come along. They have been observed in this position on oak trees a number of times. The insect passes through the usual number of five molts before becoming adult.

Mating. Mating has been observed and is similar to mating in *diadema.* In each case the tip of the beak of the male is applied to the point of junction of the head and prothorax of the female, and seems to be used as an additional brace.

Length of Stages. Several individuals have been reared through the whole course of their life history from adult to adult, and the length of the different stages in each case should be valuable. This is given for four individuals in the following table:

Stage.	Individual No. 1.		Individual No. 2.		Individual No. 3.		Individual No. 4.	
	Date.	No. days.	Date.	No. days.	Date.	No. days.	Date.	No. days.
Eggs laid	June 26	.....	June 28	.....	June 28	.....	June 28	.....
Hatched	July 11	14	July 13	15	July 13	15	July 13	15
Second stage	July 20	9	July 23	10	July 23	10	July 24	10
Third stage	July 24	4	July 29	6	July 29	6	Aug. 1	9
Fourth stage	July 31	7	Aug. 5	7	Aug. 4	6	Aug. 9	8
Fifth stage	Aug. 9	9	Aug. 17	12	Aug. 18	14	Aug. 19	10
Adult	Aug. 24	15	Sept. 1	15	Sept. 4	17	Sept. 4	16
Totals	....	58	....	65	....	68	....	68

While the examples given above are uniform in that the eggs in each case were deposited in late June and the insects resulting from them became adult in late August or early September, it should be remembered that this is not the case for all the insects of this species, as the egg-laying period extends from late April to early August, and the yearly brood of insects might become adult anywhere from late May to early October.

In a larger series than that given above the following periods were found necessary for the stages given:

The egg stage lasted from 12 days, in the warmer days of summer, to as long as 20 days in the cooler parts.

The first stage varied from 8 days, which was the usual length of time in hot weather, to 13 days.

The second stage varied from 4 to 8 days and was passed through more quickly than any other stage.

The third stage was also short and varied from 6 days to 9 days. The average time for 8 individuals was 7 days.

The fourth stage lasted from 8 days to 14 days, and the average for 9 individuals which passed through this stage was 10 days.

The fifth stage lasted from 12 days to 17 days, and the average for 5 individuals was 15 days.

In general it might be said that it takes about two months for the insect to become adult after the eggs have been deposited.

DESCRIPTION OF INSTARS.

Egg. (Pl. XX, Fig. 7.) In size, shape and general appearance very similar to that of *Sinea diadema.* Length, 2.1 mm.; width, .8 mm.; diameter of extension of chorion, 1.1 mm. Color brown, extension of chorion buff, darker near rim of cap; central area of cap brown, with central spines darker. Shape elongate-ovate, slightly narrowed towards cap; extension of chorion produced from top of egg, reticulated, margin irregular and much incised. Central area of cap disklike, with erect spine in center. Periphery of cap with a dark membrane, divided into many very delicate, filamentous, erect appendages.

This egg may be distinguished easily from that of *Sinea diadema* from the fact that in *diadema* the extension of the chorion is lighter in color and less deeply incised than in *spinipes;* the scales of the cap are more numerous and conspicuous, and are inclined toward the center of the egg in *diadema,* but are less numerous and erect in *spinipes.*

First Instar. (Pl. XX, Fig. 1.) Length of body from 1.7 mm. in newly hatched individuals to 2.1 mm. in older individuals; length of front femur, .36 mm.; length of first antennal segment, .85 mm.

General color dark; head, rostrum, basal half of first antennal segment, thorax, legs, with exception of front tarsi and apical half of mid and hind tibiæ, and median dorsal region of abdomen black; other parts dirty whitish.

Head rather elongate, narrower at base, bears no spines in this instar; antennæ filiform, four-segmented, first and fourth segments longest, others shorter. Thorax slightly wider than head, dorsum of prothorax with a pair of erect spines, and dorsum of mesothorax with a pair of much smaller spines. Fore legs thickened, especially the femora; each femur with six rows of spines, two ventral, two dorsal, and two lateral, the two ventral rows of five spines each, the apical dorsal spines the most prominent; tibiæ with three pairs of well-developed spines. Mid and hind legs much more slender than fore legs, mid legs shortest. Abdomen slightly swollen, openings to stink glands marked by dark plates on dorsal surface.

Second Instar. (Pl. XX, Fig. 2.) Length of body, 3.86 mm.; length of front femur, 1.36 mm.; length of first antennal segment, 1.19 mm.

General color somewhat lighter; distribution of color as in preceding; front tibiæ now dark only at base, and middle and hind legs without dark coloration; dark median area on dorsal surface of abdomen now lighter.

Head with four pairs of spines in this instar, two anterior to, and two posterior to epicraneal suture. Pronotum with one large and one small pair of spines on disk, the more cephalic pair the larger, and an additional pair at the caudocephalic angles. Meso- and metanota each with a small pair of spines on the disk. Abdomen with three pairs of erect spines guarding the openings of the dorsal stink glands and one pair of spines on the segment immediately following, also very small spines along lateral margins. Front legs with spines in same arrangement as in preceding instar.

Third Instar. (Pl. XX, Fig. 3.) Length of body, 5.3 mm., length of front femur, 1.87 mm.; length of first antennal segment, 1.6 mm.

Much lighter in general color than preceding; head, thorax and dorsal region of abdomen in region of stink glands now brownish, somewhat mottled; front femora dark, especially apically, marked by a lighter band at about two-thirds the length, front tibiæ dark basally, light apically; antennæ, except for dark base of first segment, mid and hind legs, and remainder of abdomen dirty white.

Head now with six prominent pairs of spines, three before epicraneal suture, of which the most caudal are the longest, and three behind the epicraneal suture, of which the second pair are the longest. Pronotum with three pairs of conspicuous spines on disk, the anterior pair two-branched; also with spines at anterior and posterior lateral angles. Mesonotum with a pair of erect spines on disk; wing pads also with small lateral spines. Abdomen with spines on the segment containing the openings of the stink glands, and also on the segment immediately following these; spines along lateral margins of abdomen strong in this instar. Front legs spined as in preceding instar. Wing pads present, very small, apices extended only to first abdominal segment.

Fourth Instar. (Pl. XX, Fig. 4.) Length of body, 6.9 mm.; length of front femur, 2.55 mm.; length of first antennal segment, 1.93 mm.

General color more of a uniform mottled greyish brown than in preceding instars, dorsum of head and thorax and dorsal abdominal plates marking openings of stink glands darker. Fore femora mottled greyish brown basally with black apex; front tibiæ dark basally, light apically; middle and hind legs light, femora with a faintly darker preapical band.

Spines on head as in preceding instar with addition of a number of small spines; prothorax with an increased number of spines; in abdominal region spines at openings of stink glands smaller, those along lateral margins of abdomen more distinct. Spines on fore legs as in preceding instars. Wing pads larger, now extended to second abdominal segment.

Fifth Instar. (Pl. XX, Fig. 5.) Length of body, 9.2 mm. to 10.2 mm.; length of front femur, 3.7 mm.; length of first antennal segment, 2.9 mm.

General color mottled greyish brown; head somewhat darker at base and at epicraneal suture; antennæ banded with different shades of brown; prothorax with caudal margin darkest, cephalic and lateral margins lighter; wing pads rather dark, especially so at apices; abdomen mottled, with dark plates on dorsum at openings of stink glands; front femora mottled, with dark band at apex; of the two ventral rows of spines on front femora the outer row is dark and the inner row light, dorsal apical spine dark at base, light at apex; fore tibiæ darker for basal half and at extreme apex; outer row of tibial spines dark, inner row light; mid and hind legs lighter than fore legs, darker at apices of femora, tibiæ and tarsi.

An increase in the number of spines on the upper surface of the body in this instar; the lateral margins of the abdomen rather deeply notched and with conspicuous spines; spines on fore legs as in preceding instars. Wing pads now extended almost or quite to fourth abdominal segment.

Localities. Probably rather widely distributed over the greater part of the United States, at least east of the Rocky Mountains, and in addition recorded from Mexico, Central America and South America. Its occurrence in the last-mentioned locality is questioned.

Sinea rileyi Montandon.

Montandon, Proc. U. S. Nat. Mus., XVI:51; 1893.

"Ferrugineous brownish with a grayish pubescence, very short and not so dense upon the elytra, denser beneath, especially on the breast. Posterior and middle femora and all tibiæ in the middle paler than the body. Head a little shorter than the pronotum, with a double row of three short spines before the eyes, the anterior spines longer than the posterior, and behind the eyes on each side two tubercles before and behind the ocelli. Neck not spinose. Anterior part of the pronotum covered with small, not very acute tubercles, more robust at the middle, the anterior part one-fourth shorter than the posterior, which is granulose; disk much swollen, with a slight longitudinal impression in the middle; lateral angles slightly acuminated; posterior margin narrowly pale with two small teeth alongside the scutellum. Elytra paler at the base, the lateral margins and the small quadrangular discoidal cell near the membrane; brownish on the disk and at the terminal exterior angle. Membrane pale vitreous with a brownish black spot at the interior angle, divided and continued upon the nervures and reaching to the extremity of the membrane. Abdomen much broader than the elytra (♂ and ♀), laterally margins largely rounded in the two sexes, especially ♀, with a broad pale fascia at the extremity of each segment. Abdomen beneath ferrugineous, paler in the middle. Anterior femora as in all species of the genus *Sinea,* with sometimes whitish and very slender hairs. Superior spine at the extremity of the femora robust and pale as the spines of the inferior part. Antennæ wanting in the specimen before me.

"♂: length, 9¾ mm; abdominal width, 2¾ mm. ♀: length, 11 mm; abdominal width, 4 mm. Panamint Valley, California. Collection of the United States National Museum and my own."

The following description and notes are given by Caudell:

"Length, 9.5-12 mm. Head with large tubercles or short blunt spines before the eyes instead of well-developed spines. A pale fascia at the lateral extremity of each segment of the abdomen, which is entire and with the margins well rounded, not at all angulated at the sides in either sex. Membrane of the hemelytra with a longitudinal dusky mark extending to the top, rarely obsolete or not easily seen.

"This species is somewhat allied to *sanguisuga* and related forms, but the short anteocular spines will serve to distingush it from all except *defecta,* in which case the characters given in the table will serve to distinguish it. It was described from California and there are specimens in the National Museum from Texas and Arizona. There is also a single specimen labeled 'North Carolina.' This seems quite out of its ordinary range and the specimen may be wrongly labeled.

"The antennæ of this species are obscurely ringed with pale bands on the first segment, in some cases scarcely visible."

Biology. Van Duzee reports this species as common from March to October at San Diego county, California.

Blatchley reports that it occurs on low shrubs in open pine woods in Florida.

Localities. North Carolina, Florida, Texas, Utah, Arizona, California.

Sinea defecta Stal.

Stal., Stet. Ent. Zeit., XXIII:445; 1862.

"Dark cinnamon; head before the eyes on either side with a series of minute, rather acute tubercles, and near the antennæ on either side a rather short, obtuse spine, some minute tubercles in the region of the ocelli; anterior lobe of prothorax with small scattered tubercles, lateral angles of posterior lobe straight; apex of scutellum subfoliaceous, rounded; dorsum of abdomen black, on either side somewhat rounded and flat, apices of segments two, three and five marked with pale on either side; two annuli on the basal segment of the antennæ, and an obsolete annulus of the posterior femora pale. ♀. Length, 14 mm.; width, 3 mm."

Champion gives the following discussion of this species:

"Stal's first description appears to have been made from a single imperfect female example, with the long spine near the apex of the upper side of the anterior femora broken off. In some specimens the second and third spines of the series on each side of the anteocular portion of the head are reduced to small rounded tubercles, but in others they are as long as the anterior one. The anterior lobe of the pronotum is set with scattered rounded or short subconical tubercles; the posterior lobe is very coarsely rugose, without distinct gibbosities on the disk; the lateral angles are moderately acute. The abdomen is very similarly shaped in both sexes, somewhat rounded at the sides, but narrower in the male than in the female; it is gradually widened to the apex of the fourth segment and narrowed thence to the apex, the outer apical angles of the fourth segment being more or less prominent in the male; the connexival margins are feebly serrulate.

"*S. defecta* is very like an insect from the Southern United States sent to me by Prof. Uhler as *S. spinipes* (Herrich-Schaeffer), as a species not identified by Stal; but in the latter the lateral angles of the pronotum are more acute and the spines on the head are longer; *S. rileyi* Montandon, from California, must also be a nearly allied form. The comparatively short third spine or tubercle of the anteocular series will separate the present species from many of its allies."

Caudell's description and notes on this species follow:

"Length, 11-13.5 mm. Head and thorax as in *rileyi*. Abdomen entire, segment four without a pale fascia. The fourth and the basal half of segments five and six of the abdomen usually darker than the rest of the body, generally more constant in the females. Abdomen of the males with the apical angles of the fourth segment slightly prominent or subangulate. Membraue of the hemelytra without a longitudinal dusky mark.

"This species resembles *spinipes* in coloration, size and form but is at once distinguished from it, as well as from all others, by having only very short blunt spines or tubercles on the anterior part of the head."

Localities. Arizona, Mexico, Guatemala, Nicaragua, Costa Rica. Panama.

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EXPLANATION OF PLATES.

PLATE I.

Emesaya brevipennis (Say).

1. First instar.
2. Second instar.
3. Third instar.
4. Fourth instar.
5. Fifth instar.
6. Adult.
7. Egg, 6 × scale of 1-6.

PLATE I.

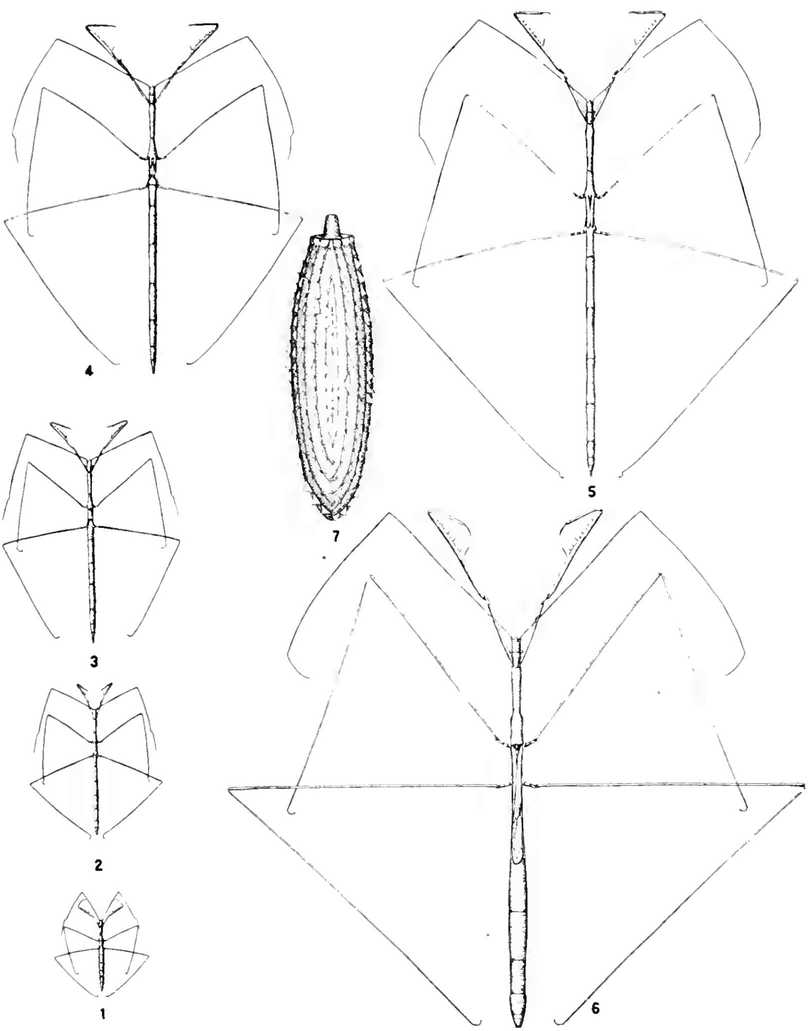


PLATE II.

Metapterus fraternus (Say).

1. Fifth instar of winged individual.
2. Fifth instar of wingless individual.
3. Winged adult, male.
4. Wingless adult, female.
5. Egg, 3 × scale of 1-4.

PLATE II.

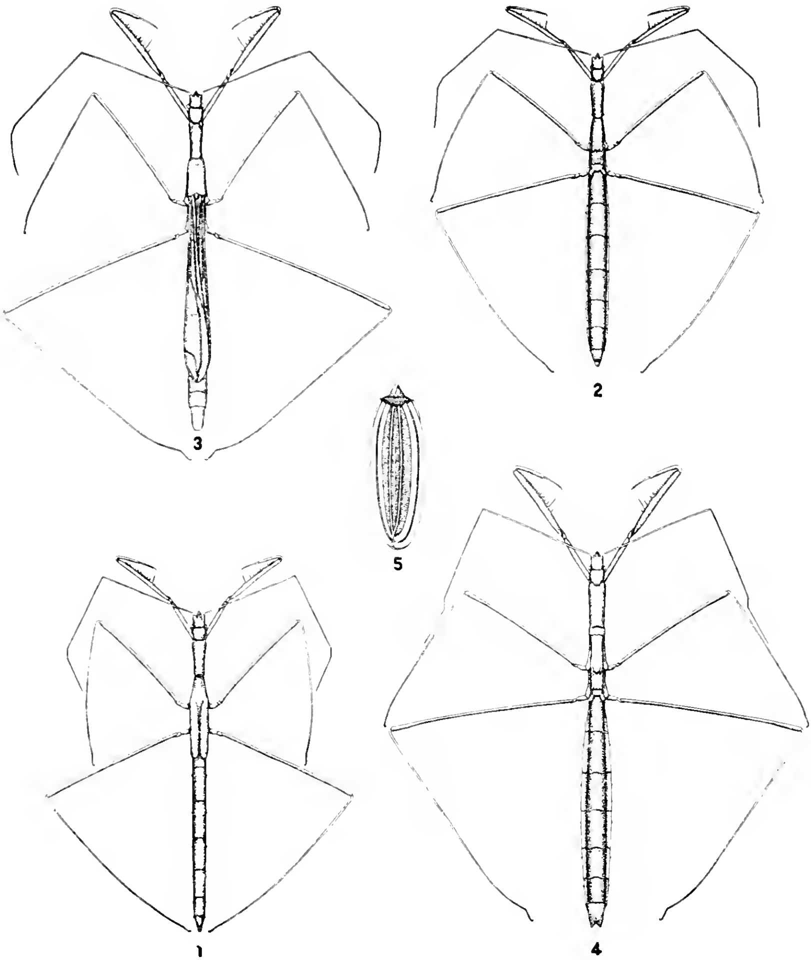


PLATE III.

Pygolampis pectoralis (Say).

1. Third instar.
2. Fourth instar.
3. Fifth instar.
4. Adult male.

PLATE III.

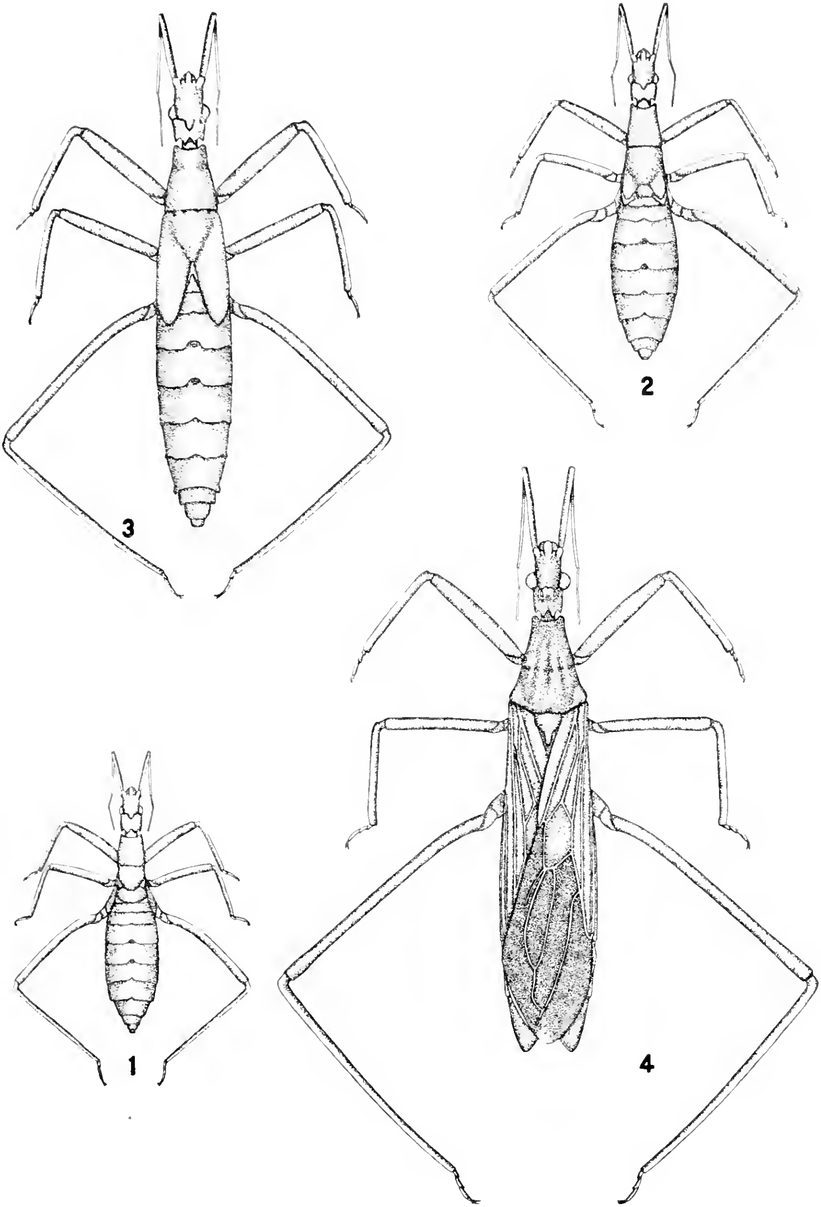


PLATE IV.

1. Egg of *Oncocephalus geniculatus* (Stal) in natural position in ground.
2. Same, lateral view, before hatching.
3. Same, lateral view, after hatching.
4. Egg of *Reduvius personatus* (Linnæus).
5. Egg of *Melanolestes picipes* (Herrich-Schaeffer) in natural position in ground.
6. Same, lateral view, before hatching.
7. Same, lateral view, after hatching.
8. Egg of *Rasahus biguttatus* (Say) in natural position in ground.
9. Same, lateral view, before hatching.

PLATE IV.

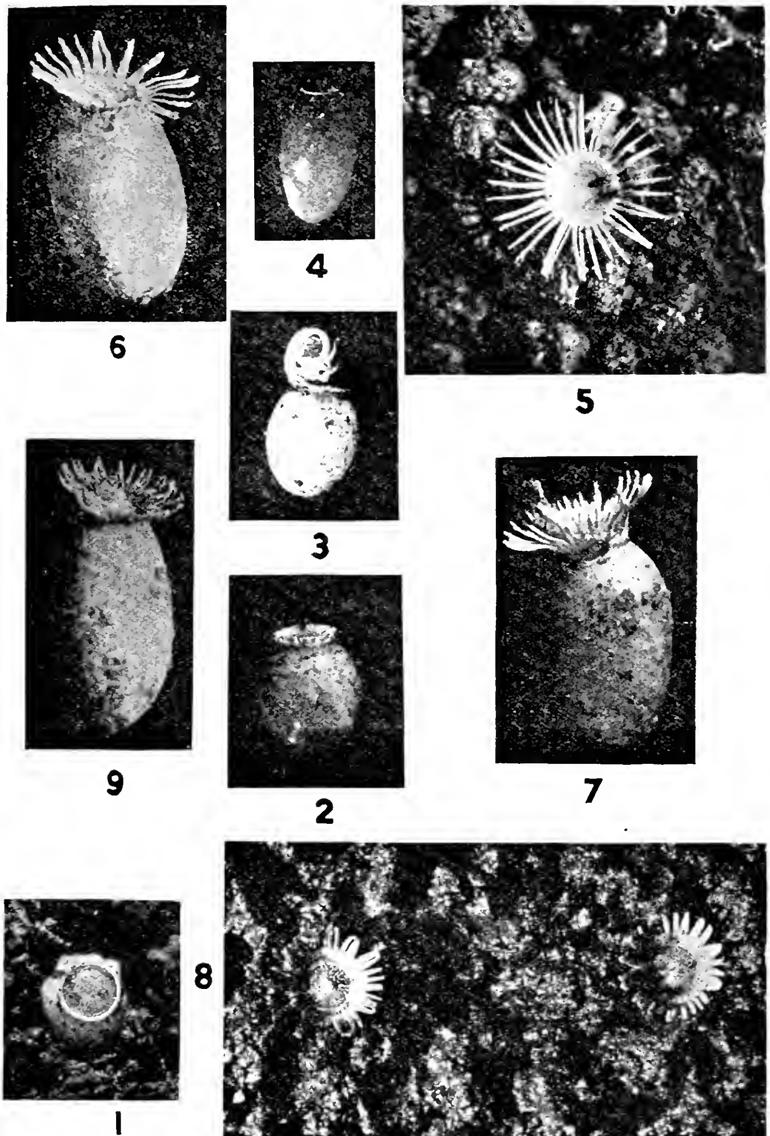


PLATE V.

Oncocephalus geniculatus (Stal).

1. First instar.
2. Second instar.
3. Third instar.
4. Fourth instar.
5. Fifth instar.
6. Adult male.
7. Adult female, wingless.
8. Egg, 3 × scale of 1-7

PLATE V.

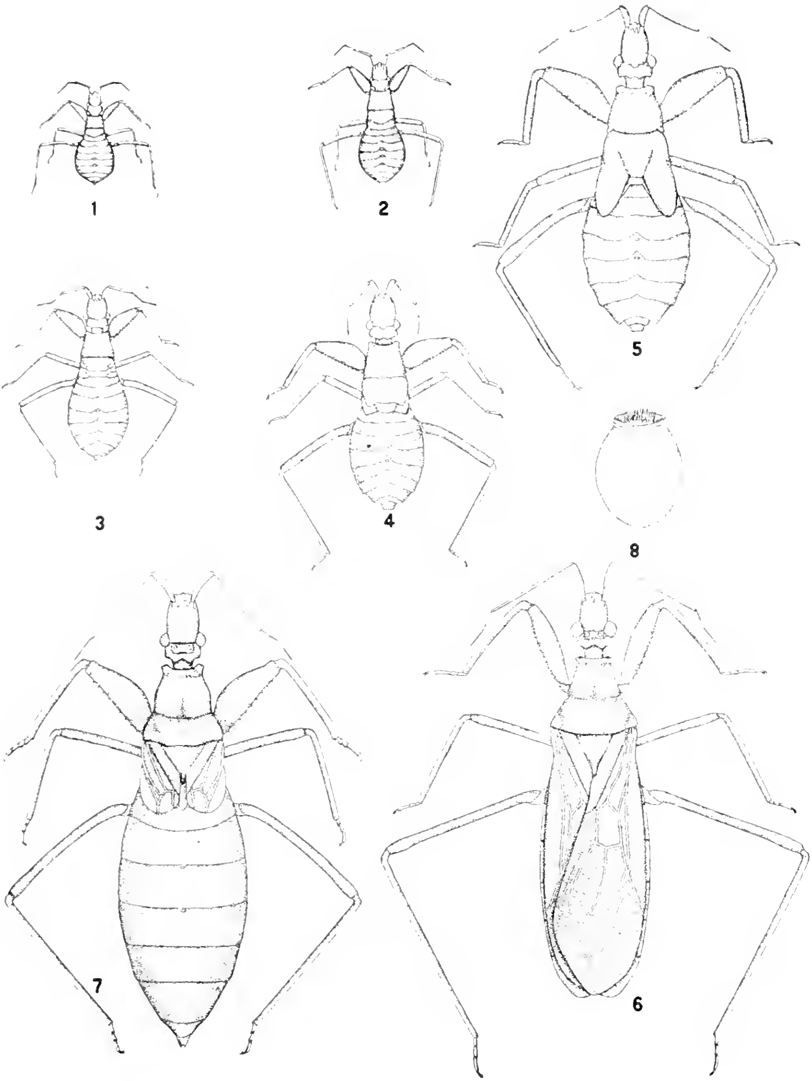
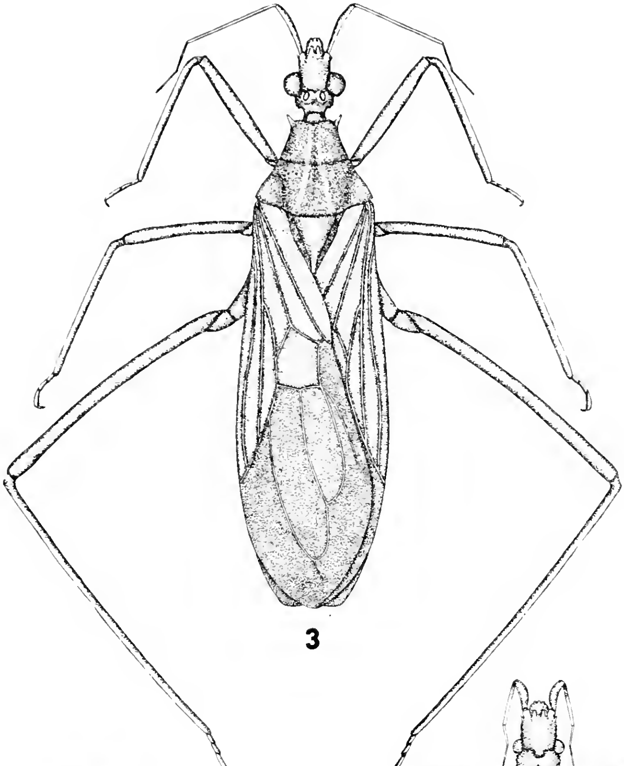


PLATE VI.

Narvesus carolinensis Stal.

1. Fourth instar.
2. Fifth instar.
3. Adult male.

PLATE VI.



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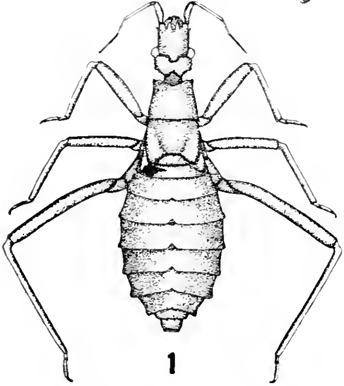

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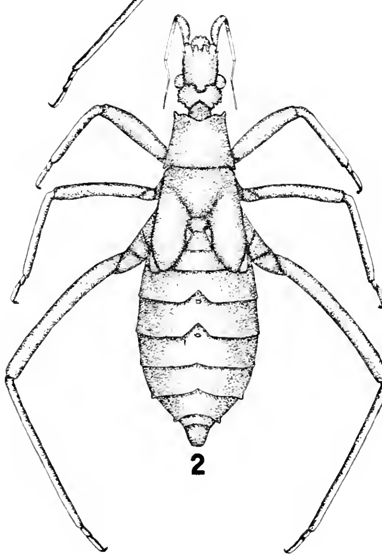

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PLATE VII.

Reduvius personatus (Linnæus).

1. First instar.
2. Second instar.
3. Third instar.
4. Fourth instar.
5. Fifth instar.
6. Adult female.
7. Egg, 3 × scale of 1-6.

PLATE VII.

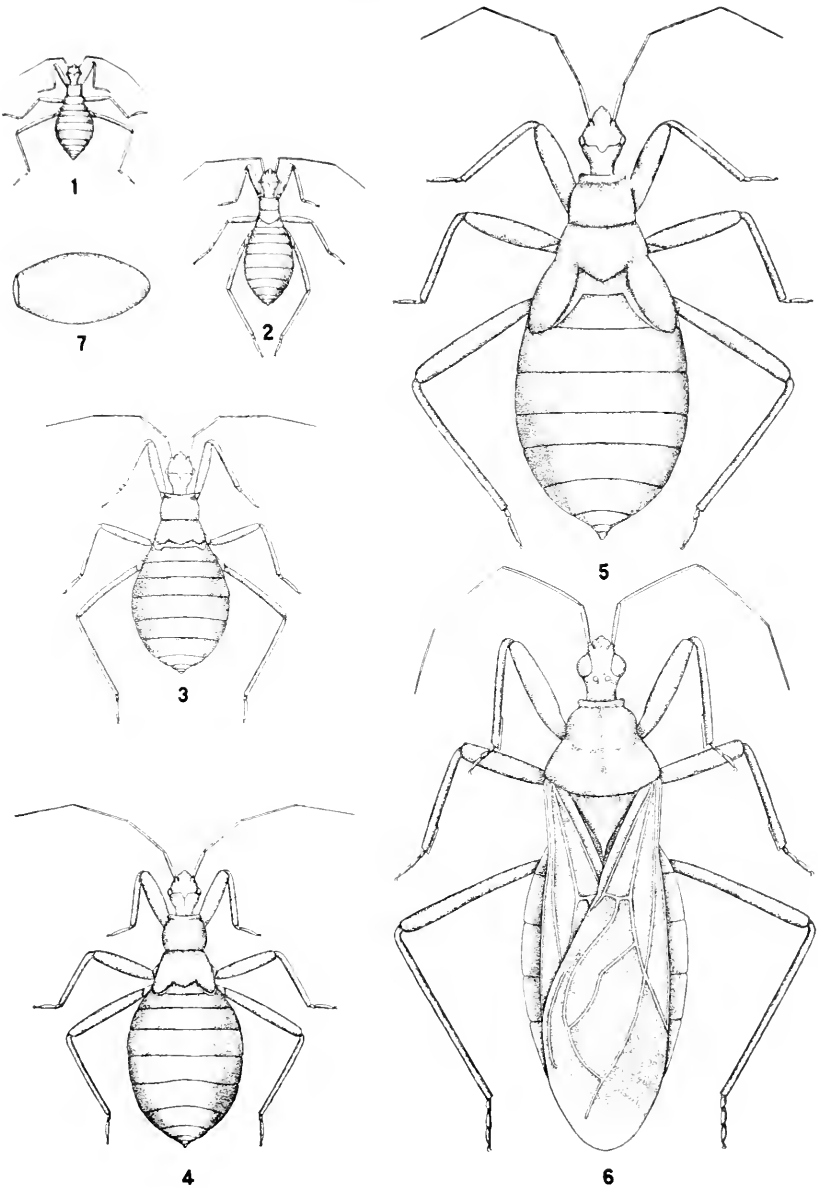


PLATE VIII.

Melanolestes picipes (Herrich-Schaeffer).

1. First instar.
2. Second instar.
3. Third instar.
4. Fourth instar.
5. Adult female.
6. Egg, 3 × scale of 1-5

PLATE VIII.

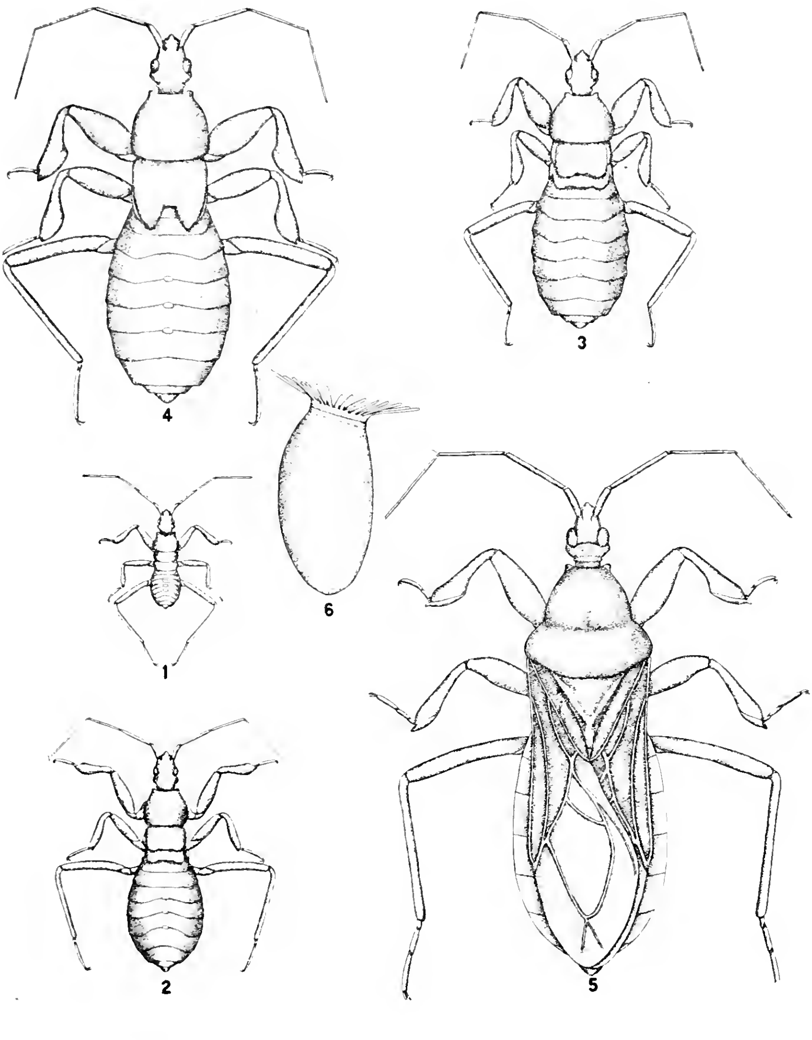


PLATE IX.

Rasahus biguttatus (Say).

1. First instar.
2. Second instar.
3. Third instar.
4. Fourth instar.
5. Fifth instar.
6. Adult female.
7. Egg, 3 × scale of 1-6.

PLATE IX.

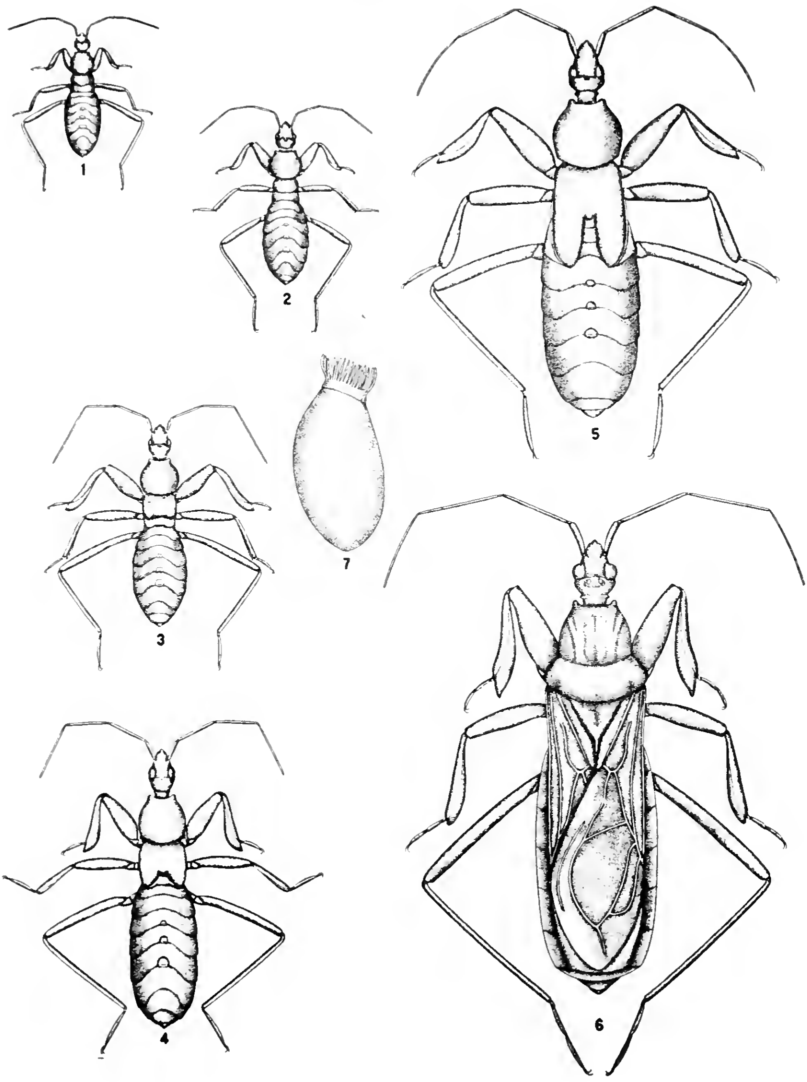


PLATE X.

Hammacerus purcis (Drury).

1. Third instar.
2. Fourth instar.
3. Fifth instar.
4. Adult female

PLATE X.

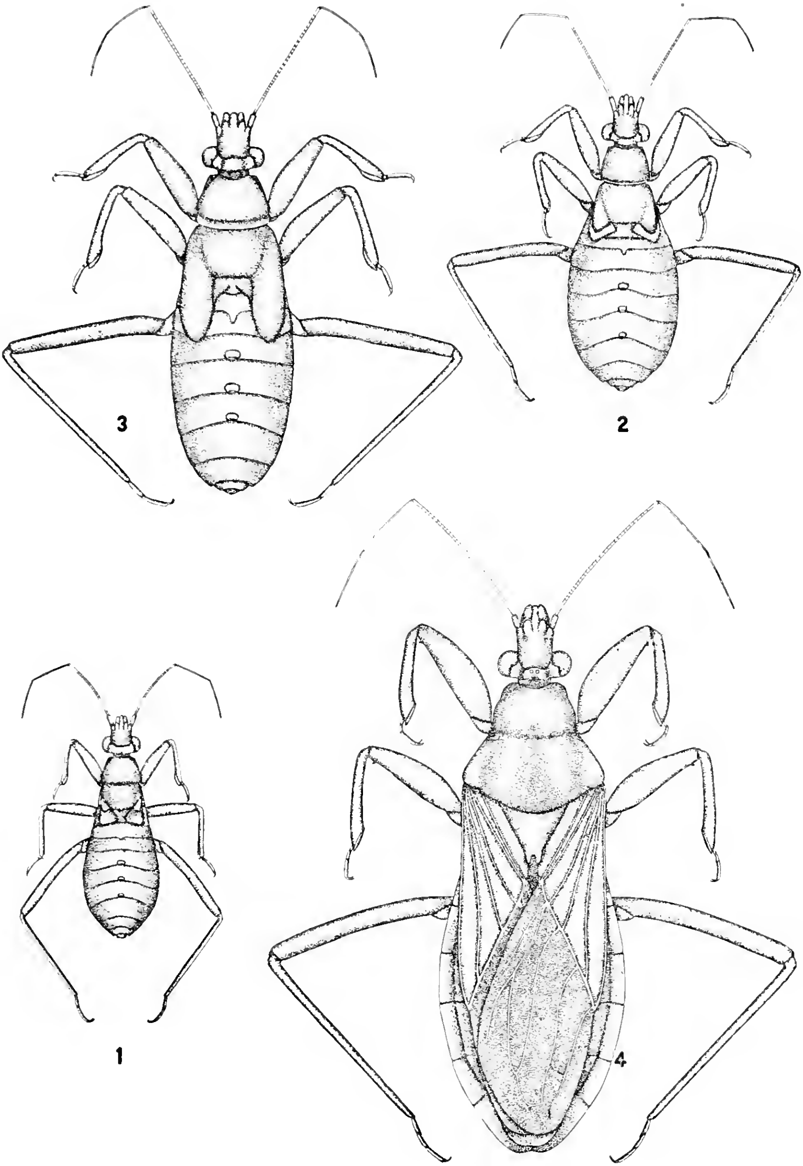
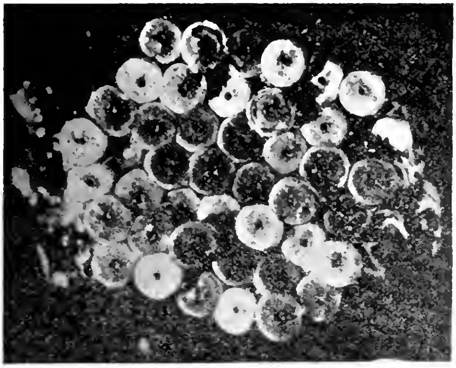


PLATE XI.

1. *Apiomerus spissipes* (Say), egg mass from above.
2. Same, individual eggs, lateral view, before hatching.
3. Same, after hatching.
4. *Zelus exsanguis* (Stal), egg mass on leaf.
5. Same, top of egg mass, enlarged.
6. Same, individual eggs, lateral view, before hatching.

PLATE XI.



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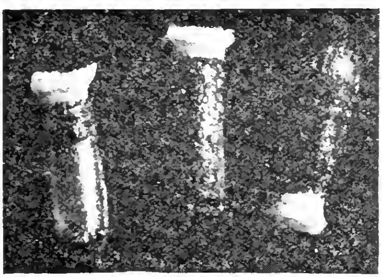

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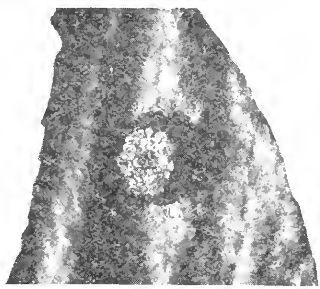

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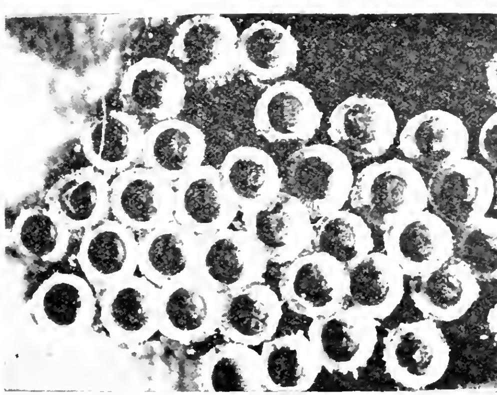

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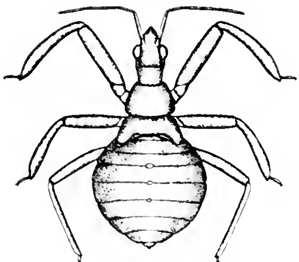
PLATE XII.

Apiomerus spissipes (Say).

1. First instar.
2. Second instar.
3. Third instar.
4. Fourth instar.
5. Fifth instar.
6. Adult.
7. Egg, 3 × scale of 1-6

PLATE XII.



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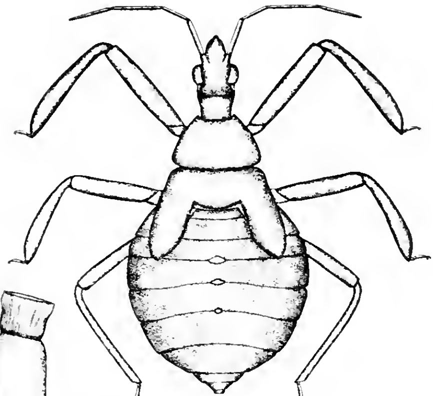

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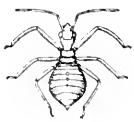

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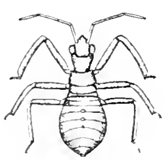

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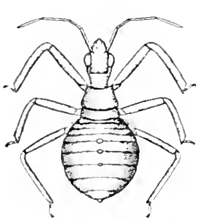

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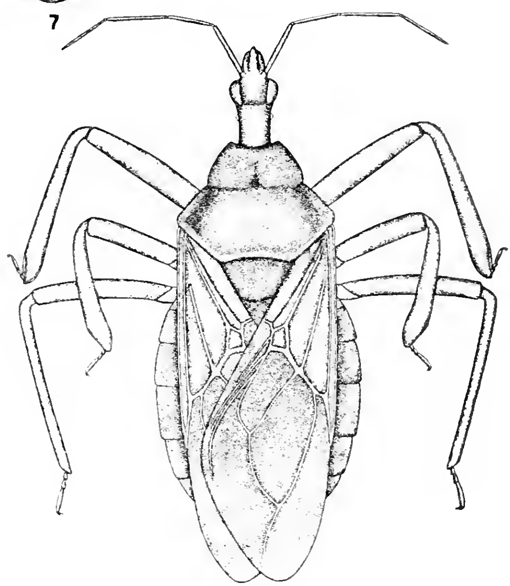

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PLATE XIII.

Zelus exsanguis (Stal).

1. First instar.
2. Second instar.
3. Third instar.
4. Fourth instar.
5. Fifth instar.
6. Adult.
7. Egg, 3 × scale of 1-6.

PLATE XIII.

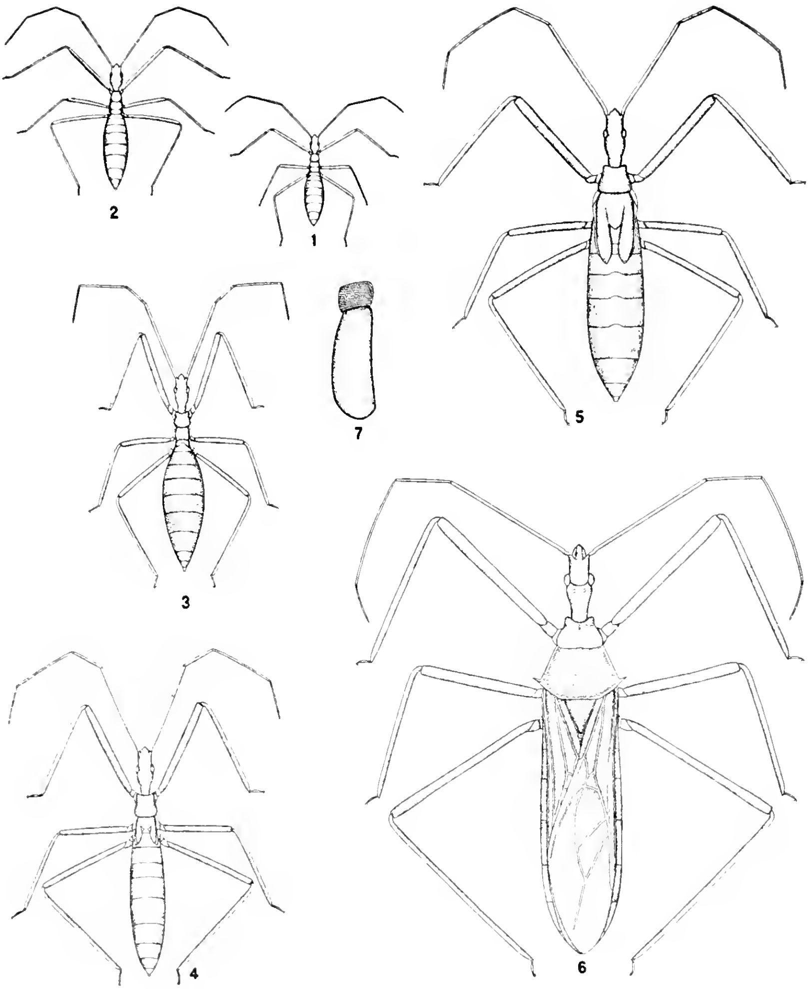

PLATE XIV.

1. *Zelus socius* (Uhler), fifth instar.
2. Same, adult.
3. *Pselliopus barberi* Davis, fifth instar.
4. Same, adult.
5. Egg of *Zelus socius* (Uhler), 3 × scale of 1-4

PLATE XIV.

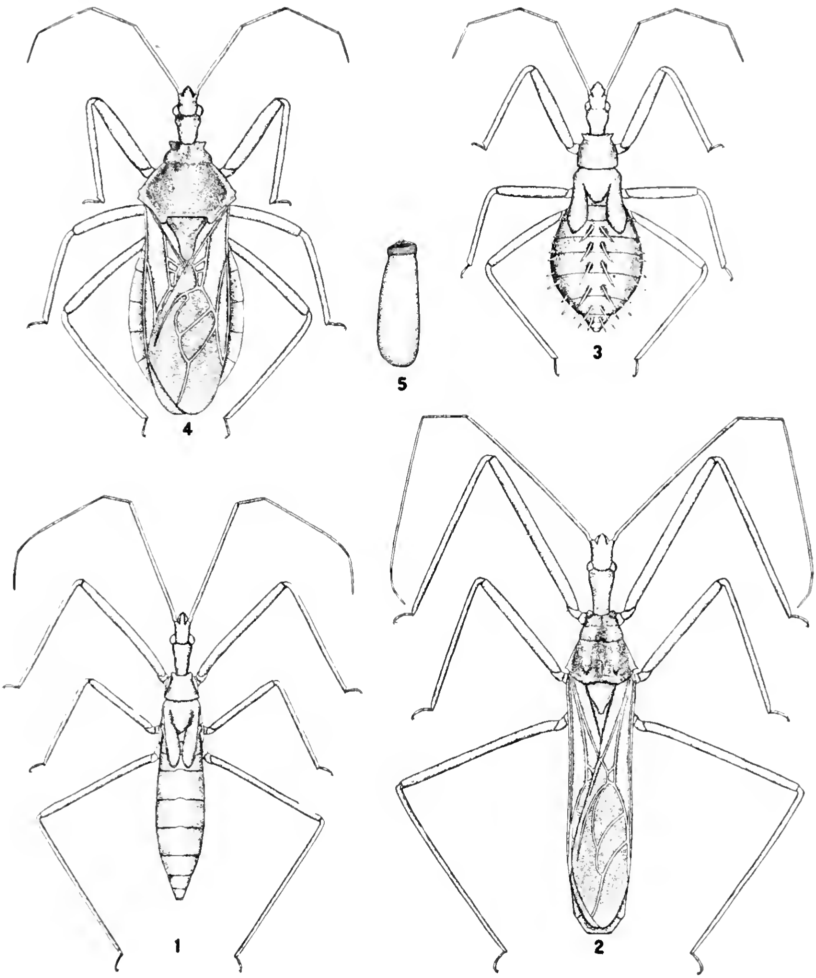

PLATE XV.

Pselliopus cinctus (Fabricius).

1. First instar.
2. Second instar.
3. Third instar.
4. Fourth instar.
5. Adult.
6. Egg, 3 × scale of 1-5.

PLATE XV.

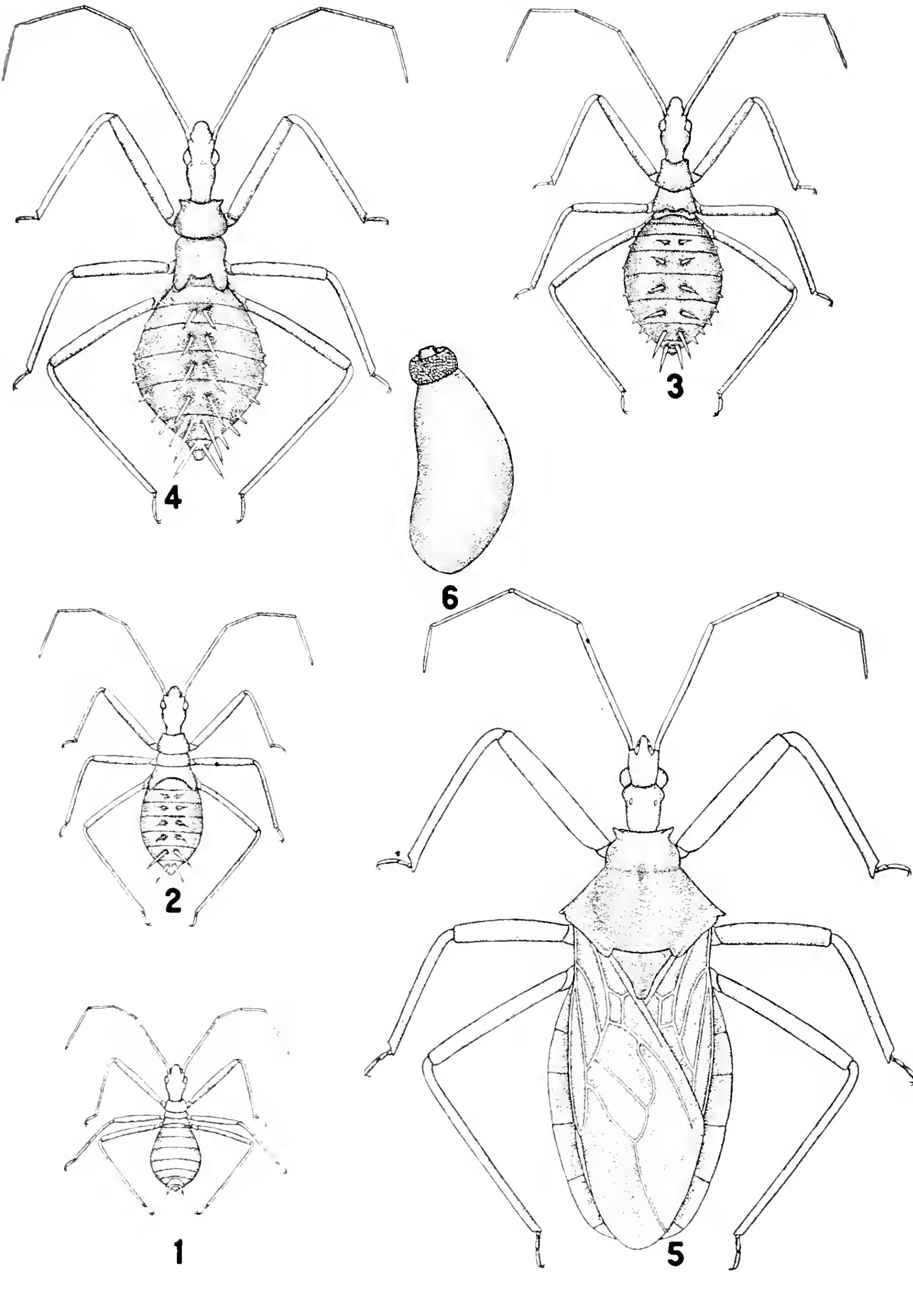

PLATE XVI.

1. *Arilus cristatus* (Linnæus), eggs from above.
2. *Acholla multispinosa* (De Geer), egg mass on twig. (Photograph by B. H. Walden.)
3. *Sinea diadema* (Fabricius), egg mass from above, unhatched.
4. Same, egg mass from above, hatched.
5. Same, individual egg, lateral view.

PLATE XVI.

5

2

4

3

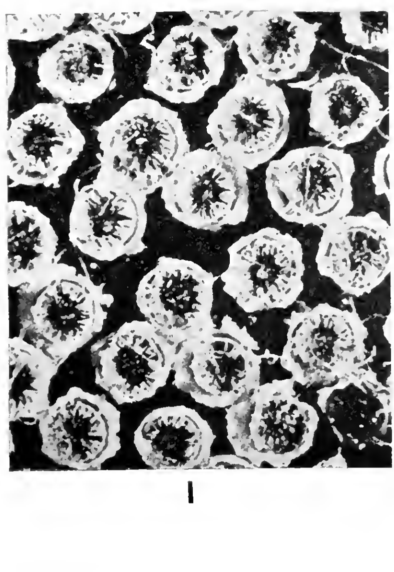

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PLATE XVII.

Arilus cristatus (Linnæus).

1. First instar.
2. Third instar.
3. Fourth instar.
4. Fifth instar.
5. Adult female.
6. Egg, 6 × scale 1-5.

PLATE XVII.

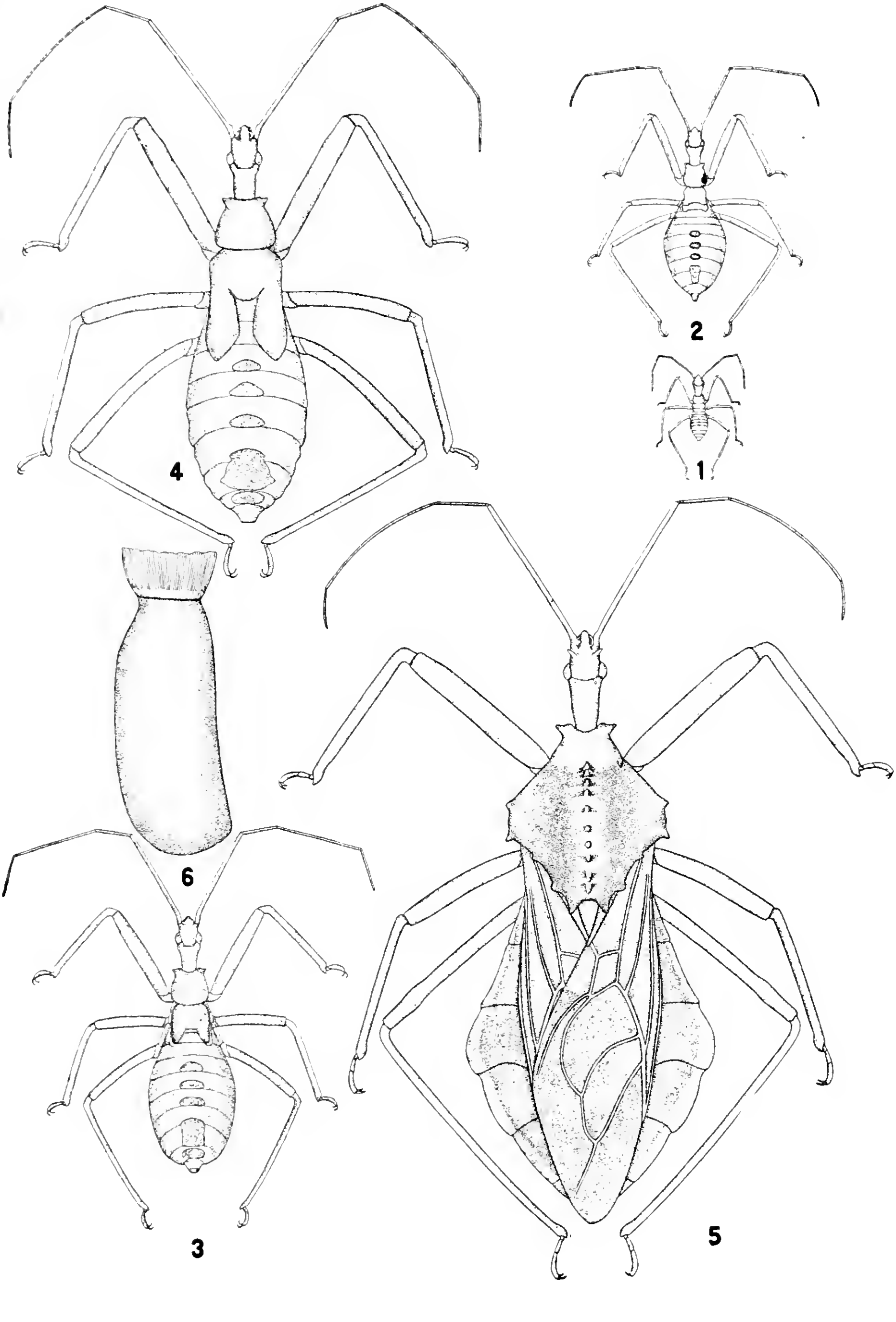


PLATE XVIII.

Acholla multispinosa (De Geer).

1. Third instar.
2. Fourth instar.
3. Fifth instar.
4. Adult female.
5. Egg, 6 × scale of 1-4.

PLATE XVIII.

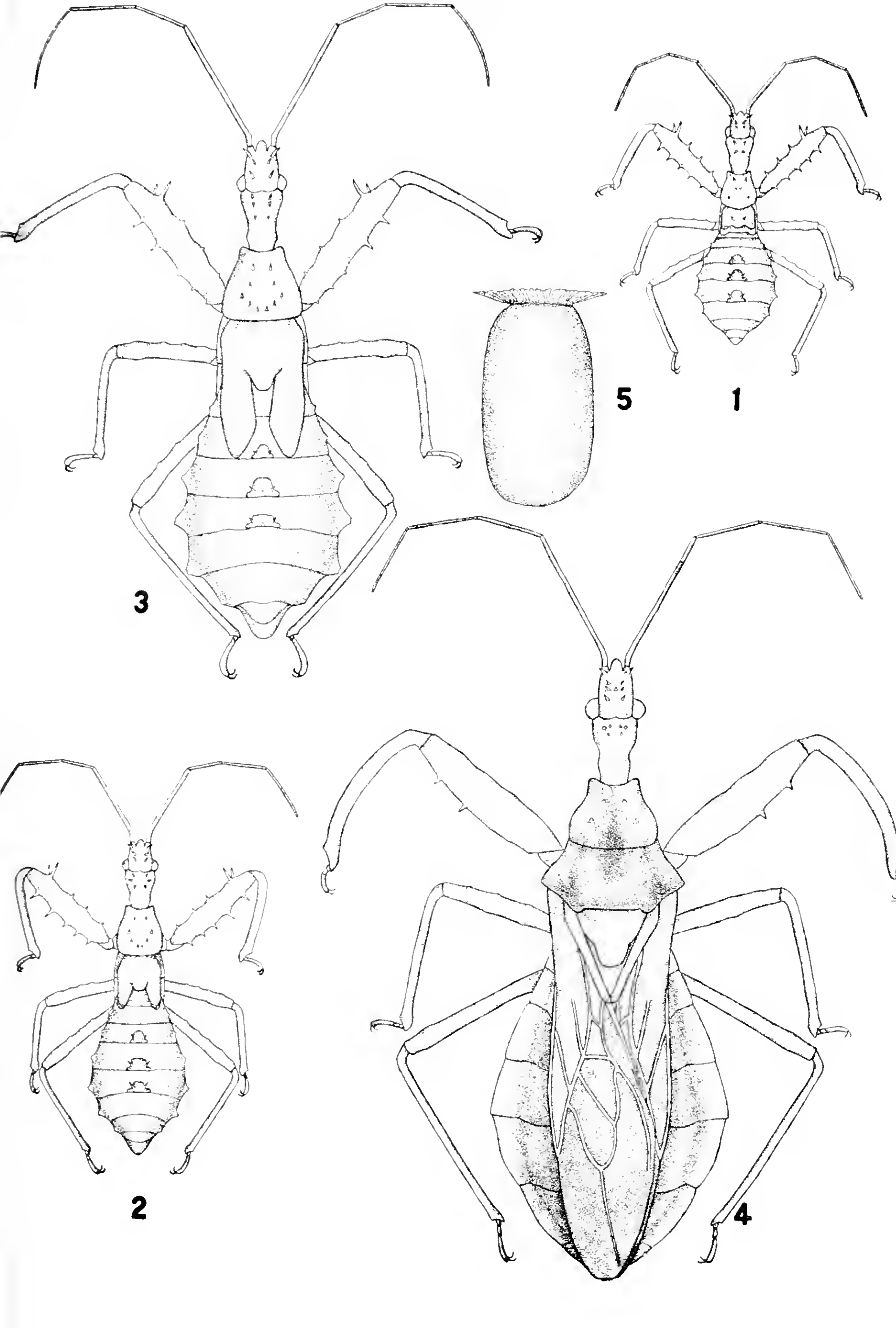


PLATE XIX.

Sinea diadema (Fabricius).

1. Egg mass on stem.
2. Egg, newly laid.
3. Egg, after spreading of collar.
4. First instar.
5. Second instar.
6. Third instar.
7. Fourth instar.
8. Fifth instar.
9. Adult female.

PLATE XIX.

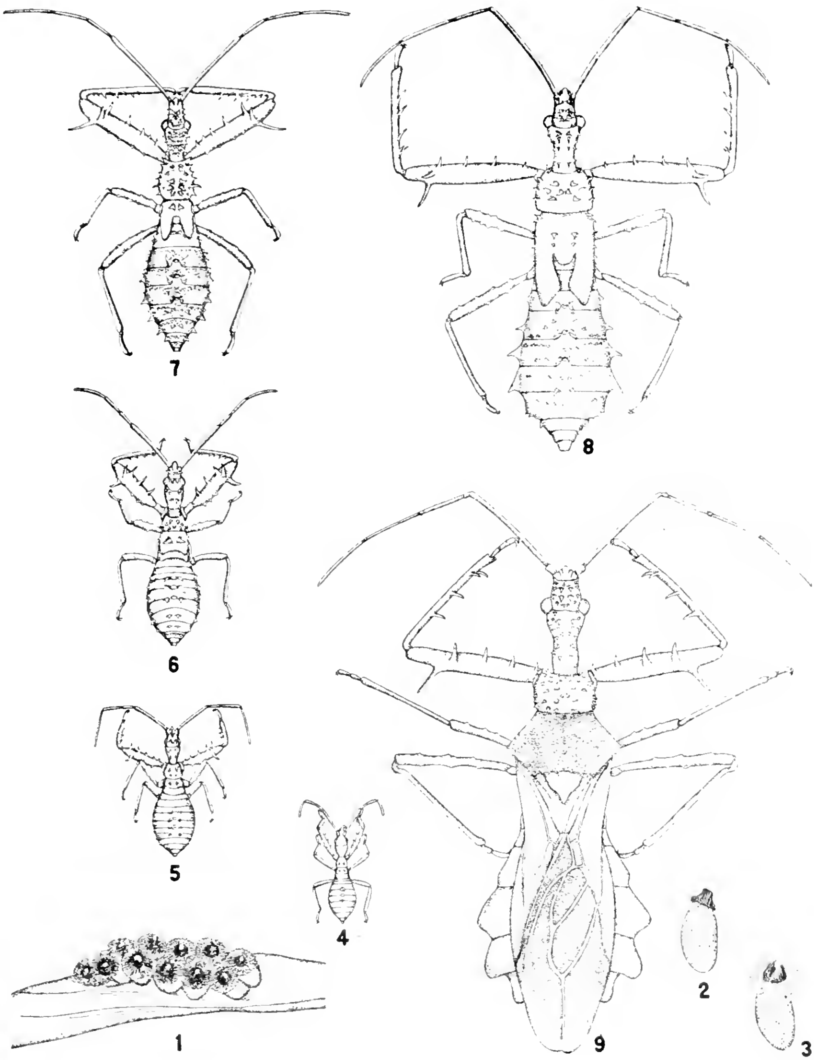


PLATE XX.

Sinea spinipes (Herrich-Schaeffer).

1. First instar.
2. Second instar.
3. Third instar.
4. Fourth instar.
5. Fifth instar.
6. Adult female.
7. Egg, 3 × scale of 1-6.

PLATE XX.

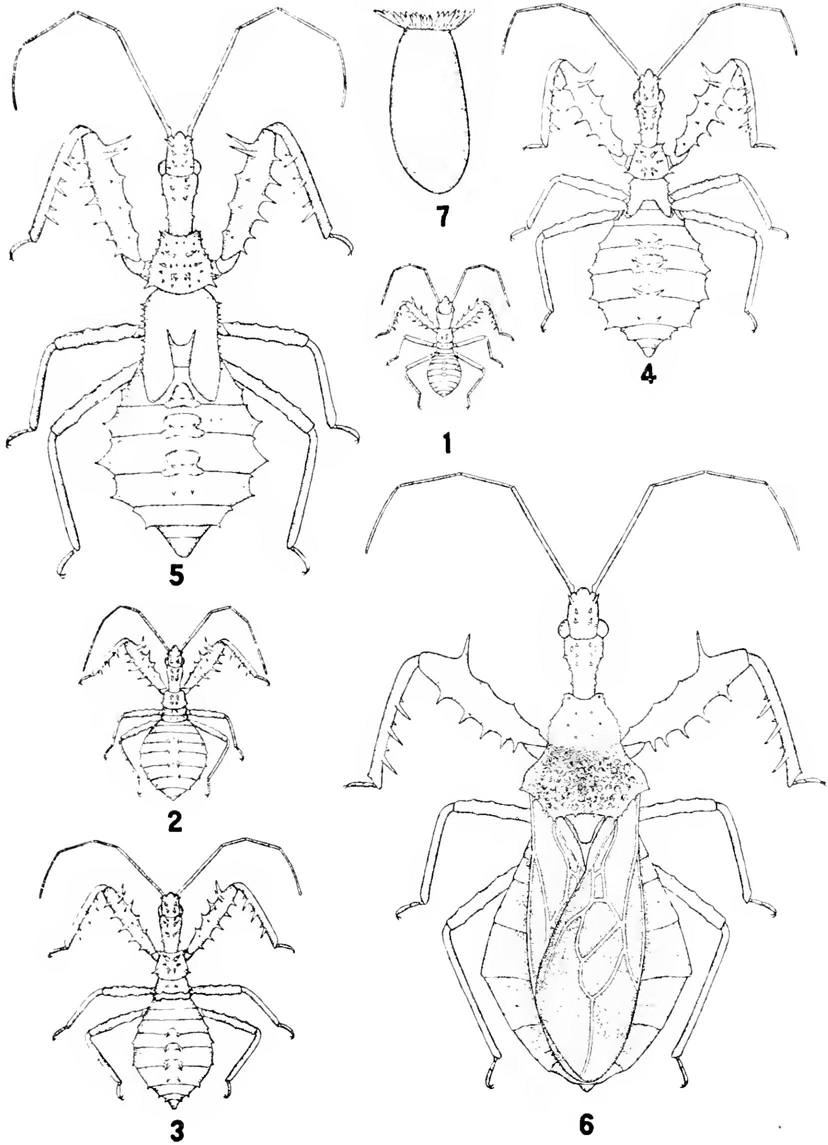


PLATE XXI.

(All figures after McAtee and Malloch.)

1. Forewing of *Stenolemus pallidipennis* McAtee and Malloch. *v*, Vein emitted from costal margin of basal discal cell.

2. Forewing of *Empicoris orthoneuron* McAtee and Malloch. *vv*, Straight veins closing discal cell.

3. Forewing of *Stenolemus arizoniensis* (Banks). *c*, Closed subtriangular cell.

4. Terminal abdominal tergite of male of *Ploiaria denticauda* McAtee and Malloch.

5. Terminal abdominal tergite of male of *Ploiaria hirticornis* (Banks).

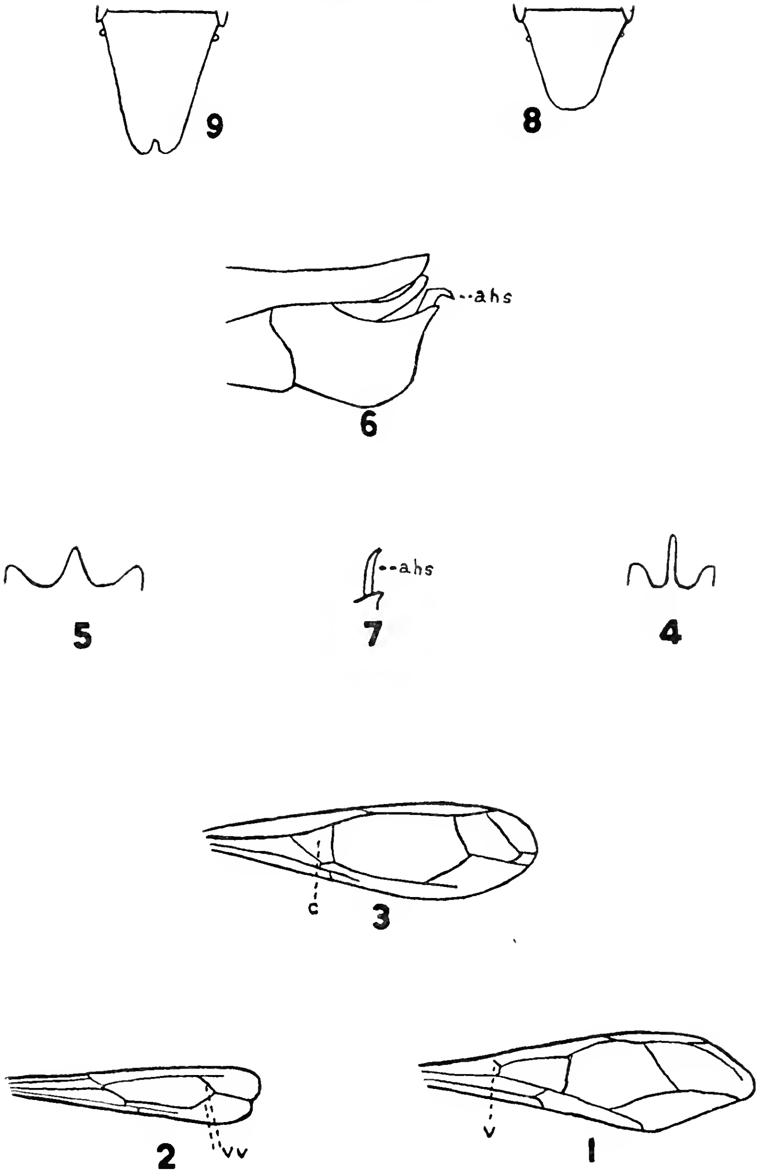
6. *Metapterus uhleri* (Banks), apex of abdomen of male from side.

7. *Metapterus neglectus* McAtee and Malloch, hypopygial hook from side.

8. *M. uhleri*, apical tergite of female.

9. *M. neglectus*, apical tergite of female.

PLATE XXI.



□

[END OF PART I.]

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VOL. XXVIII | DECEMBER 1, 1927. | NO. 18

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Vol. XVII, Nos. 1, 2, 3, 4, 5, 6 and 7

(IN TWO PARTS)

(Continuation of Kansas University Quarterly.)

PART II

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DEVOTED TO

THE PUBLICATION OF THE RESULTS OF RESEARCH BY MEMBERS OF THE UNIVERSITY OF KANSAS

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(IN TWO PARTS)

(Whole Series, Vol. XXVIII)

PART II

PUBLISHED BY THE UNIVERSITY,

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1927

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CONTENTS OF VOLUME XVII.

(IN TWO PARTS)

PART I.

PART II.

THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XVII.] SEPTEMBER, 1927. [No. 2.

A New Rhinoceros from Kansas.[1]

H. H. LANE, Department of Zoölogy.

THE Tertiary beds of North America have yielded several interesting genera of Rhinocerotidæ, among the best known of which are *Teleoceras*, *Aphelops* and *Peraceras* from the Upper Miocene and Lower Pliocene.

Among rhinocerotine material in the Museum of Vertebrate Paleontology at the University of Kansas, there is a practically complete lower jaw of a large individual, probably an old male, of a species not hitherto recognized. It is from the Republican river deposits near Plainville, Rooks county, Kansas, and is likely Upper Miocene, though some consider these deposits as Lower Pliocene. This specimen was obtained from a gravel pit, and was donated to the museum by Mr. Roy Dial, of Topeka.

The size and character of this mandible, together with its age and geographical location, suggested at once the probability that it belonged to one of the three genera which have been mentioned. Since there is considerable *Teleoceras* material in the museum, detailed comparison has been made with that genus.

The following generic characterizations have been drawn from the publications of Osborn and Matthew, and concern only those features which may be observed or inferred from the mandible.

PERACERAS: *Brachycephalic; occiput broad at base; upper incisors absent; premolars unreduced; molars brachyodont.*

TELEOCERAS: *Mesaticephalic; broad occiput; strong upper incisors; lower tusks curving upward; premolars reduced; molars hypsodont; symphysis short.*

APHELOPS: *Dolichocephalic; narrow occiput; upper incisors absent or weak; lower tusks heavy, procumbent; premolars unreduced; molars brachyodont; long symphysis.*

1. Paper read at the eighth annual meeting of the American Society of Mammalogists, in New York, April 29, 1926. (See Journal of Mammalogy, Vol. 7, No. 3, Aug. 1926, p. 238.)

Comparison of the specimen in hand directly with *Peraceras* is impossible, since the mandible of this genus has never been positively identified.* However, *Peraceras* is brachycephalic, and the type of *P. malacorhinus* as figured by Matthew,[2] shows that the transverse dimension of the mandible across the condyles is not less than 430 mm., whereas in the case of the specimen under consideration here the same dimension is only 306 mm. Moreover, Matthew's figure of *P. malacorhinus* shows clearly that its mandibular length could not have been over 460 mm., while in our specimen the corresponding length is 600 mm. Being 125 mm. less in width across the condyles, and about 150 mm. longer, this mandible clearly could not belong to such a brachycephalic form as *Peraceras*, but rather to a dolichocephalic genus.

Turning next to the dolichocephalic *Aphelops*, with its narrow occiput and brachyodont molars, we find in these characters suggestive resemblances, but, on the other hand, *Aphelops* has upper incisors which are weak or wanting altogether, whereas in our specimen the worn posterior faces of the tusks show that well-developed upper incisors must have been present in this species. Furthermore, while *Aphelops* has heavy tusks, in this respect like the specimen before us, they are *procumbent*, and not erect as in our specimen. However, the premolars in *Aphelops* are unreduced; they are reduced in the Rooks county form. In both cases the molars are short-crowned, or brachyodont. Then, too, in *Aphelops* the first lower molar is as long as the third, whereas in this specimen the lower molars form a graded series in which the third is the longest of all. The elongated symphysis tends to ally this mandible with that of *Aphelops;* but all in all, while clearly there are certain important resemblances, the differences are too great to allow the ascription of our specimen to the genus *Aphelops*.

There remains for consideration the genus *Teleoceras*, fortunately the best known of the three. As already indicated, this is a mesaticephalic form with a broad occiput—two characters which appear unlikely to have belonged to our specimen as judged from the size and proportions of the jaw already given. It seems to have been dolichocephalic with a narrow occiput more like that of *Aphelops*.

* While the present paper was in press, Stock and Furlong published a description and figure of a rhinocerous jaw which they probably correctly identify as that of *Peraceras*. It agrees exactly with the conception of the jaw of this genus held by the present author, and "differs from *Aphelops* and from *Teleoceras* in the greatly shortened symphysial region and in the absence of a lower tusk" [See Chester Stock and E. L. Furlong: *New Canid and Rhinocerotid Remains from the Ricardo Pilocene of the Mohave Desert, California.* Univ. of Calif. Pubs., Bull. Dept. Geol. Sciences, vol. 16, No. 2, p. 50, and Plate 10.]

2. Hitherto Unpublished Plates: Tertiary Mammalia and Permian Vertebrata. Prepared under the direction of Edwin Drinker Cope for the U. S. Geol. Survey of the Territories with description and plates. By William Diller Matthew. 1915.

While it agrees with *Teleoceras* in having strong upper incisors, and tusks which project upward, the tusks of that genus, at least in all of the Kansas University specimens, are less heavy and are circular in outline at the level of the alveolus, whereas in this specimen the tusks are very heavy, convex on their anterior faces, and ovoid in outline on a cross section at the level of the alveolus. In both the premolars are reduced, but Osborn and Matthew regard the molars of *Teleoceras* as hypsodont,[3] whereas in our specimen they are clearly low-crowned and distinctly fanged, *i. e.*, brachyodont. Furthermore, the crown pattern of both the premolars and molars is decidedly different in the two cases, so much so that it does not seem possible to account for it either by sex, age, or degree of wear.

More directly, perhaps, comparison should be made with Hatcher's *Teleoceras major*,[4] since it is the only known species of that genus which approaches ours in size. "The type consists of a portion of the skull and lower jaw. The superior and inferior molars are preserved, and also the fourth upper premolar" (Hatcher). The two species *(aside from the generic differences already pointed out)* differ in the following particulars: The last lower molar in *T. major* "has a basal cingulum on the posterior border" (Hatcher), which is wanting in our specimen. The crown pattern of the teeth in Hatcher's species is typically teleoceran, being identical with that of *T. fossiger*, and quite different from that in our specimen. (See Pl. XXV.) The length of the ramus from its posterior margin to the anterior border of premolar four is 420 mm. in *T. major*, and 460 in the Rooks county individual, a difference of 40 mm. The height of the ascending ramus from the bottom of the angle to the condyle is 200 mm. in *T. major*, and 280 mm. in the latter form, a difference of 80 mm. The obliquity of the condylar surface in *Teleoceras major* is decidedly less than in our form, and there are significant differences in the shape of the condyle, in the postglenoid fossa, the posterior margin of the ascending ramus, etc. The length of the lower molar dentition in *T. major* is 155 mm., in our specimen 185 mm., a difference of 30 mm. The length of molar two is 54 mm. and 62 mm., respectively; of molar three, 58 mm. and 69 mm. The new form is, therefore, much larger than *Teleoceras major*, has molars two and three brachyodont, instead of hypsodont or subhypsodont (see Pl. XXIV, B), etc., and cannot be identified with that species.

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3. Though both Osborn and Matthew insist that the molars in *Teleoceras* are hypsodont, the writer is convinced that they are rather to be termed *subhypsodont*. (See Pl. XXIV, B.)

4. Through the kindness of Dr. Wm. J. Sinclair, the writer has had the privilege of examining the type of *Teleoceras major* in the paleontological collection of Princeton University.

Except for the erect tusks, this specimen resembles *Aphelops* as much or indeed more than it does *Teleoceras*, but it differs in important respects from both. If one is justified in separating any of these forms from the genus *Rhinoceros*,[5] it would seem that the relationship of this specimen can best be indicated by assigning it to none of these genera. Much as one should avoid adding to the list of generic names already encumbered with synonyms and indeterminate species, I am convinced that this specimen must be assigned to a new genus. Since it seems to be somewhat nearer to *Aphelops* than to either *Teleoceras* or *Peraceras*, I propose to call it by the name *Paraphelops*.

PARAPHELOPS, genus novum.

Dolichocephalic; narrow occiput (?); dental formula, I_1, C_0, P_2, M_3. Median lower incisors wanting; lateral lower incisors a pair of large curved, erect tusks, ovoid in transverse section at base; lower canines wanting; lower premolars one and two lacking; third lower premolar decidedly smaller than the fourth, somewhat triangular in crown pattern; fourth lower premolar molariform; lower molars in graded series, first (54 mm.) shorter than the third (69 mm.), which is the longest of the series; symphysis extends posteriorly to the middle of the *fourth* premolars. Alveoli of the tusks on the sides of the rami. *Type species:*

Paraphelops rooksensis, species nova.

Type: A practically complete lower jaw with both rami intact and united at the symphysis, with the full (lower) dentition (see Pls. XXII, XXIII, and XXIV-*A*). Catalogue No. 2913, Museum of Vertebrate Paleontology, University of Kansas, of a very large individual, probably an old male. Characters of the genus as given above, and the following details:

The total length of the mandible from the anterior margin of the symphysis to the posterior border of the ascending ramus, projected upon a plane surface, is 603 mm., slightly less than that of large specimens of living *Ceratotherium simum*. (Pl. XXIII.) The body (ramus) (Pl. XXII) of this mandible is rather heavily built, its

5. Hatcher correctly remarks (Amer. Nat., Vol XXVIII, 1894, p. 245-46): "Technically, perhaps, *Teleoceras* should not be considered as generically distinguishable from *Rhinoceros*, and had it been found in Europe it would doubtless have been referred to that genus. Since, however, it is an American form, found in the same beds with *Aphelops*, its unmistakable ancestor, which as has been shown by Cope, Scott and Osborn, is quite distinct from *Rhinoceros*, I have decided to refer it to a distinct genus; believing that classification should rest so far as possible upon our knowledge of actual relations, and should be an expression of those relations, so far as they are understood, and not a mere set of conveniences, bas d entirely upon the presence or absence of and similarity or dissimilarity of parts."

vertical diameter below the third molar being 115 mm.; its transverse diameter at the same level 55 mm.

The anterior margin of the symphysis is slightly notched in the median line and broadly concave on its dorsal aspect (Pl. XXIII). Posterior to the tusks there is a diastema 65 mm. in its shortest length. The circumference of the jaw just posterior to the tusks is 355 mm., while the same measurement taken immediately anterior to the premolars is 370 mm. Both these planes of measurement lie between the extremities of the symphysis, which extends posteriorly from the tip of the jaw for a distance of 173 mm. to a line joining the middle points of the *fourth* premolars, whereas in *Teleoceras,* so far as I have been able to observe that genus, the symphysis reaches posteriorly to a point never back of the middle of the *third* premolars. On its dorsal aspect the symphysis in *Paraphelops* is marked by a broad but relatively shallow lingual fossa; this long symphysis is suggestive of relationship to *Aphelops.* On the ventral aspect of the symphysis in *Paraphelops,* there is a deep, rectangular excavation extending posteriorly to about the level of the hinder margin of the alveoli of the tusks; a much less marked excavation occurs in *Teleoceras.* The vertical thickness of the jaw in *Paraphelops* over this recess averages about 15 mm., while at its posterior end the symphysis has a dorso-ventral thickness of 73 mm., there being in fact a sort of mental prominence or boss on the ventral side of the jaw beneath the posterior half or so of the symphysial portion. While the symphysis in *Paraphelops rooksensis* has a length of 173 mm., that of *Teleoceras fossiger* averages about 117 mm., or 56 mm. less.

The diastema in *Paraphelops rooksensis* (Pls. XXII and XXIII) is marked on its mesodorsal surface by a ridge which extends mesad from the anterior margin of the alveolus of the third premolar to a point somewhat mesad of the inner line of the cheek teeth, whence it turns sharply forward, and somewhat obliquely laterad, to a point 35 mm. posterior to the alveolus of the tusk. Here it turns outward and downward, making practically a right angle to its previous course, though the apex of this angle itself is rounded. After extending for about 25 mm. downward from this angle, the ridge fades away into the outer side of the jaw about 17 mm. posterior to the alveolus of the tusk. The mesial surface of this ridge slopes sharply downward, forming a portion of the lateral wall of the lingual fossa. Externally, *i. e.*, laterally, the surface of this ridge is very steep, in fact, concave in form, with an average height of about 10 mm., though immediately in front of the premolars it is approximately 20 mm. in height. The width of the mandible, measured at the level of the right angle of these ridges, is 70 mm.

On the outer (lateral) aspect of the jaw the ascending ramus arises at a point 48 mm. posterior to the last molar, while on the mesial aspect it begins to rise 30 mm. back of that molar. The anterior margin of the ascending ramus at its base is 51 mm. wide, and it tapers irregularly dorsad until at a point 128 mm. above its base it is compressed abruptly into the thin coronoid process. The posterior margin of the ascending ramus is only slightly reflected on the mesial side and reaches its greatest thickness (76 mm.) across the postcotyloid process (Pl. XXIV-*A*). The angular margin of the jaw is rather evenly convex in outline and extends as a corrugated ridge from a point 90 mm. posterior to the level of the last molar to a point 180 mm. up on the posterior margin of the ascending ramus (Pl. XXII).

The bottom of the mandibular notch is 268 mm. above the level of the ventral face of the jaw. The coronoid process rises 61 mm. above the bottom of the notch with a very sharp, slightly concave slope, while its anterior margin is strongly convex. The width of the coronoid process at the level of the bottom of the mandibular notch is 76 mm., and its greatest thickness at the same level is 19 mm.

The lateral surface of the ascending ramus is marked by two concavities, the somewhat larger lower one (for the attachment of the masseter muscle) being separated from the somewhat smaller one above (? for the attachment of the temporalis) by a low irregular diagonal ridge running from the neck of the condyle downward and forward toward the point where the ramus begins its ascent, back of the last molar. The angular margin of the masseterial concavity is marked by several vertical corrugations (Pl. XXII).

The articulation of the lower jaw in this, as in all other species of Rhinocerotidæ, is peculiar and unlike that found in other mammals. There is no glenoid fossa, strictly speaking, but instead the under surface of the zygomatic process of the squamosal is in the form of a semicylindrical rod—not concave as in other mammals. In *Paraphelops* the postglenoid process of the squamosal must have been a much stouter spike than that found in the related genera, if one may judge from the shape and size of the notch into which it is fitted. This notch is mesad to a large bony mass (the *postcotyloid process*) which lies behind the condyle proper, at the upper end of the thickened posterior margin of the ascending ramus. The postcotyloid process in *Paraphelops* is a much larger and more prominent mass than in *Teleoceras* or *Aphelops* (Pls. XXIV-*A* and XXV). It is in fact considerably larger than the condyle proper, of which it is really a part but marked off by a transverse groove.

The condyle proper forms a ridge 130 mm. long extending transversely across the upper margin of the ascending ramus. It consists of two distinct portions, an external or lateral subovate condyle, which forms the principal part of the articulation, 67 mm. in length, and a mesial extension in the form of a rodlike ridge, 64 mm. long, which expands at its mesial end into a convexly flaring liplike process running ventrad for 43 mm. The condyle proper is separated by a groove, 14 mm. wide at its narrowest point, from the postcotyloid process. This groove fades out posterolaterally over the exterodorsal surface of the postcotyloid process, while mesially it broadens and deepens, and turns ventrad along the mesial face of the postcotyloid process and the posterior margin of the ascending ramus. This descending portion of this groove, which served for the reception of the very large postglenoid process, has a maximum width of 52 mm. and a maximum depth of 33 mm. on its lateral wall (postcotyloid process), and of 14 mm. on its mesial (condylar) wall. Its outer (lateral) wall rises almost perpendicularly, while its inner (mesial) wall forms a gentle slope (Pl. XXIII and XXIV-*A*).

The mesial face of the angle and of the ascending ramus is deeply hollowed out, its surface being irregularly corrugated for the attachment of the pterygoideus internus muscle. The posterior margin of the ascending ramus is slightly reflected mesad (Pl. XXIV-*A*) and grows broader as it rises toward the neck and the postcotyloid process. The transverse dimension of the jaw across the condyles is 306 mm., while the posterior reflected margins of the ascending rami are only 217 mm. apart.

Dentition: While we have identified the tusks as lateral incisors, according to Osborn's interpretation they are canines and both pairs of the lower incisors are wanting in this specimen, there being no trace of incisival alveoli in the unbroken end of the mandible. However, the tusks are often identified by other authors as lateral incisors, the interpretation followed in this paper. They are ovoid in cross section at the base, with the mesially directed portion of the oval decidedly sharper, or more nearly pointed, than the outer. In this respect these tusks are notably different from those of *Teleoceras*, in which the transverse section of the tusks is circular. The tusks, in both *Paraphelops* and *Teleoceras*, are sharp-pointed and worn flat on the posterointernal surface. In *Paraphelops*, this worn face of the tusk (Pl. XXIII) extends downward for a distance of

98 mm. from the tip, and, while a plane surface distally, becomes decidedly concave near its lower end where it is bounded by the sharply transverse margin of the unworn portion of the tooth below. The base of the tusk up to about the lower margin of the worn surface is covered with enamel; distad to that level the enamel is wanting. The tusks measure 132 mm. in greatest length, *i. e.*, along the exterolateral convexity, from the margin of the alveolus to their tips. Their circumference, taken at right angles to their longitudinal axis and at the upper (mesial) margin of the alveolus, is 150 mm. The anterior surface of the tusks is decidedly convex and rises to the tip, which is about 35° from the vertical, *i. e.*, the tusks are more nearly vertical even than in *Teleoceras*, where their inclination is about 60°, and far from procumbent as in *Aphelops*.

The alveoli of the tusks in *Paraphelops* lie on the sides of the mandibular rami (Pl. XXII), instead of being terminal or on the dorsal surface as in *Teleoceras* and *Aphelops*. They are ovoid, in fact almost triangular, in outline, instead of circular as in *Teleoceras*. The distance between the alveoli of the tusks across the upper surface of the mandibular symphysis is 60 mm. at their nearest points. The posterolateral extremity of the alveolus is 55 mm. posterior to its anteromesial corner. The total circumference of the margin of the alveolus is 165 mm.

There are but two premolars present, the third and fourth of the series, and there is no indication whatever of the former presence of the first or second. The third premolar is smaller than the fourth, and has an extreme length of 40 mm., and its greatest breadth, near its hinder end, is 30 mm. In the crown view (Pl. XXIII) it is rather arrowhead-shaped, with a convex anterior margin and a concave posterior. The enamel is wanting over the whole posterior surface of the tooth. On the median face there are two reëntrant angles or folds of enamel, the valleys or fossettes of the metalophid and hypolophid, respectively. The anterior one, or prefossette, is very shallow, a mere notch; the posterior valley, or postfossette, is somewhat deeper. The two lophids are separated on the lateral surface of the tooth by a median, broad and shallow, *i. e.*, very obtuse, reëntrant angle, the apex of which is slightly posterior to the middle of the tooth. This tooth, like all the others in the molar series, is brachyodont, and its fangs rest in a projecting shelf on the side of the jaw.

The fourth premolar (Pl. XXIII) is decidedly larger than the third and is molariform. Its greatest crown length is 50 mm.; its greatest breadth, across the hypolophid, is 42 mm. As in the other teeth of the molar series, its mesial surface is marked by two reëntrant folds of enamel, the prefossette and postfossette, the former extending about 8 mm. and the latter about 15 mm. into the area of the tooth. The prefossette is about as deep as the postfossette of the third premolar, but the angle is not nearly so acute. The prefossette is almost vertical, while the postfossette is decidedly inclined, particularly toward the mesial margin of the tooth. The external or lateral surface of this tooth consists of two broad vertical pillars, the metalophid and hypolophid, the former the broader, and the two are separated by an obtuse reëntrant angle. The anterior margin of this tooth is enameled and gently convex; the posterior margin is partly without enamel and gently concave.

The first molar (M_1) has an extreme length of 54 mm.; its greatest breadth, 38 mm. The prefossette is very shallow, not so large as that in the third premolar. The postfossette in the first molar is very narrow; in fact, its sides are in contact for the greater part of its length, approximately 10 mm., the line of contact running obliquely posteromesad and dropping down over the mesial surface of the tooth toward the middle of the posterior fang. The anterior face of this tooth is irregularly convex; the posterior slightly concave or nearly plane. The external (lateral) surface of this tooth is marked by a reëntrant fold of enamel, which at the crown forms nearly or quite a right angle. The metalophid, unlike that of the premolar, is only about two-thirds as broad as the hypolophid, *i. e.*, 22:32 mm., respectively. In the fourth premolar these dimensions are 25:23 mm. (Pl. XXIII).

The second molar (Pl. XXIII) is larger than the first, having an extreme length of 65 mm. and an extreme width (hypolophid) of 38 mm. The corresponding tooth in *Teleoceras fossiger* (Pl. XXIV) averages about 61 x 33 mm. The third molar is larger still, being 69 x 38 mm. This gradation in the size of the molars is a generic character that distinguishes *Paraphelops* from *Aphelops*. The description of the first molar, disregarding size, applies very well to both the second and third molars, except that they are faced with enamel all around, and their posterior faces are not concave. In the second the posterior face is practically plane, while in the third it is obliquely convex, the obliquity forming the posteroexternal surface of the tooth. The crown pattern in all of these teeth shows a gradual change from the arrowhead of the third premolar to a W in the third molar, the intermediate teeth showing the transition stages between these two extremes. *All of the molars are brachyodont.*

The total length of the premolar-molar series, at the margin of the alveoli, is 260 mm.; this is identical with the same dimension in the American Museum specimen of *Teleoceras fossiger* as reported by Osborn (Pl. XXIV-*A*). While Osborn gives the width of the skull across the arches in his *T. fossiger* as 380 mm., in *Paraphelops rooksensis* it is approximately 306 mm.; in total length of jaw, Osborn records 510 mm., whereas in our species it is 635 mm. *Paraphelops*, therefore, must have been dolichocephalic, and not mesaticephalic as was *Teleoceras*.

A few instructive comparisons may be made between *Paraphelops rooksensis* and the mounted specimens of *Teleoceras fossiger* in (*a*) the American Museum of Natural History and (*b*) the Museum of the University of Kansas:

Species	*T. fossiger.*		*P. rooksensis.*
Specimen at	American Museum of Natural History.	Museum of the University of Kansas.	
	mm.	mm.	mm.
Skull width across zygomatic arches (6)	383		306(7)
Length of jaw, condyle to tip of tusk (straight line)	510		635
Teeth, grinding series	260		260
Dentition to tip of tusk	350		395
Length of condyle (transverse)		116	131
Length of symphysis		116	173
Width of posteotyloid process		128	160
Height of posteotyloid process		73	93
Distance from M_3 to mesial end of condyle		186	227
Distance from M_3 to posterior margin of ascending ramus		167	220
Width of ascending ramus at posteotyloid process		128	160
Length of diastema			65
Transverse distance between PM_3's			73
Transverse distance between hypolophids of M_3			90
Transverse distance between tusks			62

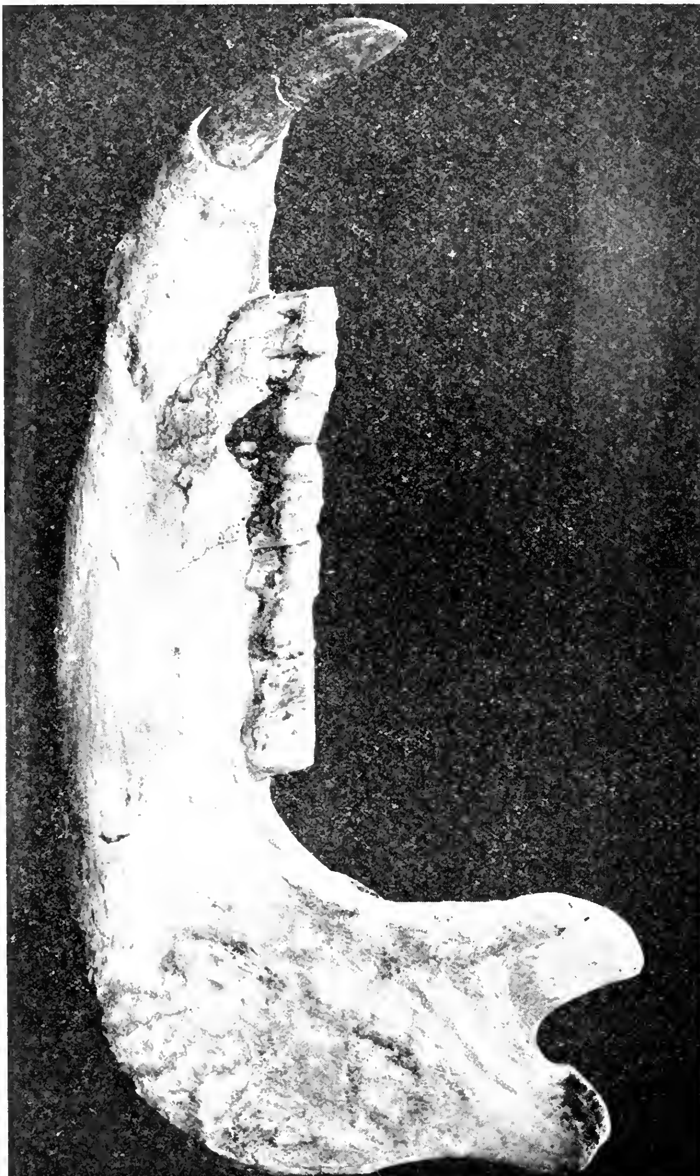
(6) In other words, in Osborn's specimen the width of the mandible across the condyles (Approx. = width across zygomatic arches) is approximately 74½ per cent of the total length of the mandible; while in *Paraphelops* this relation is approximately only 47½ per cent. *Paraphelops*, therefore, belongs to a relatively longer-headed species than *T. fossiger*.

(7) Estimated.

Through the kindness of the authorities of the American Museum of Natural History the writer has had the privilege of examining, among other rhinocerotine material in that institution, specimen No. 10878, which Osborn (New Miocene Rhinoceroses with Revision of Known Species, Bull. Amer. Mus. Nat. Hist., Vol. 20, 1904) has provisionally assigned to *Peraceras superciliosus* Cope. He says (p. 312-13): "Jaws (Amer. Mus., No. 10878) found in the same region . . . ['Loup Fork, So. Dak., N. E. Rosebud Agency, White River Country'—label, Am. M. N. H.] possibly belong to this species; as compared with those of *T. fossiger*, they exhibit (1) large canines, (2) a wide space between M_3 and the coronoid process, (3) forward pitch or inclination of the condyle and coronoid region, (4) somewhat less hypsodont molars."

Examination of this specimen has convinced me that it belongs to our species *Paraphelops rooksensis*. The variations between it and the type as described are such as would indicate sex differences. No. 10878 in the American Museum is most probably the *female* of this species, and not a *Peraceras* as Osborn was inclined to regard it. Its presence in the Loup Fork would tend to fix the deposit in which the Rooks county specimen was found as Upper Miocene rather than Lower Pliocene.

PLATE XXII.

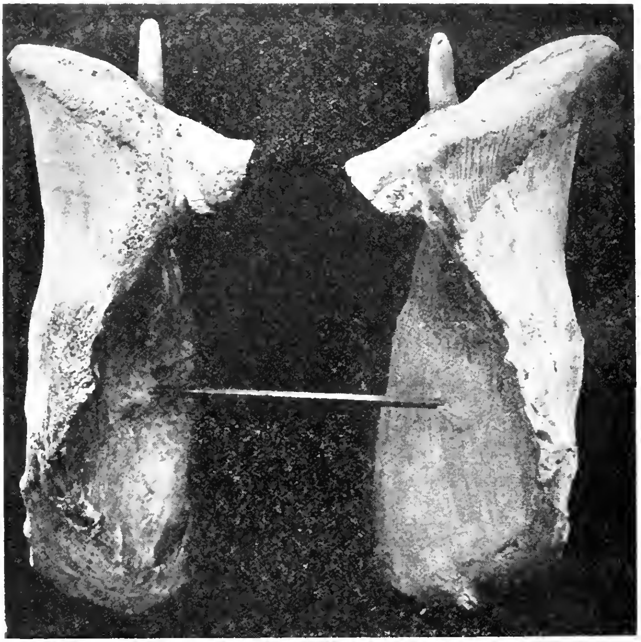


Lateral aspect of the mandible of *Paraphelops rooksensis* type.

PLATE XXIII.

Crown view of the same, showing length of symphysis, tooth pattern, etc.

PLATE XXIV-*A*.



Posterior aspect of the same, showing obliquity of the condyle, massiveness of the postcotyloid process, reflected margin of the ascending ramus, and tips of the coronoid processes.

PLATE XXIV-*B*.

Median aspect of the mandible of *Teleoceras fossiger* with a portion removed to show the full extent and character of M_2 and M_3—*subhypsodont* instead of hypsodont as usually described.

PLATE XXV.

Comparison of tooth pattern, size, etc., in *Paraphelops rooksensis* (left) and *Teleoceras fossiger* (right). Note the nearly equal length of the tooth row in the two cases; that the symphysis extends posteriorly in *Paraphelops* to a point opposite the middle of P_4, while in *Teleoceras* it ends opposite the middle of P_3. (The apparent position in the figure is due to angle at which the photograph was taken.) Note, also, the *greater* distance between M_3 and the ascending ramus (coronoid process) in *Paraphelops* than in *Teleoceras*. Note, too, the difference in the shape, size and proportions of the condyle and postcotyloid process in the two genera.

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A New Protypothere from the Santa Cruz Formation of Patagonia.[1]

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IN THE collection of the Museum of the University of Kansas, among the fossils collected in 1903 by Mr. H. T. Martin from the Santa Cruz beds near the Rio Gallegos, in southern Patagonia, is an apparently undescribed species of *Protypotherium.*

Protypotherium martini, spec. nov.

Type. The left premaxilla and maxilla, with premolars 2, 3, 4, and molar 1; incisors, canine, and premolar 1, missing but the alveoli distinct; also a fragment of the left frontal, including the anterodorsal margin of the orbit; No. 19 (collector's No. 69) of the Patagonian collection, Museum of the University of Kansas, Department of Vertebrate Paleontology. Collected from the Santa Cruz beds near the Rio Gallegos, by Handel T. Martin, for whom the species is named on account of his indefatigable industry and ingenuity in the discovery of vertebrate remains, and in recognition of his knowledge of vertebrate paleontology.

So far as known to the writer, only six well-defined species of the genus *Protypotherium* have been previously described, and these by Ameghino. Of these, three, viz., *P. australe*, *P. prærutilum* and *P. attenuatum*, have been redescribed in such detail by Sinclair (see Reports of the Princeton University Expeditions to Patagonia, 1896-1899, Vol. VI, pt. I) that there is no difficulty in recognizing them, and the University of Kansas Museum has representatives of all three; of *P. australe*, in fact, the material is abundant. Three other species, *P. diversidens*, *P. diastematum*, and *P. claudum*, I have seen

1. Paper read at the seventh annual meeting of the American Society of Mammalogists, in Washington, D. C., April 7, 1925. (See Journal of Mammalogy, August, 1925, p. 213.)

only in photographs of Ameghino's types,[2] but, as will appear below, enough is known of them to afford a basis of comparison with *Protypotherium martini*.

The distinguishing characteristics of *P. martini* are best indicated by a comparison of the dental index of the three premolars and one molar in the type specimen with that of the corresponding teeth in other species heretofore described. By the term "dental index" is meant the ratio of width to length of a tooth obtained by dividing the maximum breadth of the crown by the maximum length, the quotient expressing the ratio in the form of a percentage. The value of the dental index lies in the fact that it allows direct comparison in a very exact way impossible otherwise even when the absolute lengths and breadths are stated, for in *Protypotherium* it is not affected by individual or age differences in size, since in this genus the proportions of a tooth vary less than absolute dimensions. It avoids the annoyances incident to the use of such terms as "slightly longer" or "scarcely as wide," etc., which are the bane of the systematist who may not have access to the identical specimen so described.

In *Protypotherium martini*, the first upper molar has a maximum length of 8 mm. and a maximum breadth of 4.5 mm., giving a dental index for this tooth of 0.5625. In *P. australe*, four specimens give an average dental index for the first upper molar of 0.6630, varying in individual cases from a minimum of 0.6250 to a maximum of 0.6930. In *P. prærutilum*, the corresponding data are: average dental index 0.7038, with a minimum of 0.6818 and a maximum of 0.7258. In *P. attenuatum*, the average dental index is 0.6872; maximum 0.7077 and minimum 0.6667. In other words, the first upper molar in *P. martini* is narrower in proportion to its length than the corresponding tooth in the other species mentioned.

In *P. martini*, the fourth upper premolar has a maximum length of 5 mm., and a maximum width also of 5 mm., giving a dental index of 1.0000. In *P. australe*, the fourth upper premolar has an average dental index (four specimens) of 0.8346, with a maximum of 0.9375 and a minimum of 0.7500. In *P. prærutilum*, the average index of the same tooth is 0.8188; maximum 0.8333 and minimum 0.8043. In *P. attenuatum*, the average index for the corresponding tooth is 0.8546, with a maximum of 0.9091 and a minimum of 0.8000. In

2. The photographs of Ameghino's types were made by Prof. W. B. Scott, of Princeton University, to whom the author is greatly indebted for the loan of them, since otherwise it would have been very difficult, if not impossible, to identify some of the species Ameghino has described.

short, while in the other three species the fourth premolar is distinctly longer than wide, in *P. martini*, the maximal length and breadth are identical.

In *P. martini*, the third upper premolar has a maximum length of 4 mm., and a maximum width of 5 mm., giving a dental index of 1.2500. In *P. australe*, the third upper premolar has an average dental index of 0.7090, with a maximum of 0.7500 and a minimum of 0.6667. In *P. prærutilum*, the corresponding tooth has an average dental index of 0.7359, with a maximum of 0.7608 and a minimum of 0.7111. In *P. attenuatum*, the corresponding data are: average dental index 0.7639; maximum 0.7778 and minimum 0.7500. In respect, therefore, to the third upper premolar, while in the other three species the maximum breadth is approximately only three-fourths of the maximum length, in *P. martini*, this premolar is actually one-fourth wider than long.

In *P. martini*, the second upper premolar has a maximum length of 3.5 mm., and a maximum width of 4 mm., giving a dental index of 1.1111. In *P. australe*, the second upper premolar has an average dental index of only 0.7000, with a maximum of 0.7778 and a minimum of 0.6603. In *P. prærutilum*, the average index of the same tooth is 0.6861, with a maximum of 0.7143 and a minimum of 0.6579. In *P. attenuatum*, the average index of the corresponding tooth is 0.7572, with a maximum of 0.7714 and a minimum of 0.7429. In respect, therefore, to the second upper premolar, while in the other species mentioned the width of the tooth is only three-fourths (or even less) of the length, in *P. martini*, on the other hand, the width of the tooth is over 10 per cent greater than the length.

Aside from the dental index, the most striking feature in *P. martini*, which serves to distinguish it from all the other species of the genus, is to be found in the shape of the posterointernal margin of the crown of the premolars. In the other species this margin of the upper premolars is broadly convex, whereas in *P. martini* it forms a distinctly *acute* angle, most noticeable perhaps in premolar 3, where this margin of the tooth terminates in a very sharp edge.

From the remaining three species of *Protypotherium* described by Ameghino, *P. martini* can be recognized by various characters. Thus, from *P. diversidens*, it may be distinguished first of all by size, since *P. martini* corresponds in this respect to *P. australe*, while *P. diversidens* is "of relatively small size." Furthermore, in *P. martini* the external vertical groove in the upper premolars runs the whole length of the tooth, being, if anything, deeper and more sharply defined at the base of the crown than at the tip, while in *P. diversidens*, this groove, "broad on the crown but narrowing and suddenly disappearing toward the base," is distinctly different in appearance.

From *P. diastematum*, which has a short diastema between the first and second upper premolars, *P. martini* is distinguished by the total lack of such a diastema, premolars 1 and 2 evidently touching along their whole adjacent faces. Moreover, *P. diastematum* is about the same size as *P. prærutilum*, while *P. martini* is larger, equaling *P. australe* in this respect.

From *P. claudum*, which Ameghino knew only "from a fragment of the right ramus of the mandible," *P. martini* can be distinguished by size alone, since the mandible of the latter is wholly unknown, as is the premaxilla and maxilla of the former. But *P. claudum* is "of quite small size," while *P. martini* compares with the largest known species, so that the two are evidently distinct.

No other described species of *Protypotherium* are known to me. It seems, therefore, that *P. martini* must be recognized as a valid and easily distinguishable species. I have no hesitancy, therefore, in giving it a distinctive name despite the fragmentary nature of the type specimen.

PLATE XXVI-*A*.

Lateral view of the type specimen of *Protypotherium martini*.

PLATE XXVI-*B*.

Palatal view of the same.

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The Extirpation of the Thyroid Gland and Its Effects upon the Hypophysis in *Bufo americanus* and *Rana pipiens*.

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LITERATURE.

During the past decade a great amount of literature has appeared which has quite conclusively proved that the removal of the thyroid gland causes the hypertrophy of the hypophysis. Most of the work has been done on mammals and the observations have been more or less limited to a study of the anterior lobe.

Rogowitsch, in 1886, was the first to show that the removal of the thyroid gland causes the hypophysis to become altered and enlarged. Degener, working at about the same time, found that the increase in weight was directly proportional to the time which had elapsed after the removal of the gland, and that this removal affected all parts of the hypophysis, but more especially the parts anterior. This worker also observed the increase of hyaline and granular masses in the pars intermedia and their passage in large numbers through the pars nervosa into the infundibular extension of the third ventricle. Herring makes the statement that this denotes an increased activity on the part of the pars intermedia.

Rogowitsch, in 1888, removed the thyroid gland in rabbits and dogs and in eight to fourteen days after the operation he found an increase in the size of the hypophysis. Upon a further study of the cells, he found this increase due to an actual increase in the size of the cells, enlargement of the spaces between the nuclei, increase in the number of vacuoles and the amount of colloid in the cell body as well as a marked dilation of the blood vessels.

Hofmeister, in 1892, found that the extirpation of the thyroid gland of young rabbits, the external parathyroids left in situ, was followed by a retardation of growth and the development of a condition of chronic cachexia. In the internal organs Hofmeister found a condition similar to that described by Rogowitsch in the case of adult rabbits, namely, enlargement of the glandular portion of the hypophysis cerebri and the appearance of large vacuoles in the protoplasm of the enlarged principal cells.

Biedl found an increase of colloid and also that the degree of enlargement varied according to the length of life after the operation. In animals which lived for some time after the removal of the thyroid glands, the hypophysis frequently became two or three times as large as the control. Allen, Adler and Smith have all shown that only the anterior lobe of the hypophysis and the thyroid gland are necessary for the phenomenon of metamorphosis. Allen, in his work on gland implantation, has shown this very conclusively. He finds that a pituitariless tadpole undergoes metamorphosis when the anterior lobe alone of the hypophysis of a mature frog is implanted subcutaneously. Rodger (1918) found that the removal of the thyroid gland increases the size of the anterior lobe of the hypophysis in *Rana pipiens.*

Atwell (1918), in describing the development of the hypophysis of the *Anura*, uses the terms which will be used by the writer of this paper. The same terms are used by Rasmussen (1921) in describing the hypophysis of the woodchuck. The pars intermedia and pars nervosa together are often spoken of as the posterior lobe. The latter term seems a bit unsatisfactory, because the pars nervosa is not of epithelial origin but of neural origin. According to Atwell, the hypophysis of the *Anura* consists of three epithelial parts and a neural part. The lobes of epithelial origin are the anterior lobe proper, the pars intermedia and the pars tuberalis. The pars intermedia is always conformed to the extent of the neural lobe.

In reptiles, birds and mammals the pars intermedia is a thin epithelial layer applied to the neural lobe and is derived from the supradorsal wall of Rathkes' pocket. Later in life the pars intermedia invades the tissue of the neural lobe to a considerable extent. In the frog and toad, also, the pars intermedia conforms to the neural lobe in shape and the two protrude in a bulging fashion on either side of the anterior lobe.

MATERIAL AND TECHNIQUE.

The material used in this experiment was collected near Lawrence, Kan., during the spring and summer of 1918. The writer performed almost all of the operations. The thyroid was removed when the larva was about five millimeters long. A few thyroidless *Bufo americanus* and a few control *Bufo americanus* of an advanced age were secured from Prof. B. M. Allen. He also placed at my disposal several prepared slides of the hypophysis. The thyroidless specimens used varied from five to twenty millimeters in body length. The control specimens varied from five to almost thirty millimeters in body length. The largest control had completely metamorphosed.

The specimens used for measuring the hypophysis were chosen in pairs—a control and a thyroidless. The total length and body length were used as the deciding criteria for pairing. The criticism might be made that these measurements vary considerably even in a given number of controls of the same age, but when a large number of specimens are used and the averages taken this will not be a great enough factor to affect results seriously. The metamorphosed and nearly metamorphosed *Bufo* were compared with the largest of the thyroidless specimens.

The following measurements were made on all specimens: total length, body length, and leg lengths. They were measured and fixed at different intervals in order to secure a full series from the youngest to the oldest. Bichromate acetic and Zenker's preserving fluids were used. After running the specimens up to 70 per cent alcohol the brains were carefully dissected out and five measurements were made on the hypophysis. These measurements will best be understood by referring to figure 1. This phase of the work might be called a gross measurement study and the second phase a microscopic study.

For the microscopic study the sections were cut in a saggital plane from five to ten microns thick and stained with Heidenhains iron-alum hæmatoxylin. Hæmalum with an eosin counter stain was also used for a few of the slides.

In the microscopic study the three lobes were easily differentiated and every fifth or tenth section projected by a camera lucida on paper ruled into square millimeters. These squares were counted, divided by the magnification and multiplied by the thickness of the section and the number of sections. By this method the volume of each gland was ascertained. This also acted as a check on the gross measurements and shows in a graphic manner the size differences in the different lobes as well as size differences in comparing the controls with the operated specimens. This method is the well-known "Hammar paper method."

RESULTS.

A. GROSS MEASUREMENT STUDY.

Five measurements were made on the hypophysis of eighty-five thyroidectomized *Bufo americanus* and upon seventy-five control *Bufo americanus*.

The removal of the thyroid gland prevents metamorphosis and causes the tadpole to retain its larval characters in spite of the fact that it grows in size. The effects of the extirpation can be detected quite early in the incomplete development of the hind legs as compared with those of a control of a corresponding age. In *Bufo* this

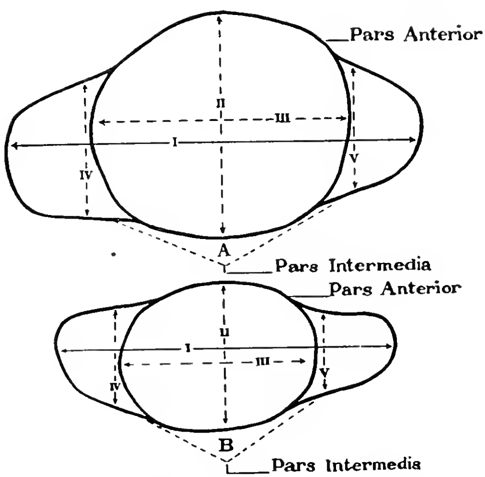

Fig. I. Cameria lucida outline drawing of the entire hypophysis of a thyroidectomized tadpole (A), body length 16.2 mm., and a metamorphosed control (B), body length 28.2 mm. Roman numerals indicate measurements. A Bausch & Lomb 3 mm. objective and ocular 10 were used.

difference is not quite so pronounced as in *Rana*. In the former the body factors which have an effect on metamorphosis exert their influence for a greater length of time in the absence of the thyroid (Allen).

In five- and six-millimeter operated larvæ of *Bufo* the incomplete development of the hind limbs are noted. In many cases they were mere buds. Also the measurements of the hypophysis of the same specimens showed a slight increase over the controls. This increased as size increased.

The accompanying Figure 1 will serve to illustrate the position of the five measurements made on every hypophysis studied and at the same time will show graphically the immense enlargement that results from the thyroidectomy.

Figure A is the hypophysis of a thyroidectomized *Bufo americanus* and Figure B of a metamorphosed *Bufo americanus*. The length of the body of the operated specimen was only 16.2 millimeters as compared with the metamorphosed control, whose body length was 28.2 millimeters. In spite of the difference in body size, the hypophysis of the thyroidless *Bufo americanus* was considerably larger in all of the measurements.

TABLE 1.—The average body and hypophysis measurements of most of the specimens studied. Each group represents the average measurements of at least ten control *Bufo americanus* and ten thyroidectomized *Bufo americanus*.

PAIRS OF SPECIMENS.	Body measurements in mm.			Hypophysis measurements in mm.				
	Total length.	Body length.	Hind leg length.	Horizontal measurement of anterior lobe. 1	Vertical measurement of anterior lobe. 2	Horizontal measurement of pars intermedia. 3	Vertical measurements of pars intermedia. 4	5
Control	12 1	5 5	.2132	0792	0847	.1968	0382	0382
Thyroidless	11 0	5 5	0710	0874	0902	1612	0464	0464
Control	16 4	6 8	7579	1180	1204	2861	0175	0475
Thyroidless	13 4	6 8	.2640	1173	1246	.2261	0638	0656
Control	17 1	7 6	9713	1371	1379	3045	0519	0515
Thyroidless	18 2	7 6	.5774	1678	1692	3087	0745	0753
Control	18 9	8 2	5 3020	1625	1617	3564	0627	0685
Thyroidless	17 7	8 3	6835	1968	1944	3481	0756	0857
Control	19 9	9 4	5 9329	1618	1752	3578	0738	0688
Thyroidless	19 8	9 4	1 5370	1922	1916	3429	0828	.0879
Control	19 3	10 0	4 568	1581	1667	3365	0686	.0916
Thyroidless	22 1	10 4	1 885	1863	1901	3280	1048	0879
Control	22 3	11 2	6 7258	.1822	1550	3660	0775	0730
Thyroidless	24 4	11 3	1 3390	2012	1960	3369	0961	0984
Control	21 0	12 0	9 2820	1541	755	4182	0803	0803
Thyroidless	25 8	12 4	1 5450	2230	2676	3552	1049	0918

As suggested before, the increase in size of the hypophysis is noticeable in the youngest specimens and it becomes more pronounced as older and older *Bufo americanus* are studied. These measurements were all made by means of a micrometer eyepiece at the same magnification. The average lengths of the forelegs were omitted because a very few of even the eleven- and twelve-millimeter specimens showed the first appearance of a forelimb.

Several of the operated specimens lived a few months past the normal time for metamorphosis. In comparing the hypophysis of these with the hypophysis of metamorphosed and nearly metamorphosed controls, the size differences were so marked that the comparison could readily be made without the aid of a microscope.

TABLE II.—A few representative pairs out of the dozen or more such pairs of the larger specimens measured.

Pairs of Specimens.	Body measurements in mm.				Hypophysis measurements in mm.				
	Total length.	Body length.	Fore leg length.	Hind leg length.	Horizontal measurement of anterior lobe. 1	Vertical measurement of anterior lobe. 2	Horizontal measurement of pars intermedia. 3	Vertical measurements of pars intermedia. 4	5
Control 88	14 1	14 1	5 9231	10 684	.1558	1394	.2870	.0656	.0656
Thyroidless 41	37 0	14.0	......	9 328	.3280	4100	.0984	.1312	.1312
Control 44	14 0	14 1	5 684	10 132	.1476	.1394	.2788	.0574	.0574
Thyroidless 2	30.1	14 2	....	6 000	.2870	.2788	.4100	.3608	.3608
Control 81	22 0	22 0	15 000	30 200	.3526	.4592	.9348	.1722	.1722
Thyroidless 107	41 8	16 2	.	6 400	5740	.4920	.6704	.1640	.1640
Control 80	19 0	19 6	12 500	25 500	.3198	.4428	.9020	.1640	.1640
Thyroidless 101	41 8	19 0	.	4 510	7954	8528	.1024	.3362	.3562
Control 91	26 3	26 3	18 200	33 900	1344	.3790	.6642	.0984	.0984
Thyroidless 98	43 8	20 0		3 280	8282	.7872	1 2628	.4592	.4920
Control 86	23 0	meta	13 500	25 800	3280	.3690	.7134	.1640	.1804
Thyroidless 96	42 0	16 4		5 000	5248	6150	.9666	2050	.2050

In these gross measurements the neural lobe could not be measured except as associated with the pars intermedia. The only successful way to measure the neural lobe is by means of microscopic sections. As previously explained the neural and intermediate lobes are very closely associated. In *Bufo americanus* especially, the neural lobe protrudes slightly beyond the intermediate, but it can only be detected upon exceedingly careful differentiation. This lobe is also comparatively late in development. It does not make its appearance in *Rana* until the larva is about eighteen millimeters in body length (Atwell). It probably develops somewhat earlier in *Bufo*.

The two measurements on the anterior lobe are fairly simple to make, but the measurements on the intermediate lobe offer a more difficult problem. In the averages of the third measurement, namely, across the length of this lobe, a discrepancy often appears. This measurement in the control is sometimes as long as the same measurement in the thyroidectomized specimen. This is usually true only in younger specimens and is probably due to the fact that the pars intermedia bulges out beyond the anterior lobe rather irregularly. This seems to be especially true in the operated specimens and probably at first the growth increase is more in depth than length.

B. MICROSCOPIC STUDY.

Now that it has been shown by gross measurement that the pars anterior and pars intermedia enlarge following the removal of the thyroid gland it becomes of interest to test the same point by a study of serial sections of normal and thyroidectomized specimens. As suggested, previously, successful gross measurements of the neural lobe cannot be made and therefore especial attention was given to the study of this lobe in the microscopic sections.

The serial sections of twenty-one hypophysis were studied. Of these nine were controls and twelve operated *Bufo americanus* and *Rana pipiens*. For the sake of convenient comparisons, these specimens were divided into three groups, large, medium and small.

The "Hammar paper method" was used for determining the volume of the different lobes.

TABLE III.—Body measurements, volumes of the three lobes of the hypophysis and number of sections in each series of seven control and six thyroidectomized *Bufo americanus*. These were chosen from twenty-one hypophyses studied in serial sections.

LARGE.

	Body measurements in mm.	Volume of anterior lobe.	Volume of intermediate lobe.	Volume of neural lobe.	Number of sections in series.
Control *Bufo* 17.15	Body length 11 9 Total length 11 9	004250	.001420	002285	36
Control *Bufo* 16.17	Body length 11 7 Total length 11 7	001510	000988	0008639	50
Control *Bufo* 17.16	Body length 11 0 Total length 11.0	003400	.002092	.001164	37
Thyroidless *Bufo* 19.76	Body length 21 6 Total length 43 4 Hind leg length 5 3	.198585	086750	021180	127

MEDIUM.

	Body measurements in mm.	Volume of anterior lobe.	Volume of intermediate lobe.	Volume of neural lobe.	Number of sections in series.
Control *Bufo* 17.19	Body length 10 1 Total length 20 8	002412	000954	001085	33
Control *Bufo* 17.18	Body length 11 6 Total length 23 5	002800	.001600	001185	30
Tyroidless *Bufo* 19.86	Body length 18 2 Total length 23.5	.018000	.014607	.003772	63
Thyroidless *Bufo* 19.71	Body length 19.0 Total length 43 9	.043510	019025	.002890	71
Thyroidless *Bufo* 19.72	Body length 19 1 Total length 43 0	030451	015839	006693	86

SMALL.

	Body measurements in mm.	Volume of anterior lobe.	Volume of intermediate lobe.	Volume of neural lobe.	Number of sections in series.
Control *Bufo* XVIII	Body length 9 2 Total length 23.0	001520	.000885	.001015	45
Control *Bufo* II	Body length 27 0 Total length 11.0	002085	.001255	001285	45
Thyroidless *Bufo* XXI	Body length 9 5 Total length 22 0	.008135	.007985	001055	65
Thyroidless *Bufo* VI	Body length 11 2 Total length 27 9	016340	.006185	.000756	61

TABLE IV.—Body measurements, volumes of the three lobes of the hypophysis and number of sections in each series of two control and two thyroidectomized *Rana pipiens*.

	Body measurements in mm.	Volume of anterior lobe.	Volume of intermediate lobe.	Volume of neural lobe.	Number of sections in series.
Control *Rana* XI	Body length........ 14 0 Total length........ 17.2	.001599	.001326	.001525	45
Control *Rana* B	Body length........ 21 8 Total length........ 24.3	.003950	.003775	.003795	57
Thyroidless *Rana* IX	Body length........ 25 0 Total length........ 41.2	.0115695	.008269	.0011329	106
Thyroidless *Rana* No. 3	Body length........ 20 1 Total length 40 3	016160	.018656	.003275	77

In a comparison of control XVIII and thyroidless XXXI the difference in volume of the anterior lobe and pars intermedia is already quite noticeable. These were the youngest specimens studied in microscopic sections. In the older specimens the enlargement of the two lobes was simply enormous. Plates XXVII and XXVIII are the camera lucida drawings of sections of the hypophysis of a metamorphosed *Bufo americanus* and a thyroidectomized *Bufo americanus*. The control is specimen number 17.15 in Table III and the thyroidectomized specimen is number 19.71 in the same table. The body length of the control was 11.9 millimeters and the same measurement for the operated specimen was 19.9 millimeters. These were all drawn at the same magnification and bring out very clearly the size comparisons of the different lobes and especially the enlargement of the lobes in the thyroidectomized *Bufo americanus*.

Every fifth section in the series was drawn. The hypophysis of the control consisted of thirty-six sections and of the operated there were seventy-three sections, each cut ten micra thick.

In all sections of the hypophysis of the controls the three lobes were decidedly easy to differentiate. The anterior lobe was the largest in every case. In the majority of sections the pars intermedia was as large as the neural lobe or slightly larger. There is probably very little actual-size difference in the two.

In all the serial sections of the operated specimens there were several more sections than in controls of a corresponding age. This shows an actual-size increase. In all but one of the thyroidectomized specimens (Rana No. 3) the anterior lobe has a greater volume than the intermediate lobe, but the intermediate lobe is especially large when compared with the same lobe of a control specimen.

The neural lobe is very difficult to differentiate in the operated tadpoles. In many sections it was almost impossible to distinguish a trace of neural material. In many sections, if there was such material it was loose and scattered along the margin of the infundibulum and not collected into a mass which could be differentiated as a lobe.

The pars intermedia apparently occupies the position of the combined intermediate and neural lobe of the control. Undoubtedly the neural lobe, because of its normally late development and because of the interference of this normal development by thyroidectomy, does not develop to any appreciable extent. Conditions comparable to this are noticed in the study of other structures in thyroidless tadpoles.

CONCLUSIONS.

1. The extirpation of the thyroid gland causes the hypertrophy of the anterior lobe proper and the pars intermedia of the hypophysis in *Bufo americanus* and *Rana pipiens*.

2. Thyroidectomy causes a continuation of larval characteristics in the amphibia and hence the neural lobe is hindered in its growth because of its normally late development. Probably in the oldest thyroidectomized specimens material from the enlarged intermediate lobe has migrated into the small amount of neural tissue present and for that reason the two appear almost inseparable in many sections.

3. The neural lobe is very distinct in the controls. The pars intermedia and neural lobe are of about the same size. The intermediate lobe may be somewhat larger. The anterior lobe is considerably larger than either of these two.

4. The anterior lobe of the thyroidectomized *Bufo americanus* which has lived past the normal time for metamorphosis is at least twice as large as the pars intermedia, and the pars intermedia several times larger than the neural lobe. The anterior lobe and pars intermedia of the thyroidectomized *Bufo americanus* are several times larger than the corresponding lobes of a normal *Bufo americanus* of the same size.

I wish here to express my appreciation to Prof. B. M. Allen, formerly of the University of Kansas, now at the Southern Branch of the University of California, at whose suggestion this problem was undertaken. His help and encouragement made this paper possible. I also wish to thank Dr. H. H. Lane for kindly criticism while writing the final draft of this paper.

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PLATES XXVII AND XXVIII.

Drawings of every fifth section of the hypophysis of a metamorphozed *Bufo americanus* (17.15 in Table III) and a thyroidectomized *Bufo americanus* (19.71 in Table III). The odd numbers represent sections of the hypophysis of the control, while the even numbers represent sections of the thyroidectomized specimen. This arrangement was thought best in order to show at a glance the comparison between the two. Section XV is the last one for the control, but due to the increase in size of the hypophysis of the thyroidectomized *Bufo americanus* there are several more of the latter. As suggested in the text, the neural lobe is quite difficult to differentiate in a thyroidectomized specimen, and so in the drawings it is always shown in close relationship with the intermediate lobe. In the control the line of demarcation is very distinct.

All figures were drawn with the aid of a camera lucida at table level. A Bausch & Lomb 3 mm. objective and ocular 10 were used.

Abbreviations: A, anterior lobe; N, neural lobe; I, intermediate lobe.

PLATE XXVII.

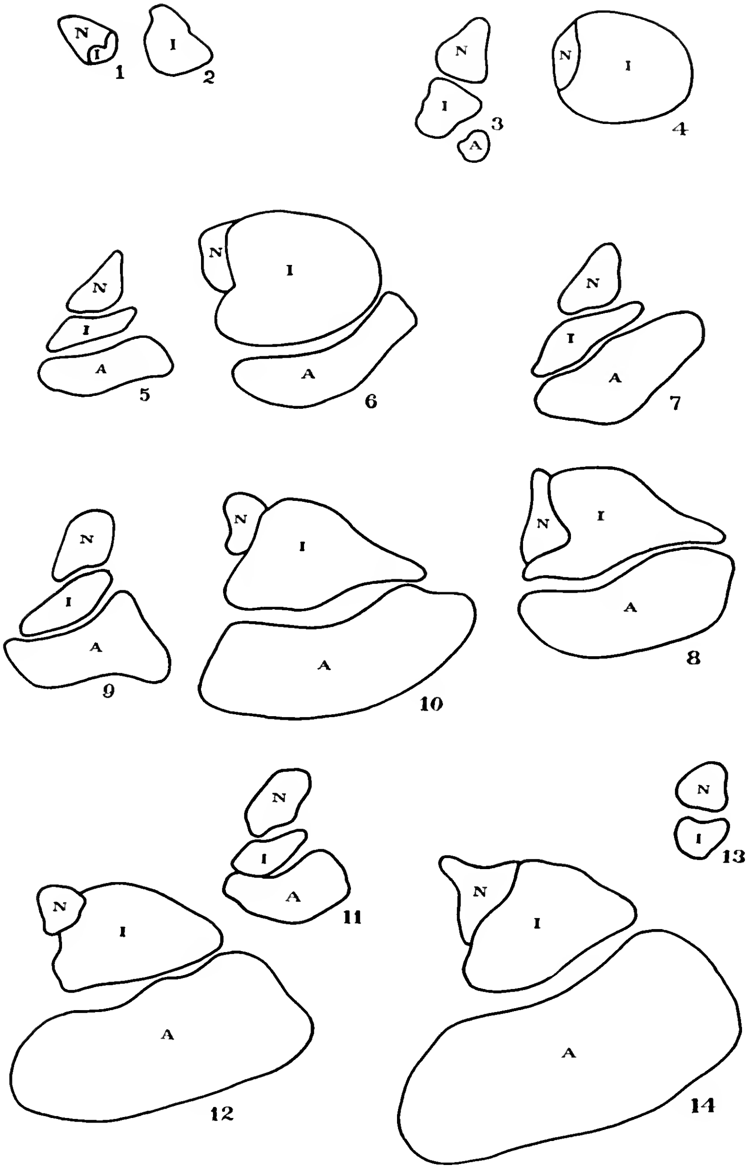
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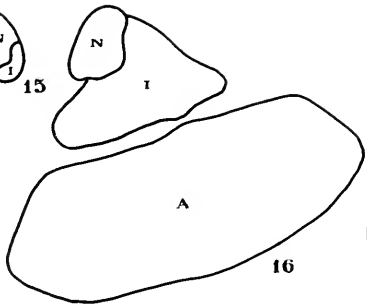
PLATE XXVIII.

15



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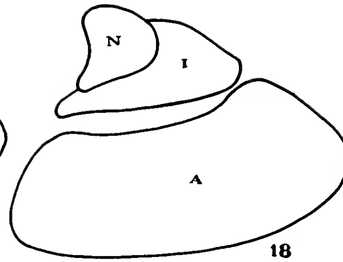

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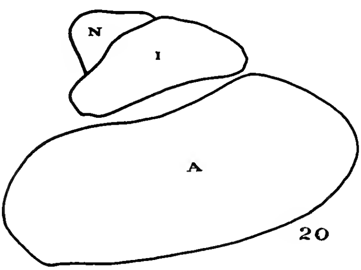

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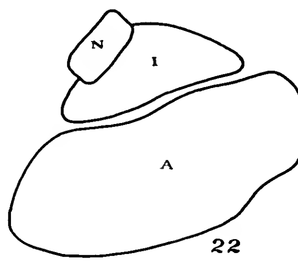

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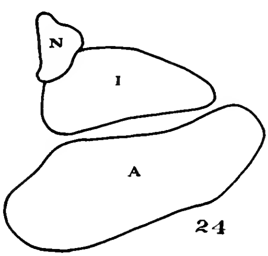

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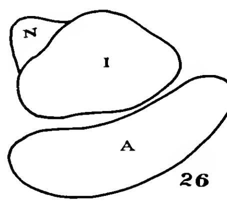

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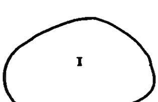

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Some Studies on the Structure and Behavior During Germination of *Gymnocladus canadensis* Lam.

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INTRODUCTION.

IN THIS paper an attempt was made to determine the source and use of mucilage. Both of these points have been discussed in the literature and various views stated, some of which will be taken up a little later on in this paper. I was especially interested in trying to find whether or not it was used as food in this plant. Some of the drawings included are quite like those published by Pammel (13) and are used here only to help complete the set. Along with this study I attempted to find why the percentage of germination of the seeds was so low in nature, and with these studies made a few anatomical observations.

SEED PODS.

The seeds of *Gymocladus canadensis* Lam. are borne in a typical leguminosæ pod (Pl. XXIX, Fig. 1), which is from 3 to 7 inches long, to 2 inches wide and about 1 inch thick. The pods mature about the first of October and some may fall then, but the greater part of them hang on the trees well into spring, and it is not unusual to see some still hanging on the trees in midsummer.

The seeds, except in rare cases, remain in the pods until they fall and are broken up or decay, which may take two years.

The two valves of the pod are composed of a hard tissue which is made of cellulose and lignified cell walls. The very outer layer is cutinized and just under this there is a thin layer which gives a good test for tannin when treated with ferric chloride.

In the mature pods microchemical tests failed to show any reserve food in the form of starch, sugar, protein reserve cellulose, oil, inulin, or mucilage.

Within the two valves and surrounding the seeds is a loose cellular structure made of long cylindrical cells. (Pl. XXIX, Figs. 4, 5.) This mass of cells fills in the entire cavity around the seeds until they are nearly mature. Just before maturity these cells have a large amount of starch stored in them. (Pl. XXIX, Fig. 5.) About the time of maturity there is a general breaking down of this cellular structure into a brown sticky mass which remains around the seeds. After this disintegration the starch content of the cells disappears almost entirely (Pl. XXIX, Fig. 4), but for all I can tell from the available material there is no breaking down of the cell walls. Cellulose was the only membrane substance identified in the cell walls, except possibly pentosans, for which I got a slight test with orcin and hydrochloric acid. This substance absorbs water and swells some but not as much as mucilage does. It is sweet and with phenolhydrazine hydrochloric I was able to identify glucose and fuctose, and got two different tests for lactose.

The mucic acid test for galactose was negative. Tests for protein, reserve cellulose, oil, inulin and mucilage were all negative. Tannins were not found in this mass.

When the pods become moist they are often pushed open by this gummy mass, but if an excess of moisture is present the two valves will usually close tight. Fungi seem to thrive in this gummy mass, which may have some connection with germination of the seeds. I will take this up later.

Millspaugh reports this mass of cells, in the unripe fruit, and the green leaves as containing cytisine ($C_{24}H_{27}N_3O$) which is extracted with alcohol and used some in medicine. Millspaugh also reports the crushed green leaves as being an excellent fly poison when sprinkled with water and molasses. (See Millspaugh, l. c.)

Bretschneider (4) reports that the Chinese use this mass from the ripe pods as a soap, and he also lists it as one of the important articles of export from China. It does have a soapy consistency and lathers freely in water.

Insects are quite commonly found feeding upon this substance while in the pods.

STRUCTURE OF SEEDS.

There are from 1 to 7 seeds borne in each pod with an average of 4½ seeds in 200 pods examined. These seeds are attached to the pod with a funiculus which is about 9 mm. long and 1 mm. in diameter.

When dry the funiculus of mature seeds is very hard. In cross section it has very thick-walled cells with a small cell cavity. (Pl. XXXII, Fig. 1.) The cell walls give a good test for cellulose but not test for lignin. After being soaked in water the outer layers of cells start swelling and at six hours they were rounded out as in Plate XXXII, Figure 2. Plate XXXII, Figure 5, shows the condition after 24 hours soaking. Here the cell walls have entirely broken down into a mucilaginous mass, leaving only the small masses of protoplasm intact. Some of the cells do not undergo this change, but only swell slightly and still retain their identity as cells. When these cells are converted into this mucilaginous substance there is a limit as to how far the reaction may go. Never have I found them going into a colloidal solution. After two days, when nearly all of the cells were in that state, the funiculus would still be tough enough to section readily. A good mucilage test was obtained in all stages of the swelling.

The only use that I could imagine for this phenomenon in the funiculus is that probably this mucilaginous layer could hold water in contact with the cutinized layer long enough for it to break through into the embryo. I do not have any experimental evidence to base this on.

Microchemical tests failed to show any form of stored food in the funiculus.

The seeds average about 16 mm. long, 14 mm. wide, and 11 mm. thick. (Pl. XXXIII, Fig. 1.) The average weight for 100 seeds was 2.3 grams. When mature, and fresh, they are of a glossy dark-brown color. Later, after they have laid on the ground for some time, they lose the glossy finish. This is due to a checking of the very outer layer of the epidermis. (Pl. XXX, Fig. 1, A-1.) I have never found the checks extending down through the entire epidermis. The seeds are so hard that the Chinese coolies strung them and used them for armor (5).

SEED COATS.

The hard seed coats are made up of two distinct layers. (Pl. XXX, Fig. 1.) The outer layer is the epidermis and is made up of several layers of very thick-walled, elongated cells, and averages about 0.2 mm. in thickness. (Pl. XXX, Fig. 2.) These cells were separated out by boiling in a concentrated solution of potassium hydroxide.

This outer layer forms a waterproof coat over the entire seed, there being a like layer laid down with the abscis layer, which cuts the seed off from the funiculus. This coat is so thoroughly waterproofed that seeds showed no signs of swelling after being soaked in water for nine months. No weights were taken. Seed from the *Gleditsia triacanthos* L., which are waterproofed with a similar layer, only much thinner, showed no signs of swelling after being soaked for thirteen months.

The cells making up the epidermis give a good test for cellulose but not for lignin. In Plate XXX, Figure 1, the area A-1 gave a good test for chitin. This was checked up with insect wing and elm wood, but I still feel that there is possibly some other substance present which gave the reaction. This also dissolved out in boiling concentrated potassium hydroxide, but boiling saturated potassium hydroxide did not affect it. The area A-2 gives a strong test for cutin, and A-3 a much weaker test for cutin. Between the areas A-1 and A-2 (Pl. XXX, Fig. 1) there is a clear line which I was unable to identify. Various explanations of this line have been offered, but I did not try to check them up. Pammel (12) states that as far as he knows it is always connected with a reproductive body, and obviously has some function. I was unable to demonstrate any living protoplasm, or any form of storage substances, in fresh sections of the epidermis.

It is possible for seeds to be absolutely impervious to water and still carry on respiration, as O_2 can pass through a cutinized layer that is absolutely waterproof. A saturated solution of chromic acid and concentrated solutions of nitric, hydrochloric and sulphuric acids make their way through the seed coat after standing for some time. (See germination charts on pages 343 to 346.) The point of attack is usually at the point where the funiculus was attached. In most cases the seed coat was unaffected at any other point. Seeds that were in 20 per cent hydrochloric acid for two hours showed a general breaking down of the outer uncutinized area of the epidermis, but no damage was done to the cutinized part of the epidermis. Seeds soaked two hours in 50 per cent nitric acid were coated with a slimy mass formed by the breaking down of the uncutinized part of the epidermis. In the tables the seeds which germinated, after being treated with dilute acids, very likely had slight defects in the seed coats.

When this epidermal layer is broken the seed takes up water very rapidly and the epidermis cracks and peels off. (Pl. XXXIII, Fig. 2.)

The inner layer of the seed coat is made up of thick-walled cells (Pl. XXX, Fig. 1-B) which are very hard. There is no difference in the structure or properties of these cells, except for the very outer layer where the cells are much different in shape (Pl. XXX, Fig. 1) but not in other general properties, and are apparently unaffected by the peeling off of the epidermis. These cells are connected to each other by relatively large pits in their walls, but the intercellular spaces are very small and few.

Microchemical tests for starch, reserve proteins, reserve or hemicellulose, oil, tannins, mucilage, and inulin were all negative. When boiled with Fehling's solution the seed coats gave a good reduction test for sugar. However, I cannot say that it was sugar, because it would not dissolve out in water, even after long soaking. It is evidently some carbohydrate which is easily hydrolized, or some other reducing substance, possibly an aldehyde, which is not soluble in water.

When the epidermis is cut through and the seeds then put into water for 48 hours there is a large amount of swelling in the seed coat. This swelling increases the thickness of the seed coat and also increases the circumference of the seed coat. The following weights and measurements are very close to an average:

Weight of seed dry	2.140 grams
Weight of seed soaked	7.400 grams
Water absorbed	5.292 grams

The seed coat had not yet broken as it did later.

Length of seed dry	18 mm.
Width of seed dry	16 mm.
Thickness of seed dry	11.4 mm.
Length of seed soaked	26.5 mm.
Width of seed soaked	22.7 mm.
Thickness of seed soaked	18 mm.
Thickness of seed coat dry	.6 mm.
Thickness of seed coat soaked	1.3 mm.

This last measurement was made on sections soaked on a slide, but the increase in thickness averages up pretty well with that which occurs in the whole seeds.

The walls of these cells are composed of cellulose and lignin. I was unable to detect any mucilage or other substances that would account for so large an amount of swelling. After swelling, the inner layer of the seed coat, which is the only part left, is very tough and pliable and will give to the pressure of the expanding cotyledons and mucilage within.

There is an exception to the above description of the inner layer of the seed coat. At the point just under the absciss layer (Pl. XXIX, Fig. 3-H) the cells, when dry, appear just like all of the other cells of the inner layer (Pl. XXXII, Fig. 1), but react much differently. These cells give a test for cellulose but not for lignin. When put into water the walls of most of them start swelling, as in Plate XXXII, Figure 5, and continue swelling until they lose their identity as cell walls and become a mass of mucilage. This is a remarkable modification of the seed to aid in germination, as it is at this point that the growing radicle, which is the first part to emerge, must break through the seed coat. (Pl. XXIX, Fig. 3-H.) With these cells breaking down into a mucilaginous mass the tender radicle can much more easily force its way through. The swelling at this point is also much greater, the seed coat increasing from 7 mm. to 4 mm. in thickness. This mucilaginous substance, while being softer than that formed in the funiculus, will not go into a colloidal solution, but does give a good color test for mucilage.

MUCILAGE LAYER AROUND EMBRYO.

Just outside the seed coat is a hard, dry mass of substance (Pl. XXX, Fig. 1-C) which is white in color and composed of cells (Pl. XXXI, Fig. 1-A) and an amorphous mass which is made up of empty cell walls embedded in mucilage. Pammel (12) terms this endosperm. This layer is about 1 mm. thick and extends around the entire embryo, with a few exceptions. However, it is always much thicker on the sides than around the edges of the cotyledons. The cells, which remain intact, are covered with mucilage and form a loose cellular structure with large intercellular spaces. (Pl. XXXI, Fig. 1-B.) This structure or tissue is usually to the outer side next to the seed coat. This layer absorbs large amounts of water and is capable of swelling from 1 mm., the thickness when dry, up to 18-20 mm. in thickness when soaked over night. (Pl. XXXIII, Fig. 4.) The cellular structure usually remains intact and as the mucilage swells it is forced into the intercellular spaces and then on out of the cellular tissue. The cotyplasm of these cells, which are undoubtedly dead, gives only a slight test for proteins and in some cases it seemed to disintegrate and disappear. Very likely it is in a state of decomposition. The walls give a good test for cellulose but not for lignin.

The empty cell walls, which are in the amorphous mass, are composed of cellulose, and may or may not surround some protoplasm, usually not. (Pl. XXXI, Fig. 5.) Before maturity these cells and the cells remaining intact contained large amounts of starch which disappeared during the ripening of the seeds. Whether this starch is converted into mucilage or not I cannot say, but it is quite evident that the mucilage is formed during the ripening of the seeds, and is not a disintegration product of the cell walls, taking place as the cells absorb water, because there is no reduction in the thickness of the cell wall. (Pl. XXXI, Figs. 1-B and 4-B.) The mucilage found here will lose its identity and pass into a colloidal solution. I say colloidal because it will not pass through a celloidon dializing tube and it does not exert any osmotic pressure. The swelling of this mucilage, together with the swelling of the embryo, is often enough to break the seed coat even when the radicle is not trying to break through. (Pl. XXXIII, Fig. 3-B.)

This mucilage also absorbs water and conducts it to the entire outer surfaces of the cotyledons and in this way hastens germination. Also, the amount of water held by this mucilage is enough to tide the germinating seedlings over a temporary dry spell. While it is helping in germination in this way, it is hindering it in another because of its excellent qualities as a culture medium for injurious organisms. During germination this mucilage contains considerable sugar, which is undoubtedly drawn from the cotyledons. From this we might conclude that the substance previously noted in the seed coat during germination and giving the reducing test for sugar, might be sugar diffusing out from the cotyledons or a hydrolisis product of the seed coats being conducted inward. However, as before stated, the seedlings grew just as well in the laboratory with this mucilage removed as they did with it present. This was not checked up with field experiments. This was noted in the laboratory; when the food was all removed from the cotyledons there were no reducing substances left in the mucilage.

Experiment in which the seed coats were removed with the mucilage layer left intact, showed that there was no loss in dry weight, from the mucilage, during germination and development of the seedlings as long as they would grow on the food stored in the seeds. In these experiments the mucilage layer was removed and weighed dry. They were then replaced and the seeds put to germinate on cotton, in bottles. When growth had ceased the plants were carefully removed and all traces of mucilage washed back into the bottles. The bottles, with the mucilage and cotton, were dried and weighed but in no case was there any loss in weight. Furthermore, seeds germinated and grew just as well and long without this mucilage layer as they did with it present.

Upon being hydrolized with 4 per cent sulphuric acid and then neutralized with barium carbonate, there was a good test for glucose, fructose and possibly mannose. When soaked over night in 10 per cent lead acetate the mucilage absorbed some water but would not swell any more when put into pure water. With alcohol it reacts slightly different from the mucilage found in the bark of *Ulmus fluva* in that it does not absorb water from 60 per cent alcohol and is precipitated by 70 per cent alcohol. The mucilage from *Ulmus fluva* absorbs water from 60 per cent alcohol and is not affected by 70 per cent alcohol.

In the work done by others there are many theories advanced as to the origin and function of mucilage. Edna L. Smith quotes Czapek's[1] summary on the origin and function of mucilage in plants:

1. Secondary thickenings in the cell walls. It may exude from the cell upon the epidermis or into the intercellular spaces.
2. Specialized layer between cell wall and cytoplasm.
3. Arises in the protoplast.

Czapek lists the protoplast slime as water holders, and that found within the tubers of orchids and the endosperm of legumes as reserve carbohydrates. He considers that slime membranes are never used as stored food, but rather as serving to (*a*) imbibe and hold water during germination and to protect against excessive transpiration, (*b*) anchor seeds to substratum, (*c*) facilitate gliding of the seeds, and (*d*) protect water plants from their natural enemies. In summarizing her work, Miss Smith concludes that the mucilage in the floral organs of *Aspasia* sp. and *Oncidium stipitata* must originate in the living protoplasm.

Gregory (8) lists the sources of mucilage as (*a*) the absorption of water by cellulose walls, as in the epidermis of flax, and (*b*) secretion by special glands. She attributes two uses to this mucilage, (*a*) against excessive water and drouth in the lower members of the *Hepaticæ,* and (*b*) protection of the embryo within the open archegonia of many of the *Musci,* from the water. No doubt she referred to the mechanical effects of the water currents. Gregory also lists gums as decomposition products of the cell walls, and in *Ricciеæ,* she states that the origin of the mucilage is unknown.

Pfeffer (9) reports the gelatinous layer of *Nostoc* as being able to absorb water in the ratio of 200-1. He also states that mucilage may be converted into cellulose by the proper treatment with acid, but he does not explain the reverse reaction.

Sachs (10) gives the cellulose walls as the source of mucilage and

1. Die Chemie und Biologie der Planzensekrete, Leipsig, 1903 and 1921.

states that the walls or parts of walls which turn into mucilage are more refractive than the walls which remain intact. In the endosperm of *Ceratonia siliqua* the outer layers of the cell walls become mucilage and the inner layers remain as a highly refractive system. In the linseed and quince seed the inner thickened mass of the epidermis changes to mucilage and absorbs enough water to burst the cuticle. Sachs offers no explanation of the chemical changes which take place in the conversion of cellulose to mucilage.

In my work I found conclusive evidence that in the funiculus and in the layer of cells in the seed coat just below the funiculus, the mucilage is formed by the absorption of water by the cell walls. That is, these walls when dry gave a reaction for cellulose and then when wet behaved like mucilage. This change may have taken place at some previous time, providing that there is some substance left that will give the cellulose reaction. With the material available it was impossible to determine the source of the mucilage around the embryo, but there was proof that it did not develop from the remaining cell walls by the absorption of water. It probably originated about the time of maturity and it may be, as Pammel (12) suggested, formed by the absorption of water by secondary thickenings in the walls. I feel sure that the large starch content that was present just before maturity played an important part in the formation of this mucilage.

EMBRYO.

The cotyledons of the embryo are very hard and swell considerably when soaked in water. The outer epidermis is covered with a very thin film of cutin. (Pl. XXXIV, Fig. 3-F.) The inner epidermis (Pl. XXXIV, Fig. 3-D) is not cutinized, and the two cotyledons are grown together for the greater part of the way at the very thick outer walls of the epidermal cells. (Pl. XXXIV, Fig. 3-E.) A general drawing (Pl. XXIX, Fig. 3) shows the relative size, shape and position of the different parts of the embryo.

The cotyledons contain starch, and oil as reserve food, and I got a faint test for inulin with the ∝ naphthol-hydrochloric acid test, but was unable to detect any inulin crystals. There was no mucilage, reserve cellulose or tannin found.

GERMINATION OF SEEDS.

During the germination the cotyledons remain in the ground and do not separate at all. There is enough food stored within them to support the seedling until it gets its second pair of leaves. The first leaves developed on the seedlings are once pinnate instead of twice pinnate as they are in mature trees.

Plate XXXV, Figures 1, 2 and 4, are drawings of bleached, embryonic leaves taken from the buds of mature trees. Figures 1 and 2 show the differentiation of the cells to form the water tubes of the leaf. Figure 1 shows water tubes developing out in the tissue of the leaf without any water tubes connecting back to the main vein already developed. Figure 2 shows the cell elongated to form water tubes but with the thickening of the walls beginning at the point farthest from the main vein. This is like the development of the veins making up the circulatory systems of animals. In young seedlings that have developed very rapidly this method of vascular development is very pronounced, much more so than in the mature trees.

Plate XXXIV, Figure 4, shows the development of the vascular bundles following closely behind the growing tip of the leaves. Epidermal cells were differentiating to form stomata at a point midway between A and B. The leaves on the mature trees are covered with hairs (Pl. XXXIV, Fig. 4-C), but in the young seedling very few are found. (Pl. XXXV, Fig. 1.) The bleached, mature leaf, looking up from the bottom, shows epidermis, veins and spongy parenchyna with relatively small intercellular spaces, much smaller than those in the palisade prenchyma. (Pl. XXXVI, Fig. 2-E.) In cross sections (Pl. XXXVI, Figs. 1, 2) the structure is quite like other leaves. The edges of the leaves have a much heavier coat of cutin than is found on the general surface or at the midrib. (Pl. XXXVI, Figs. 1-A and E, and Figs. 2-A and E.) The edges of the leaves are also strengthened with a group of thick-walled cells. (Pl. XXXVI, Fig. 1-F.) The epidermal cells at this point are also much heavier. At the midrib and the larger lateral veins there is a large amount of fibrous tissue developed for strength. (Pl. XXXVI, Fig. 2-I.)

GERMINATION OF SEEDS IN NATURE.

As best I can learn, germination of these seeds is rather uncommon in nature. On our home place there were two large and one small *Gymocladus canadensis* Lam. trees which bore many seeds each year, but during the ten years 1900-1910 only two young trees appeared, and they grew up from the exposed roots of one of the larger trees. In the winters of 1910 and 1911 the timber was burned over, killing many acres of the trees. Now the *Gymocladus canadensis* Lam. is the predominating tree, the seeds having been well scattered by the neighborhood children who used them in their sling shots.

There is another similar case a few miles northwest of Lawrence where a fence row is well seeded with *Gymnocladus canadensis* Lam. The farmer owning the land said that they appeared soon after he started burning the fence row to kill the chinch bugs. The fence separated a cultivated field and wooded pasture along a creek. The *Gymnocladus canadensis* Lam. which furnished the seeds stood about 50 feet from the fence, but there were no young trees except along the fence row where the burning was done.

Another still more striking example showed up on the campus in the spring of 1920. While burning the grass on the campus, in early spring, the fire burned around five *Gymnocladus canadensis* Lam. trees along the north edge of Marvin's grove. When the weather got warm hundreds of seedlings sprang up under these five trees while under the others there would be from none, the usual condition, up to three which were found only under one tree, where the grass was not burned.

Attempts to germinate the seeds without some form of special treatment, which will be taken up later, were useless except in the case of some seeds that had defective seed coats. (Pl. XXIX, Fig. 2.) In 10,000 seeds examined 30 were found with such coats. Some of these would have a break in the cutinized epidermis only, while in others the break would extend down into or even through the woody tissue which makes up the greater part of the seed coat. The five shown in Plate XXIX, Figure 2, were all taken from one pod. Usually there was but one in a pod. I could not find any cause for these seeds having defective coats. There were no marks on the pod nor any other signs of insects having used the pods as a host plant. it seems to be just a case of the tissue not developing. It was not possible to get enough of these seeds to make any extensive study upon them. With these defective seeds I got 100 per cent germination in the only test I ran, using 20 seeds. (See table 36.) Pammel and King (13) reported 80 per cent germination on seeds buried $3\frac{1}{2}$ feet under ground for $6\frac{1}{2}$ years and about the same percentage of germination with seeds 7 months old. They do not mention any special treatment before planting.

Sargent (11) reports that *Gymnocladus canadensis* Lam. may be propagated from seeds which will germinate in the second or third year. My results with seeds known to be two years old did not show a satisfactory per cent of germination. He gave the best method for propagation to be from root cuttings.

The treatment to aid and hasten germination falls under two general methods, physical and chemical, but the thing accomplished is the same in both cases, namely, to break through the impermeable epidermis of the seed coat and allow water to enter.

The first treatment undertaken was chemical and consisted in soaking the seeds in different concentrations of nitric, sulphuric, and hydrochloric acid. With this I got varied results. The tables show that the year-old seeds were much more resistant to the action of acids than the two-year-old seeds. Where the higher concentration of acids was used for a longer period the germination was low on account of the acid getting through to the embryo within and killing it. Where there was some germination with the weaker concentrations of acids, it is evident that the seed coats were not so well developed, or else there was some small defect in the waterproof epidermis. These experiments, tables 30-49, were carried on indoors where conditions were very unfavorable for plant growth, and a seed was considered as germinated when the radicle had developed enough to break through the seed coat. In this work the seeds were planted in sterilized petri dishes.

The physical treatment of the seeds consisted in destroying a part of the epidermis by either filing a hole in it or burning part of it away. The filing was a simple process requiring little time or care in handling. The burning was accomplished by putting the seeds on a coarse heavy screen and passing through the flame until the wires were red hot and then dropping them into water. Considerable overheating was required to kill the embryo, so that this method was very successful and much quicker than filing. Disinfectants were used with these seeds to kill the spores which were always present in the gummy mass adhering to the seeds. In the acid-treated seeds the disinfectants were not considered necessary. Where disinfectants were used on seeds either filed or burned there was a higher percentage of germination than with seeds with similar treatment but not disinfected. Additional tests were run on these seeds by soaking some of them 48 hours in water before planting. This gave a higher percentage of germination than when the seeds were not soaked. With this type of treatment the results were about the same with seeds filed or burned, and the best results were obtained by those that were soaked for 48 hours and then disinfected before planting.

SPRING, 1921.

OUTDOOR TESTS—SECOND-YEAR SEEDS.

(1) Burned, soaked 48 hours in water, treated 15 minutes with 1-1000 $HgCl_2$, and washed thoroughly in sterilized water.
Planted April 30........................May 20.... 46 germinated.

(2) Burned, soaked 48 hours in water, treated 15 minutes with 20 per cent formaldehyde and washed in sterilized water.
Planted April 30........................ May 20.... 39 germinated.

(3) Burned, soaked 48 hours in sterilized water.
Planted April 30........................ May 20.... 37 germinated.

(4) Filed, soaked 48 hours in water, treated 15 minutes with 1-1000 $HgCl_2$ solution and washed with sterilized water.
Planted April 30........................ May 20.... 32 germinated.

(5) Filed, soaked 48 hours in water, treated 15 minutes with 20 per cent formaldehyde and washed with sterilized water.
Planted April 30........................ May 20.... 40 germinated.

(6) Filed and soaked 48 hours in sterilized water.
Planted April 30........................ May 20.... 19 germinated.

(7) Treated with 50 per cent HCl for 30 minutes and washed in sterilized water.
Planted April 30........................ May 20.... 17 germinated.
May 31.... 47 germinated.

(8) Treated with 50 per cent HCl for 30 minutes and soaked 48 hours in sterilized water.
Planted April 30........................ May 20.... 13 germinated.

(9) Burned, treated with 1-1000 $HgCl_2$, and washed in sterilized water.
Planted April 30........................ May 20.... 23 germinated.
May 30.... 26 germinated.

(10) Burned, treated 15 minutes with 20 per cent formaldehyde and washed.
Planted April 30........................ May 20.... 26 germinated.
May 30.... 35 germinated.

(11) Burned.
Planted April 30........................ May 20.... 2 germinated.
May 30.... 21 germinated.

(12) Filed, treated 15 minutes with 1-1000 $HgCl_2$ and washed in sterilized water.
Planted April 30........................ May 20.... 17 germinated.
May 30.... 21 germinated.

(13) Filed, treated 15 minutes with 20 per cent formaldehyde and washed in sterilized water.
Planted April 30........................ May 20.... 23 germinated.
May 30.... 30 germinated.

(14) Filed.
Planted April 30........................ May 20.... 12 germinated.
May 30.... 13 germinated.

OUTDOOR TESTS—FIRST-YEAR SEEDS.

(15) Burned, soaked 48 hours in water, treated 15 minutes with 1-1000 $HgCl_2$ solution and washed thoroughly in sterilized water.
Planted May 1........................ May 2.... 46 germinated.

(16) Burned, soaked 48 hours in water and treated 15 minutes with 20 per cent formaldehyde solution.
Planted May 1........................ May 2.... 43 germinated.

(17) Burned, soaked 48 hours in sterilized water.
Planted May 1........................ May 21.... 33 germinated.

(18) Filed, soaked 48 hours in water, treated 15 minutes with 1-1000 $HgCl_2$ solution and washed with sterilized water.
Planted May 1........................ May 21.... 47 germinated.

(19) Filed, soaked 48 hours in water, treated 15 minutes with 20 per cent formalin and washed in sterilized water.
Planted May 1........................ May 21.... 38 germinated.

(20) Filed, soaked 48 hours in sterilized water.
Planted May 1........................ May 21.... 21 germinated.

(21) Treated with 50 per cent HCl for thirty minutes and washed in sterilized water.
Planted May 1..................... May 21.... None germinated.

(22) Treated with 50 per cent HCl for thirty minutes, and soaked 48 hours in sterilized water.
Planted May 1........................ May 21.... 3 germinated.

(23) Burned, treated 15 minutes with 1-1000 $KgCl_2$ solution and washed in sterilized water.
Planted May 1........................ May 21.... 23 germinated.
May 31.... 40 germinated.

(24) Burned, treated 15 minutes with 20 per cent formaldehyde solution and washed in sterilized water.
Planted May 1........................ May 21.... 25 germinated.
May 31.... 27 germinated.

(25) Burned and washed in sterilized water.
Planted May 1........................ May 21.... 3 germinated.
May 31.... 12 germinated.

(26) Filed, treated 15 minutes with 1-1000 $HgCl_2$ and washed in sterilized water.
Planted May 1........................ May 21.... 24 germinated.
May 31.... 29 germinated.

(27) Filed, treated 15 minutes with 20 per cent formaldehyde solution and washed in sterilized water.
Planted May 1........................ May 21.... 11 germinated.
May 31.... 14 germinated.

(28) Filed.
Planted May 1........................ May 21.... 8 germinated.
May 31.... 21 germinated.

SEEDS DUG UP FROM UNDERGROUND.

(29) The exact age was unknown, but some of them must have been several years old. Burned and soaked 48 hours and planted in sterile bottles. 200 seeds planted.
Planted March 20..................... April 1.... 168 germinated.

INDOOR TESTS—FIRST-YEAR SEEDS.

(Fifty seeds used in each test.)

(30)	Treated with 50% HCl for one hour	20 germinated.
	Treated with 50% HCl for two hours	47 germinated.
	Treated with 50% HCl for three hours	43 germinated.
(31)	Treated with 75% HCl for 10 minutes	45 germinated.
	Treated with 75% HCl for 30 minutes	46 germinated.
	Treated with 75% HCl for 1 hour	28 germinated.
	Treated with 75% HCl for 2 hours	20 germinated.
(32)	Treated with 100% HCl for 5 minutes	3 germinated.
	Treated with 100% HCl for 20 minutes	30 germinated.
	Treated with 100% HCl for 45 minutes	1 germinated.
(33)	Treated with 50% HNO_3 for 1 hour	0 germinated.
	Treated with 50% HNO_3 for 2 hours	0 germinated.
	Treated with 50% HNO_3 for 3 hours	0 germinated.
(34)	Treated with 75% HNO_3 for 10 minutes	0 germinated.
	Treated with 75% HNO_3 for 30 minutes	1 germinated.
	Treated with 75% HNO_3 for 1 hour	15 germinated.
	Treated with 75% HNO_3 for 2 hours	0 germinated.
(35)	Treated with 100% HNO_3 for 5 minutes	1 germinated.
	Treated with 100% HNO_3 for 20 minutes	11 germinated.
	Treated with 100% HNO_3 for 45 minutes	0 germinated.
(36)	Seed coats filed	48 germinated.
	Seed coats burned	49 germinated.
	Seeds with holes in coats (only 20 available) (Pl. XXIX, Fig. 2.)	20 germinated.
(37)	Treated with 50% H_2SO_4 for 1 hour	1 germinated.
	Treated with 50% H_2SO_4 for 2 hours	0 germinated.
	Treated with 50% H_2SO_4 for 3 hours	5 germinated.
(38)	Treated with 75% H_2SO_4 for 10 minutes	0 germinated.
	Treated with 75% H_2SO_4 for 30 minutes	5 germinated.
	Treated with 75% H_2SO_4 for 1 hour	10 germinated.
	Treated with 75% H_2SO_4 for 2 hours	11 germinated.
(39)	Treated with 100% H_2SO_4 for 5 minutes	3 germinated.
	Treated with 100% H_2SO_4 for 20 minutes	25 germinated.
	Treated with 100% H_2SO_4 for 45 minutes	17 germinated.
(40)	Treated with 50% HCl for 1 hour	28 germinated.
	Treated with 50% HCl for 2 hours	45 germinated.
	Treated with 50% HCl for 3 hours	17 germinated.

INDOOR TESTS—SECOND-YEAR SEEDS.

(41)	Treated with 75% HCl for 10 minutes	36 germinated.
	Treated with 75% HCl for 30 minutes	38 germinated.
	Treated with 75% HCl for 1 hour	12 germinated.
	Treated with 75% HCl for 2 hours	0 germinated.
(42)	Treated with 100% HCl for 5 minutes	20 germinated.
	Treated with 100% HCl for 20 minutes	6 germinated.
	Treated with 100% HCl for 45 minutes	0 germinated.
(43)	Treated with 50% HNO_3 for 1 hour	3 germinated.
	Treated with 50% HNO_3 for 2 hours	5 germinated.
	Treated with 50% HNO_3 for 3 hours	9 germinated.

(44)	Treated with 75% HNO_3 for 10 minutes	1 germinated.
	Treated with 75% HNO_3 for 30 minutes	2 germinated.
	Treated with 75% HNO_3 for 1 hour	12 germinated.
	Treated with 75% HNO_3 for 2 hours	0 germinated.
(45)	Treated with 100% HNO_3 for 5 minutes	5 germinated.
	Treated with 100% HNO_3 for 20 minutes	9 germinated.
	Treated with 100% HNO_3 for 45 minutes	1 germinated.
(46)	Seed coats filed	47 germinated.
	Seed coats burned	41 germinated.
(47)	Treated with 50% H_2SO_4 for 1 hour	12 germinated.
	Treated with 50% H_2SO_4 for 2 hours	7 germinated.
	Treated with 50% H_2SO_4 for 3 hours	9 germinated.
(48)	Treated with 75% H_2SO_4 for 10 minutes	8 germinated.
	Treated with 75% H_2SO_4 for 30 minutes	27 germinated.
	Treated with 75% H_2SO_4 for 1 hour	21 germinated.
	Treated with 75% H_2SO_4 for 2 hours	17 germinated.
(49)	Treated with 100% H_2SO_4 for 5 minutes	0 germinated.
	Treated with 100% H_2SO_4 for 20 minutes	12 germinated.
	Treated with 100% H_2SO_4 for 45 minutes	11 germinated.

SUMMARY.

1. The mucilage in the funiculus and in the region just below the funiculus is formed by the absorption of water by the cell wall.

2. The mucilaginous mass around the seeds, and around the embryo within the seed, appears to be formed at some time attending the maturity of the seeds and follows closely the disappearance of the starch from these cells. These cells also retain their cell walls.

3. The mucilage formed may go into a colloidal solution as in the seed pods, surrounding the seeds, or in the region of the seed coat just beneath the funiculus, or in the mass surrounding the embryo. Also it may absorb a limited amount of water as in the funiculus.

4. The mucilage is not used as food.

5. Water tube may form in the developing leaves without being directly connected back to the veins by differentiated cells.

REAGENTS AND METHODS.

1. CELLULOSE. *Iodine.*[2] Place section in a drop of I_2KI solution. (Iodine 3 grams, and potassium iodide 1.5 grams in 100 cc. of distilled water.) Cellulose membranes swell and turn blue.

Chloride of zinc.[1] Mount sections in a drop of solution containing 14 grams of zinc chloride, 5 grams of potassium iodide and 0.89 gram of iodine in 20 cc. of water. This turns cellulose walls violet.

2. HEMICELLULOSE.[2] Mount sections on a slide in 3 per cent H_2SO_4 and heat on a water bath. From 10 minutes to 2 hours is required to give complete hydrolysis. Note thickness of membrane before and after heating.

3. CUTIN. *Sudan III.* Put sections, over night, in a solution containing 0.01 gram Sudan III, 5 grams of 95 per cent alcohol, and 5 cc. of glycerine. Cutinized and suberized walls are stained red by this solution.

4. CHITOSANS.[2] Put sections into boiling saturated solution of potassium hydroxide. Cover with a watch glass and boil for 30 minutes. Cool, neutralize with hydrochloric acid, wash in water and mount in I_2KI. Chitosans give a violet color.

5. GALACTANS. (See galactose.)

6. GLUCOSIDES.[1] *General method.* If there is no reduction of Fehling's solution, put the sections into fresh Fehling's solution and let stand over night in a 37-50° oven. If glucosides were present, there should be a reduction of Fehling's solution due to the hydrolysis of the glucosides.

7. INULIN. Put sections in 70 per cent alcohol for 2 to 4 days and sphaero crystals of inulin will separate out. To identify these, locate the crystals under the microscope and add a drop of 15 per cent $\propto$ naphthol in alcohol, and then a drop of concentrated sulphuric acid. Inulin crystals become violet and dissolve, giving a violet color. This must be watched closely as sugars in solution will give the same color.

8. LIGNIN.[2] Mount section in a solution of phloroglucin (phloroglucin 0.1 gram in 10 cc. of alcohol) and let stand until the solution is partly evaporated and then add a drop of concentrated hydrochloric acid. Lignin gives a violet color.

9. MANNANS.[2] Put the section in a watch glass containing 2 per cent hydrochloric acid and heat gently, on water bath, for 30 minutes. Neutralize with 2 per cent ammonium hydroxide and test for mannose. (See sugars.)

10. OILS.[1] Put sections in Sudan III. (See cutin.) Oil appears as droplets and are stained red. Lipoids give the same reaction but they are insoluble in acetone.

11. PENTOSANS.[2] Treat the same as for lignin. Pentosans give a cherry-red color.

12. PROTEINS.[2] I_2KI.[2] A solution containing 1 gram of iodine, 3 grams potassium iodide, in 100 cc. of water, give a yellow precipitate with protein.

Millon's reagent.[1] Dissolve 20 grams of mercury in 20 grams of nitric acid and add 40 grams of distilled water. Proteids are colored brick red with this reagent.

Xanthoproteic.[2] Mount section in a drop of concentrated nitric acid. Proteins turn yellow. Add a drop of ammonium hydroxide and they then turn to a deep orange color.

13. STARCH.[2] Starch turns blue when treated with a I_2KI solution containing 0.3 gram of iodine and 1.5 grams of potassium iodine in 100 cc. of water.

14. SUGARS. Phenylhydrazine hydrochloride. (*a*) Phenylhydrazine hydrochloride 1 gram dissolved in 9 grams of glycerine. (*b*) Sodium acetate 1 gram dissolved in 9 grams of glycerine.

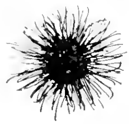
Keep both in brown bottles. Mix a drop of each on a slide and mount section in it.

(1) Fructose osazone crystals appear after 7 to 13 hours at 20° C. (See accompanying drawing.)

(2) Glucose osazone crystals appear after standing 2 days at 20° C. (See accompanying drawing.)

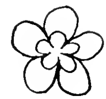
(3) Sucrose osazone crystals, like 1 and 2, appear after standing 2 days at 20° C. and then heating for 30 to 40 minutes.

(4) Mannose gives hydrozone crystals in a few minutes. (See accompanying drawing.)



Fructose osazone crystals.

Glucose osazone crystals.



Hydrozone crystals.

(5) Galactose.[2] Heat sections in evaporating dish containing 15 cc. concentrated nitric acid until it is evaporated to about 3 cc. Add 15 cc. of water, set away for 24 hours and mucic acid crystals will appear.

15. TANNINS.[1] Tannins give a blue color when treated with an aqueous solution of ferric chloride.

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PLATE XXIX.

1. Mature seed pod. $\times \frac{3}{4}$.

2. Seeds with defective seed coats. $\times \frac{3}{4}$.

3. Cross section through entire seed. $\times 4\frac{1}{2}$. A, Radicle. B, Hypocotyl. C, Epidermal coat. D, Woody layer of seed coat. E, Mucilage layer. F. Cotyledons. G, Veins running from cotyledons to growing points.

4. Cells taken from the gummy mass around the seeds in a mature pod. $\times 1000$. A, Starch.

5. Cells taken from around the seed before the cells start disintegrating. $\times 1000$. A, Starch.

PLATE XXIX.

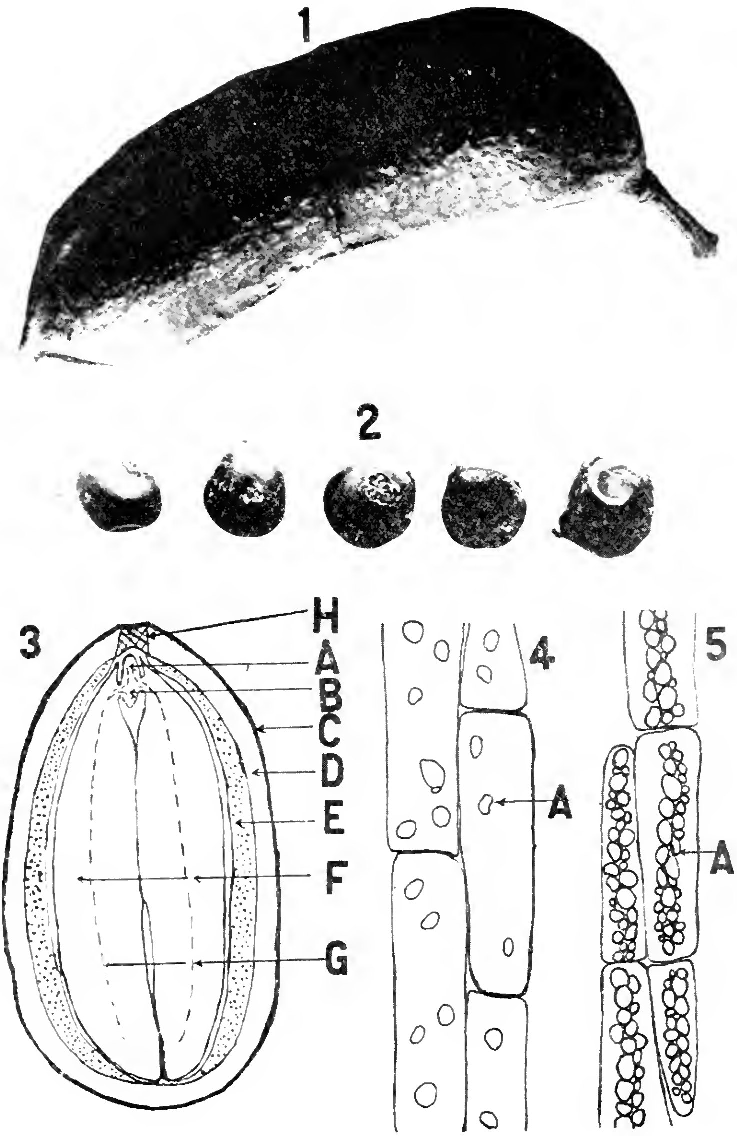
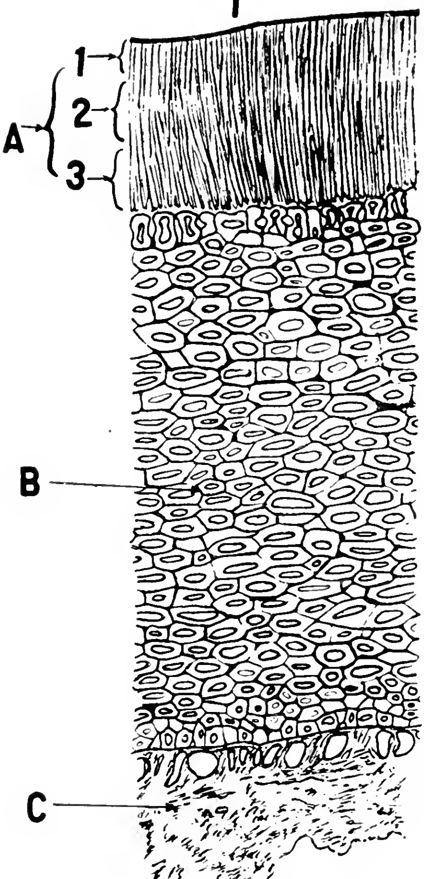


PLATE XXX.

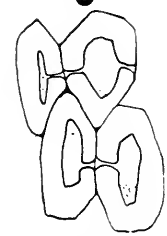
1. Section of a soaked seed coat. $\times$ 110. A, Multiple epidermis: (1) area which gives a test for chitin; (2) Area which gives a strong test for cutin; (3) Area which gives a slight test for cutin. B, Woody cells which make up the body of the seed coat. C. Mucilaginous layer.
2. Cells taken from 1-A, 1. $\times$ 1000.
3. Cells taken from 1-B, dry. $\times$ 520.
4. Cells taken from 1-B, soaked. $\times$ 520.

PLATE XXX.

1



3



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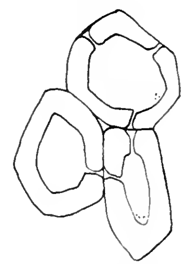

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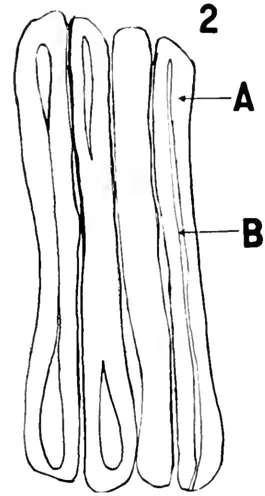


PLATE XXXI.

1. Cells from mucilage layer around the embryo. $\times$ 520. A, Cellulose wall. B, Intercellular space. C, Mucilage around cell. D, Space between cell wall and protoplasm.

2. Same section as 1, after soaking 6 hours. $\times$ 520.

3. Isolated cells, dry. $\times$ 1000. (Indexed as above.)

4. Same cells as in 3, after soaking 24 hours. $\times$ 1000. (Indexed as above.)

5. Section from amorphous mass of mucilage. $\times$ 520. A, Cellulose cell walls. B, Protoplasm with surrounding membrane.

PLATE XXXI.

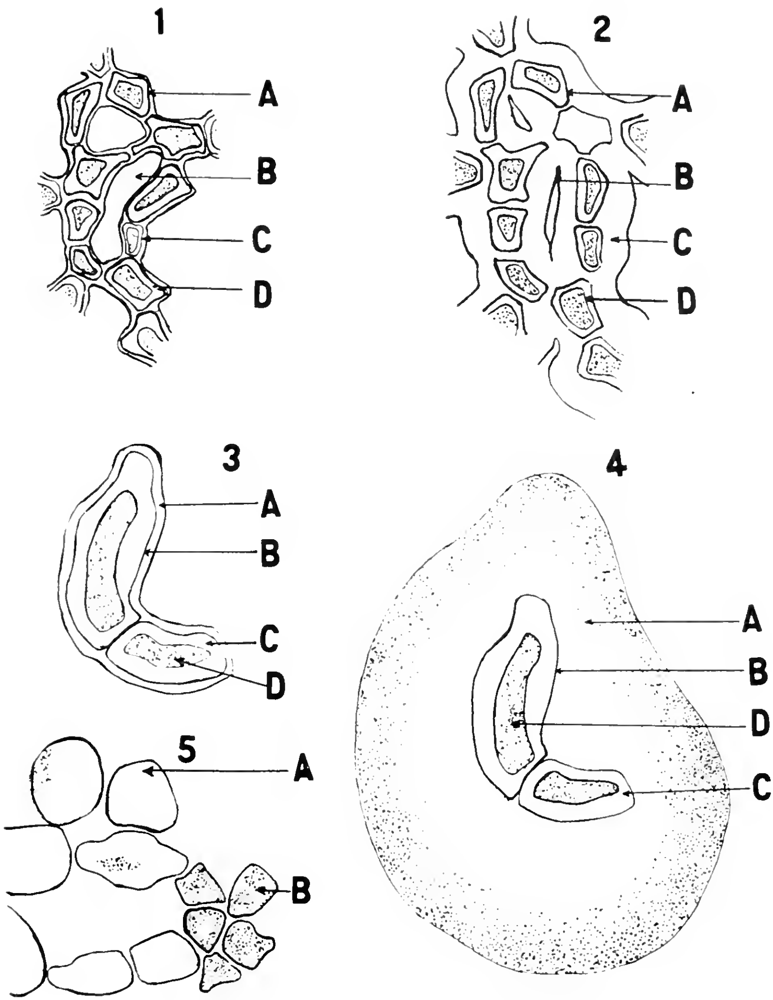


PLATE XXXII.

1. Cells from the funiculus. $\times 460$. A, Cell wall. B, Protoplasm.
2. Same as 1, after 6 hours soaking. $\times 460$. (Indexed as above.)
5. Same as 1, after 24 hours soaking. $\times 460$.
4. Cells from beneath the funiculus. $\times 460$.
3. Same as 4, after 24 hours soaking. $\times 460$.

PLATE XXXII.

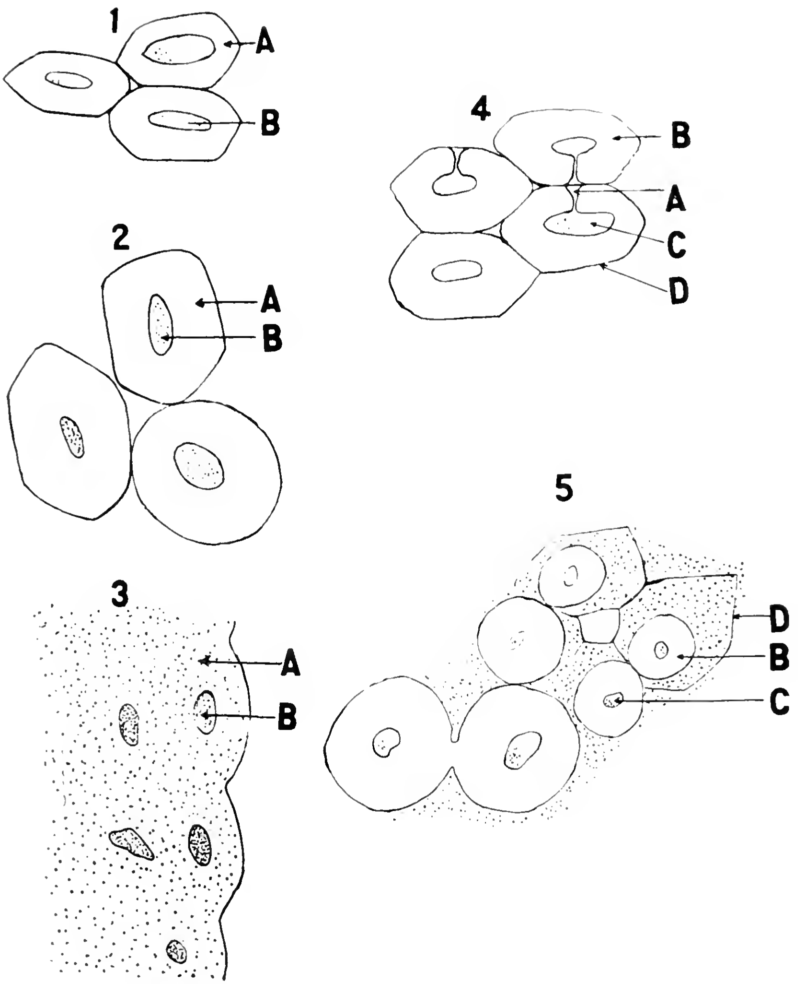


PLATE XXXIII.

1. Dry seed. $\times \frac{3}{4}$.
2. Seed soaked 24 hours. $\times \frac{3}{4}$. A, Epidermal layer peeling off.
3. Seed soaked 48 hours. $\times \frac{3}{4}$. B, Mucilage mass.
4. Mucilage mass. $\times \frac{3}{4}$. C, Soaked 24 hours. D, Cellular part. E, Mucilage mass dry.
5. First stage in germination. $\times \frac{3}{4}$.
6. Second stage in germination. $\times \frac{3}{4}$.

PLATE XXXIII.

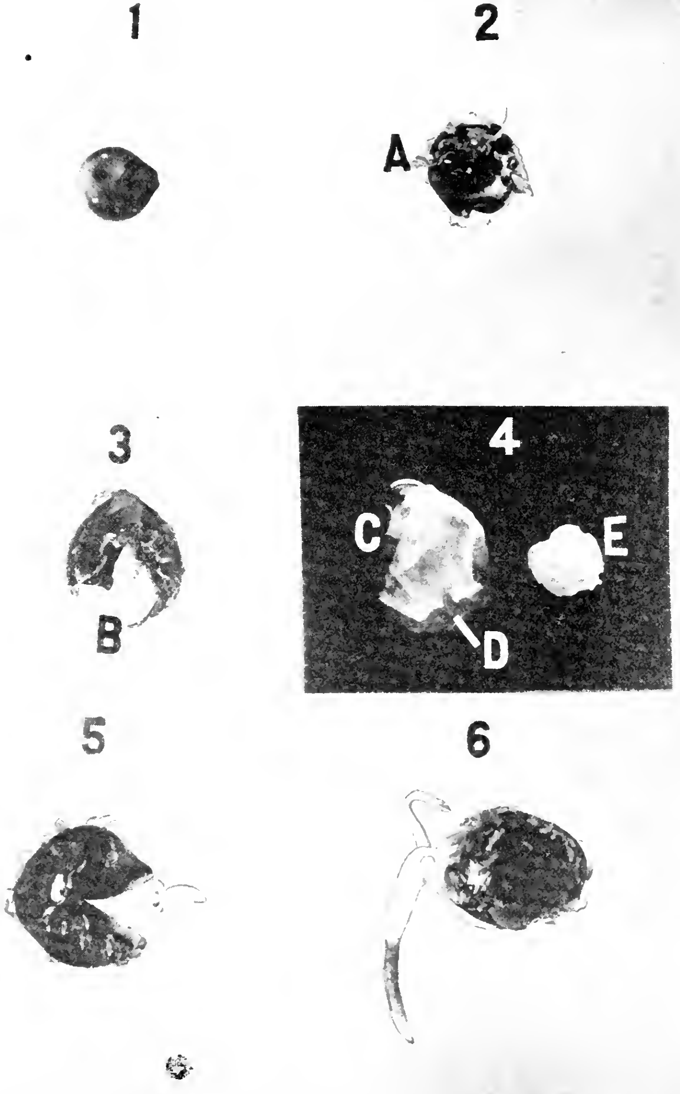


PLATE XXXIV.

1. Section of young leaflet from mature tree. $\times 280$. A, Undifferentiated cells which later become water tubes.

2. Section of same leaflet. $\times 280$. A, Cells which are differentiated but have not laid down the thickenings in the walls.

3. Section through cotyledon. A, Outer epidermis. F, A very thin cutinized layer. B, Cells. C, Intercellular space. D, Inner epidermis. E, Heavy wall which is not cutinized.

4. Section of a bleached leaflet tip. $\times 400$. A, Epidermis. B, Water tubes. C, Hairs.

PLATE XXXIV.

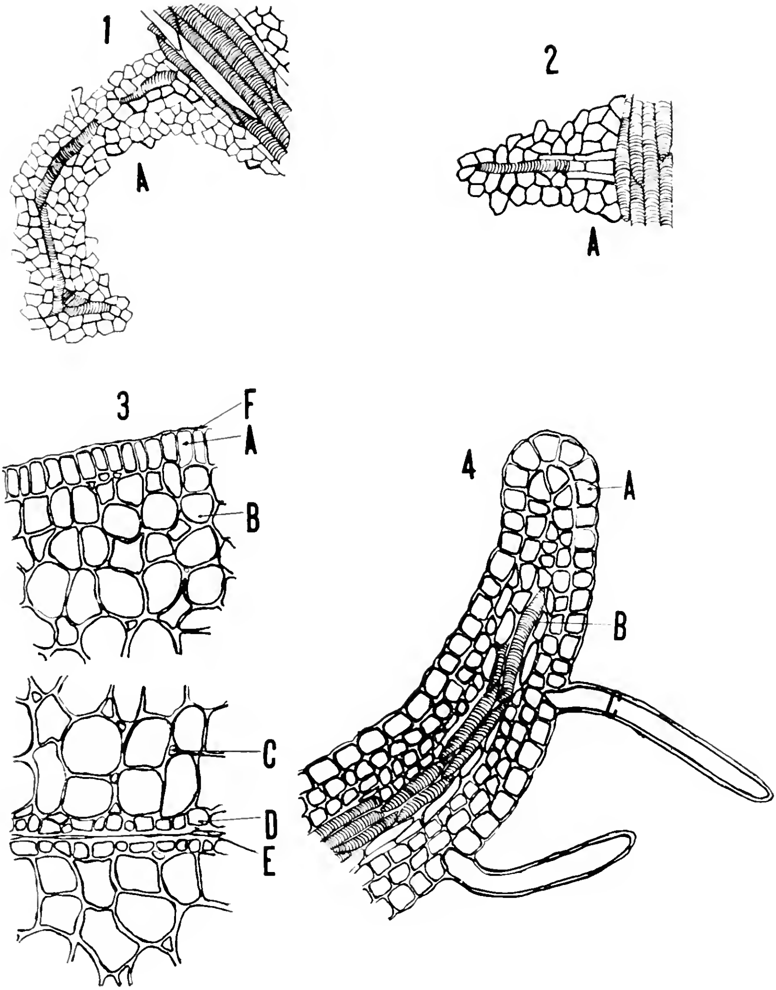


PLATE XXXV.

1. View of under side of bleached leaf. $\times 220$. A. Hair. B, Vein. C, Spongy parenchyona. D, Stoma and ground cells. E, Cell wall of epidermis indicated with double line to differentiate between spongy parenchyma cell walls.

2. View of same leaf from above. $\times 220$. B, Vein. C, Cell wall of epidermis. D, Palisade cells. E, Intercellular space between palisade cells.

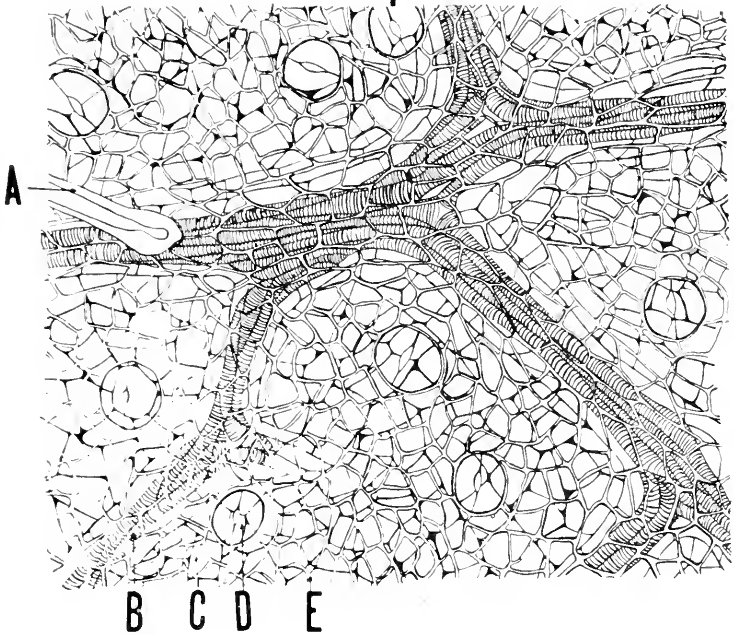
3. Strip of lower epidermis with stomata. $\times 220$.

4. Strip of upper epidermis. $\times 220$.

(Nos. 3 and 4 were taken from old leaves.)

PLATE XXXV.

1



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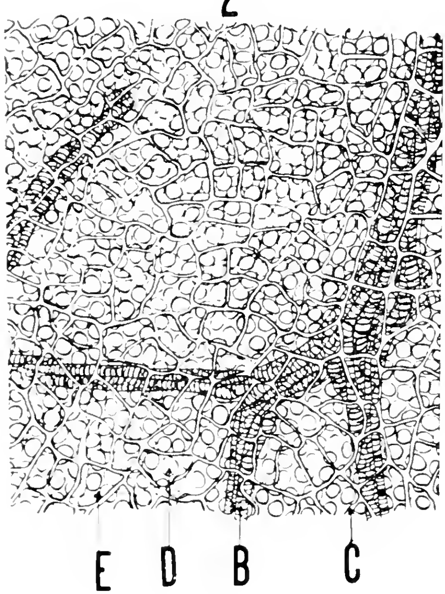

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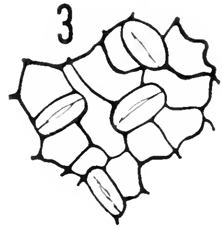

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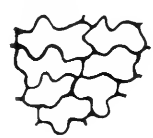


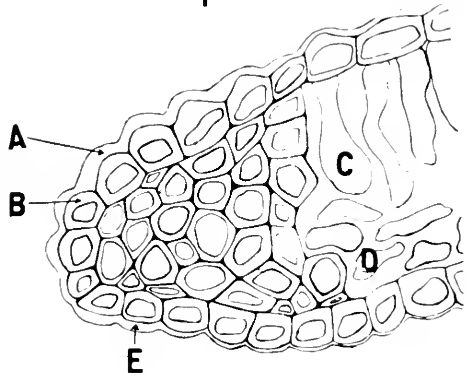
PLATE XXXVI.

1. Cross section of leaf at margin. × 80. A, Cutinized layer of upper epidermis. B, Thick-walled epidermis. C, Palisade cell. D, Spongy parenchyora. E, Cutinized layer of lower epidermis.

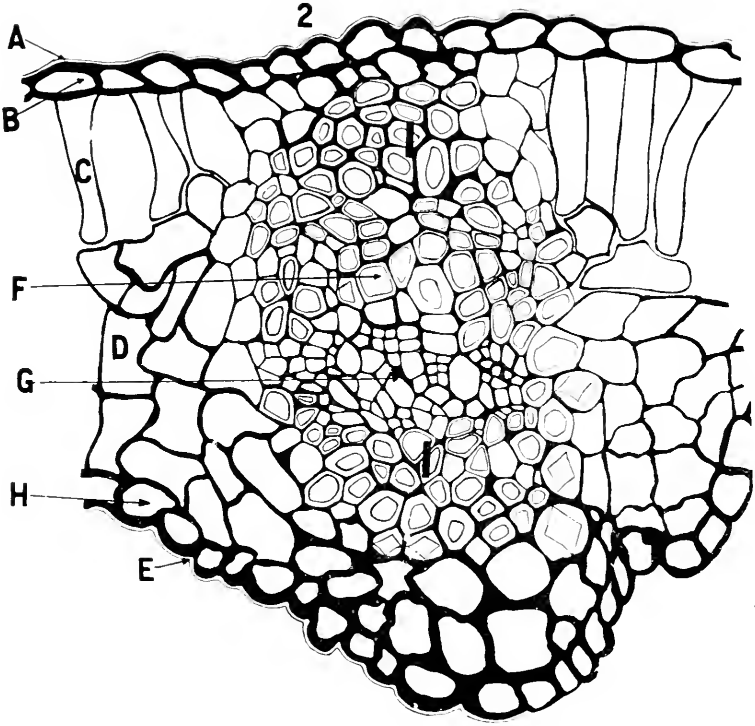
2. Cross section of midrib. × 80. A, Cutinized layer of epidermis. B, Epidermis. C, Palisade cells. D, Parenchyma. E, Cutinized layer of lower epidermis. F, Water-conducting tissue. G, Food-conducting tissue. H, Lower epidermis. I, Fiber cells.

PLATE XXXVI.

1



2



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Comparative Anatomy of Certain Hybrid Shrubs and Their Parents.

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THE study of transmitted characters in hybrid offspring has become the chief method of determining the laws of heredity. Usually, since the rediscovery of Mendel's law, this study has been one of quantitative and qualitative data in plant- and animal-breeding where clearly recognized characters were observed for several generations. Many cytological studies have also been made of hybrids, especially during recent years. Anatomical studies of plant hybrids have not been so common.

Henslow ('31) compared a hybrid *Digitalis* with its parents in a very minute way, considering the knowledge of plant anatomy of the time. He found in the size and shape of the hairs and other structures the hybrid was intermediate between those of its parents.

Wettstein ('88) compared the leaves of four coniferous hybrids and found them exactly intermediate between their parents in number of stomata, depth of epidermal cells, and number and arrangement of the sclerenchyma cells of the bundles.

Noble ('88) compared *Clematis jackmanni alba* with its parents and found it had flowers resembling both parents. He explained that the *C. patens*, its spring-flowering parent, and *C. jackmanni*, its autumn-flowering parent, seem to set up a kind of rivalry to see which is stronger. Old wood of *C. jackmanni alba* in May, June and July bears double and semidouble solitary flowers of a bluish French-grey color, as the *C. patens* parent does; and then young shoots of the hybrid bear single white flowers in pairs on a long raceme, in August and September, as the *C. jackmanni parent* does. At one age of the wood it resembles one parent, and at a later age it resembles the other parent.

Hildebrand ('89) found in a cross between *Oxalis latifolia* and *O. tetraphylla* that the characteristically distinct hairs of each species might both arise from a single epidermal cell of the offspring. Both parents seem to be contributing to a single factor.

Branza ('90) compared the tissue masses of certain seed hybrids and of *Cytisus adami,* a graft hybrid, with those of their parents. Since his observations differ in many details from those of MacFarlane ('90, '91), they are discredited.

The most extensive and intensive study of plant hybrids in relation to their parents was made by MacFarlane ('90, '91). He compared the minute structure of the following hybrids with that of their parents: *Philageria veitchei, Dianthus grievei, Geum intermedium, Ribes culverwelli, Saxifraga andrewsii, Erica watsoni, Bryanthus erectus, Masdevallia chelsoni, Cypripedium leeanum,* and *Cytisus adami* (a graft hybrid).

His conclusions are summed up in these words: "We may recall the facts advanced as to color, flowering period, chemical combinations, growth, and vigor which, though scanty and fragmentary in their nature, all point to the conclusion that hybrids are intermediate between their parents in general life phenomena." On the divergence of some hybrids or parts of hybrids toward one parent, he explains it on a purely physical basis of under or overnutrition, or through advantageous or disadvantageous position. With the exception of this conclusion, which is now explained in a very different way, his study constitutes a great contribution to the study of heredity and is so regarded by the editor of the Gardener's Chronicle ('93).

Henslow ('93), in a study of *Rhododendron* hybrids, found that one parent often impresses some peculiarity which he calls sexual hybridity, but that as a general rule characters are more or less intermediate between those of their parents.

Farmer ('97), in studying a hybrid fern, decided that inheritance is the result of an imaginary struggle between purely hypothetical combatants, and thus accounts for the resemblance of this or that cell to corresponding cells in one or the other parent.

The rediscovery of Mendel's law in 1900 explained in a new way the tendency of hybrids to resemble one or the other parent as due to dominance and recessiveness of characters. The studies in this field since that time have been largely of the plant or animal-breeding type when characters were traced through several generations.

MacDougal ('07), in a study of hybridization of wild plants states that anatomical study of a hybrid and the parents to which it has been referred would be a good method of determining whether or not it is a true hybrid. He cautions that this may not be decisive because of a tendency toward one parent.

De Vries ('10) calls those qualities which in crossing conform to Mendel's law bisexual or varietal characters, and those which give intermediates unisexual or specific characters. He states, "The points of difference between parents can be all unisexual or all bisexual, or some of them may be unisexual and others bisexual. In the first case the parents are to be considered as elementary species; in the second as varieties; in the third, however, the principle affords no decision." (p. 587.) He further states that in experiments in hybridization we must "confine our attention to certain points of difference and leave all the rest out of consideration as of subordinate importance. If the character is bisexual and behaves in a Mendelian fashion we may immediately infer that the two parents are to be considered as varieties. If it is unisexual they are elementary species, of which the one must have been derived from the other . . . by modulation."

East ('12) chose flowers in *Nicotiana*. After proving that characters were uninfluenced by environment he found that these characters were intermediate in the F_1 generation. Among the flowers in the F_2 generation he found also flowers identical with those of each parent.

Molloch ('21) found in a cross between *Hordeum vulgare* and *H. murinum*, two species which differ in a large number of morphological characters, that the hybrid died, probably due to the failure to harmonize between the reactive systems of the two species. He states, "There are all degrees of incompatibility of reaction systems in species crosses."

Tedin ('23) found that two forms of *Camelina*, differing from each other in almost every character, had probably two characters that influenced leaf shape. The interpretation was that AABB = pinnatified leaves; aabb = entire leaves; AAbb = pinnatified with shorter and broader lobes than aaBB = deeply denate single leaves.

Anyone who has undertaken a comparison of hybrids must agree with MacFarlane in his statement that, "When a hybrid is the product of parents that are widely divergent in histological details the comparison will be easy, but when we attempt to compare a hybrid with two parents which are regarded as species, but whose chief specific differences are those of coloring and size, it is almost or quite impossible to detect any blending or parent characters even though these may occur."

The histological study of hybrids has generally been considered a good means of verification of doubtful hybrids. It has not always been so fruitful for determining the laws of heredity.

Davenport ('07) states that, "The common mistake has been to note a few remarkable individuals and exceptional instances, and from these attempt to deduce the 'laws of descent.' To determine the facts of heredity with any degree of reliability we must study the race as a whole and not simply the separate individuals that compose it. The laws of descent are to be discovered by a critical study, not of individuals but of entire populations sufficiently large to be safely representative. Unfortunately, the application of the statistical method to the study of this subject is comparatively new, and as it is extremely laborious, the accumulation of a large mass of material will of necessity be a somewhat slow process." (p. 478.)

The study of the detailed anatomy of whole races of hybrids would be quite worth while, and with the advance of our knowledge of minute structure of plants and the perfecting of our methods of studying them it will some day no doubt be attempted. There are certain features which are modified greatly by differences in environment and the age of the plant. Great care must be exercised in comparing these features.

Since shrubs offer good subjects for anatomical study and many hybrids have already been produced among them, I have chosen from them for this comparative study.

The following shrubs with their parents were secured for comparison:

Berberis neubertii = *B. vulgaris* × *Mahonia aquifolia.*
Syringa chinense = *S. vulgaris* × *S. persica.*
Forsythia intermedia = *F. suspensa* × *F. viridissima.*
Lonicera bella = *L. tatarica* × *L. morrowi.*
Lonicera notha = *L. ruprechtiana* × *L. tatarica.*
Lonicera muendiensis = *L. bella* × *L. ruprechtiana.*
Lonicera muscaviensis = *L. morrowi* × *L. ruprechtiana.*

From the cross and longitudinal sections of the stems of these hybrids and their parents it was apparent that *Berberis neubertii* and its parents offered the most points of difference. It was therefore selected for the major part of this study.

The origin of *B. neubertii,* which is usually considered an intergeneric hybrid, is described in L'Illustration Horticole as follows: "Il a ete trouve, en 1850, dans un jeune plant issu de graines recueillies sur un *Berberis atropurpurea* et sur un *Berberis* (*Mahonia*) *aquifolia,* croissant tous deux l'un pres de l'autre, par M. Aug. Nap.

Baumann, horticulteur a Bolwiller (France), et est evidement le resultat d'un croisement artificiel entre ces deux especies, si diverese par le port; croisement opere par quelque insecte butineur."

The *B. neubertii* plant from which this study was made was secured from Farquhar, who secured it from Arnold Arboretum. In general characteristics of leaf and stem it agrees with the description and illustration in L'Illustration Horticole, the illustration in Gardener's Chronicle, and the description in Bailey's Encyclopedia of Horticulture, but differs in two very important details. My specimen is spined, but the descriptions and illustrations give it as spineless. The leaves are grouped as those in *B. vulgaris* in the axils of the spines, while the descriptions give them as somewhat sheathing the stem as described in *Mahonia aquifolia*. The second difference may be the result of the first, which is probably a reversion to one of its parents, *B. vulgaris*. Farquhar stated in a letter that he did not have a spineless plant but that as far as he knew his plants were true hybrids. The only explanation for the decided change in the hybrid since it was first produced in 1850 would be that it has reverted back in this respect to one of its parents, in this case *B. vulgaris*.

Farmer, in his study of a hybrid fern, found that it had a tendency to revert to one or other of its parents in certain particular characteristics, and plants obtained from cuttings of such branches grew and remained true. The reverted branch did not in every particular resemble one parent, but this parent became more strongly pronounced. He considered this a striking illustration of the unstable character of a hybrid.

The determination of the true hybridity of my specimen was therefore my first problem. As will be observed later, it agrees with what we may expect in a true hybrid.

DISCUSSION.

Mahonia (sometimes called *Berberis*) *aquifolia* is an evergreen, broad-leaved spineless shrub with odd-pinnate leaves. It has minute subulate stipules. The base of the leaf is sheathing, from one-half to completely surrounding the stem. The glossy leaves of firm texture give it a stiff xerophytic appearance. Its habit of growth is by sudden limited, tender, terminal shoots which are later strengthened. *Berberis vulgaris* is a deciduous, spined, simple-leaved shrub. The spines are morphologically leaves and the foliage leaves are borne on short branches in their axils. The growth is more gradual and indefinite than that of *Mahonia* and the branches are more pendulous and graceful. The texture is less firm and the appearance truly mesophytic. It has very minute subulate stipules, and below them the petiole is flattened and partly sheathed and indistinctly jointed.

The hybrid, *B. neubertii*, is classed as a semi-evergreen in the habitat of Boston. My specimen lost most of its leaves with the first snow, but a few leaves still clung to the branches. The spines are similar to those of *B. vulgaris* and the foliage leaves are borne on short stems in their axils. The growth is indefinite, resembling that of *B. vulgaris*, but it has a tendency toward the stiff appearance of *Mahonia*. It has very minute stipules and jointed petiole, but the petiole is much larger than that of *B. vulgaris*. The general appearance may thus be said to be intermediate between that of its parents.

Since *Mahonia aquifolia* has a compound leaf and *Berberis vulgaris* a simple leaf, the hybrid would necessarily follow one or the other of these characters. The hybrid has simple leaves showing the dominance in kind of leaf to be that of its parent, *B. vulgaris*. In many details it is clearly influenced by the leaf of *Mahonia*.

In shape the *Mahonia* leaflet (Pl. XXXVII, Fig. 3) is oblong-ovate, sessile, or nearly so, and the sides of the base are unequal. The leaf of *B. vulgaris* (Pl. XXXVII, Fig. 1) is oblong-spatulate with a petiole 8-10 mm. long and indistinctly jointed near the base. *B. neubertii* has a leaf (Pl. XXXVII, Fig. 2) of a similar shape to that of *B. vulgaris*, but the petiole is intermediate in both breadth and length between the petiolule of *M. aquifolia* and the petiole of *B. vulgaris*. The stipules are very similar to those of *B. vulgaris*. The sheathing base of the petiole below the stipules and joint is much broader in the hybrid than in that of *B. vulgaris*, showing a tendency toward the base of the leaf of *M. aquifolia*.

The margin of the leaflet of *M. aquifolia* is spinulose-dentate with lobes 5-10 mm. apart. There is a prominent veinlet for each lobe. *B. vulgaris* has a setulose-dentate leaf with the lobes 1-1.2 mm. apart, and a small veinlet for each lobe. *B. neubertii* has a spinulose-dentate leaf and thus clearly follows *M. aquifolia*, but exceeds it in the size and distance apart of the lobes. On the same branch, the leaves of *B. neubertii* are quite variable in the size and distance apart of the lobes. They have a prominent veinlet for each lobe. The spines of the margin are very similar in length and texture to those of *M. aquifolia*, being much more rigid than those of *B. vulgaris*. The spines in all cases include continuations of the group of schlerenchyma cells which form the margin of the leaves.

Sclerenchyma cells are fewer in number in *B. vulgaris* and therefore the spines of the leaf are less rigid.

In Pl. XXXVII, Figs. 1, 2, 3, the general type of venation of the leaves may be observed. *M. aquifolia* (Pl. XXXVII, Fig. 3) has 5 to 6 primary lateral veins and between each of these 3 to 6 veinlets from the midrib. The type of venation agrees with what we might expect from the shape of the leaf. *B. vulgaris* (Pl. XXXVII, Fig. 1) has 3 to 5 primary lateral veins and between each of these as many as 16 small veinlets from the midrib. In venation *B. neubertii* (Pl. XXXVII, Fig. 2) agrees very generally with *B. vulgaris*, but has fewer veinlets from the midrib, following after *M. aquifolia* in this respect.

The color of the leaf of *M. aquifolia* is a yellowish green, and lustrous when young, but dark green and lustrous when mature. The leaf of *B. vulgaris* is a pale or grayish green beneath but a dark green above. It is dull in appearance. The leaf of the hybrid agrees with that of its *B. vulgaris* parent in color.

Upper epidermis cells, as shown in Pl. XXXVII, Figs. 4, 5, 6, show the lateral walls in the leaf of *B. vulgaris* (Pl. XXXVII, Fig. 4) to be symmetrical. Corresponding cell walls in the leaf of *M. aquifolia* are very sinuous or undulated (Pl. XXXVII, Fig. 6). The hybrid (Pl. XXXVII, Fig. 5) has epidermal cells that are very similar in shape to those of *B. vulgaris*, but the size of the cells is greater than in either parent.

The stomata in both parents and the hybrid are found only in the lower epidermis of the leaf. They agree in shape and size but differ in number. In *M. aquifolia* I found by count the average number to be 260 per sq. mm. In *B. vulgaris* the average number was only 176. The mean number between these two is 218. The average number in the hybrid was found to be 216 per sq. mm. This agrees with MacFarlane's observation of *Philageria Veitchii* and other hybrids, in which the hybrid has an intermediate number of stomata between that of its parents, respectively.

The cross section of the leaf cut through the two guard cells offers a basis of comparison. The guard cells of *B. vulgaris* (Pl. XXXVII, Fig. 10-H) are closely followed by those of *B. neubertii* (Pl. XXXVII, Fig. 11-H). The guard cells of *M. aquifolia* (Pl. XXXVII, Fig. 12-H) are somewhat external to other epidermal cells.

The lower epidermal cells of the leaf and the epidermal cells of the petiole in *M. aquifolia* show a network of thickenings (Pl. XXXVII, Figs. 9-F, 12-H, and Pl. XXXVIII, Fig. 13-F). This network was very conspicuous in mature leaves, but was not seen in young leaves. *B. vulgaris* has no such thickenings in the epidermal cells (Pl. XXXVII, Figs. 7 and 10, and Pl. XXXVIII, Fig. 15-F). The hybrid has a very indistinct network of thickenings in mature leaves only (Pl. XXXVII, Fig. 8-F). This character, which behaves as an intermediate, was one of the most convincing proofs of the true hybridity of my specimen.

In the cross section of the leaves (Pl. XXXVIII) there are two distinct rows of palisade cells in the leaf of *M. aquifolia*. The third row of cells is apparently intermediate between palisade and spongy parenchyma cells (Pl. XXXVIII, Fig. 13). *B. vulgaris* (Pl. XXXVIII, Fig. 15) has but one row of palisade cells. The environmental conditions of the two plants was as nearly the same as could be secured. The hybrid very clearly follows the *M. aquifolia* parent in the number of rows of palisade cells (Pl. XXXVIII, Fig. 14), but follows the *B. vulgaris* parent in the depth of palisade cells. The greater thickness of the leaf of the hybrid than that of either parent is thus in part accounted for.

The number of rows of spongy parenchyma cells of the three leaves shows the hybrid to have more rows than either parent. The *M. aquifolia* parent has from 5 to 6 rows of spongy parenchyma. *B. vulgaris* has from 4 to 5 rows. The hybrid has from 7 to 9 rows. The size of the cells in the hybrid is also greater than in either parent. Since all of these plants were growing under similar environmental conditions, and the above-described condition appears as a constant characteristic, it may be considered as inherited.

Cross sections of the leaves cut through the midrib in various positions in the leaf offers a basis of comparison. In Pl. XXXVII, Figs. 1, 2, 3, the letter A indicates a position in the midrib in which the bundle is single, with schlerenchyma extending to both the upper and lower epidermises. At B the bundle has divided into three, at C it has divided into 5, and at D it has divided into 9 bundles (Pl. XXXVII, Fig. 3 only). By a comparison of the positions of A, B and C in the three figures, it will be observed that the hybrid clearly follows the *B. vulgaris* parent in this character.

From cross sections of the petiole of *B. vulgaris* and the petiolule of *M. aquifolia*, the number of rows of thin-walled parenchyma cells surrounding the vascular area formed a basis of comparison. In the *B. vulgaris* parent there are from 3 to 5 rows of thin-walled parenchyma cells surrounding the vascular area of the petiole. The petiolule of *M. aquifolia* has from 4 to 6 rows of cells in this area

The hybrid has from 5 to 7 rows. The hybrid thus exceeds the number of rows of both parents, which partly accounts for the larger petiole than in either parent. The petiole of *M. aquifolia* differs from the others in that the schlerenchyma cells form a complete ring around the vascular area. Near the base of the petiole the bundles again form a semicircle conforming with the sheathing base of the leaf. In *B. vulgaris* the vascular area never forms a complete ring, but somewhat more than a semicircle. The hybrid follows the *B. vulgaris* parent in this character.

A comparison of the prominence of the midrib below the blade of the leaf shows that in both parents the midrib is very prominent. The hybrid has a relatively thicker blade than either parent, and thus a relatively less conspicuous midrib below the blade of the leaf. The small veins of the leaf in the hybrid scarcely exceed the thickness of the blade, while in both parents they are prominent on the under side of the leaf.

Papillose epidermal hairs occur very generally on the lower epidermis of the leaf and always on the young stem of the *Mahonia aquifolia* parent. They average 8μ in height and 12.5μ in diameter. No epidermal hairs were found on the leaves or young stems of *B. vulgaris* nor on the hybrid. This character behaves in this instance as a recessive, but no conclusion may be drawn from this one hybrid.

Epidermal hairs were observed in *Lonicera morrowi* on leaves and young stems. On the stems they are very irregular as to length varying from .08 mm. to .48 mm. The number counted was 360 per sq. mm. of epidermal surface. In *L. tatarica* usually no epidermal hairs are found, although they were observed on a few young leaves. The hybrid from these parents, *L. bella*, has epidermal hairs varying in length from .04 mm. to .32 mm., and averaging 120 to the sq. mm. It appears in this that the hybrid has the epidermal hairs of *L. morrowi* reduced by half in number and size.

Further study of the epidermal hairs in the honeysuckle showed for *Lonicera muscaviensis*, a hybrid of *L. ruprechtiana* and *L. morrowi*, that epidermal hairs were intermediate in size, shape, and number between those of the parents. *L. ruprechtiana* has epidermal hairs varying in length from .08 mm. to .32 mm. and averaging 76 per sq. mm. of surface. The intermediate number between the parents would be 218. The hybrid averaged on several counts 160. The intermediate length between the parents would be from .08 mm. to .8 mm. The length of the epidermal hairs of the hybrid was found to vary from .08 mm. to .32 mm.

Lonicera notha, a hybrid between the parents *L. tatarica* and *L. ruprechtiana*, shows also an intermediate number and length. *Lonicera muendiensis*, a hybrid between *L. bella* and *L. ruprechtiana*, also has hairs showing an intermediate size and number. The shape of the epidermal hairs also shows the influence of both parents. These examples all point to an intermediate inheritance of epidermal hairs in *Lonicera*.

Hildebrand found that epidermal hairs in the hybrid of *Oxalis latifolia* x *O. tetraphylla* were inherited from both parents, both kinds being on a single cell of the hybrid.

MacFarlane found that in the hybrids *Ribes culverwelli, Saxifraga andrewsi*, and *Carduus carolorum*, distinct types of epidermal hairs were inherited from both parents. These are considered examples of bisexual heredity by MacFarlane.

It seems that no general rule obtains in the inheritance of epidermal hairs.

The number of stomata on the young stems of *Berberis neubertii* is much less than in either parent. In both parents the number averages about 23 per sq. mm., back where the stem has ceased to elongate. The hybrid averaged but 9 per sq. mm.

The size of epidermal cells on young stems showed the hybrid to be intermediate between that of its parents. *M. aquifolia* has cells averaging .08 mm. in length and .02 mm. in width after the stem has ceased to elongate. *B. vulgaris* has cells averaging .04 mm. x .02 mm. The hybrid has cells averaging .06 mm. x .02 mm., the intermediate between the parents.

The number of perforations in the lateral cell walls of the epidermal cells shows the hybrid to have a number below that of either parent. Pl. XL, Fig. 24-A, shows these perforations in the cell walls of *B. vulgaris*. No drawing was made of the similar cells of *M. aquifolia*. The drawing in Pl. XL, Fig. 26-A, shows the perforations in the lateral cell walls of the hybrid, much fewer in number than in either parent.

The cortex of the stem in *M. aquifolia* consists entirely of parenchyma cells. There is no distinct endodermis separating the cortex from the pericycle. Solereder has considered the primary bast-fiber ring as part of the pericycle. There is no typical collenchyma. The parenchyma cells of the cortex are large, averaging .03 mm. in width and .06 mm. in length. The cell walls are irregularly thickened with numerous perforations. The average number of rows of cortex cells was 7.2. The cortex of *B. vulgaris* also consists entirely of parenchyma, but is always thin-walled. The average diameter of these cells was found to be .03 mm. and the length was found to be .13 mm. The walls are not perforated and not thickened as in the *M. aquifolia.* The cortex cells of young stems in *B. vulgaris* contain numerous disk-shaped chloroplasts. The number of rows of cells is irregular in conformity with the angled stem and the irregular bast-fiber ring. The number of cells radially may be as small as 2, but where the bast-fiber ring indents it may be 8 cells. The average number of rows was found to be 4.4 radially.

The cortex of the stem in the hybrid in some cases follows one parent and in others the other parent. The cell walls in *B. neubertii* have perforated and irregularly thickened cell walls, thus following the *M. aquifolia* parent. In size the cells are intermediate between that of the parents, being .1 mm. in length and .03 mm. in width as compared with an intermediate of .095 mm. in length and .03 mm. in width between the two parents. The general arrangement of the cells of the cortex in the hybrid is very similar to that found in the *B. vulgaris* parent, conforming to the angled stem and the irregular bast-fiber ring. The number of rows of cells radially in the hybrid is less than in either parent. (Pl. XXXIX, Figs. 17-B and 20-B for the hybrid, 16 and 19 for *M. aquifolia*, and 18 and 21 for B. *vulgaris*.)

The primary bast forms the outer part of the pericycle in both parents and the hybrid. In the *M. aquifolia* parent the bast-fiber ring is usually discontinuous in the stem, as shown in Pl. XL, Figs. 22-C and 25-C. The number of fibers may vary from a small number as shown in Pl. XXXIX, Fig. 19-C, to many as shown in Pl. XL, Fig. 22-C. The primary bast in *B. vulgaris* forms a continuous ring around the stem until it is broken by the growth of the stem. The number of cells radially may vary from 3 cells in the depressions to 12 cells at the angles of the stem. The bast-fiber ring is persistent for a relatively longer time than in *M. aquifolia* partly because of the continuous ring and partly because of undulations which allow for growth from within by straightening out as the stem increases in size. The hybrid very clearly follows the *B. vulgaris* parent in the arrangement of the cells of the primary bast of the stem (Pl. XXXIX, Fig. 20, Pl. XL, Figs. 23-C and 26-C). In number of rows of cells radially the hybrid exceeds that in either parent, showing 7.9 cells average for the hybrid and 6.3 cells in *B. vulgaris.*

The size of the primary bast fibers in the hybrid very closely approaches the intermediate between that of the parents. The length for *M. aquifolia* averaged .8 mm, that for *B. vulgaris* 1.1 mm., the hybrid being 1.0 mm., which closely approaches the mean of .95 mm. For comparative length of bast fibers, see Pl. XLI, Figs. 31-E, 31-F, and 31-G, which represent average length of bast fibers in *M. aquifolia*, the hybrid, and *B. vulgaris* respectively. The diameter of individual bast fibers measured at the widest area shows also an intermediate size. The *M. aquifolia* parent averages 22μ in diameter, *B. vulgaris* averages 25μ in diameter. The diameter of the bast fibers in the hybrid averages 24μ, which closely approaches the mean between the parents, 23.5μ.

Macerations were made of primary bast by putting small sections into chromic acid. Other sections were placed in nitric acid and potassium chlorate and heated in a test tube, and thrown into water at the proper time to stop action. Individual bast fibers are shown in Pl. XLI, Figs. 31, 32, 33. Circular pits are found in the primary bast of *M. aquifolia* as shown in the surface view by rings and in the side walls as areas not darkened. *B. vulgaris* primary bast fibers have circular pits and elongated pits running diagonally across the fibers. The hybrid has both the circular pits, as shown in both parents, and also the diagonal pits as found in the *B. vulgaris* parent only.

The primary bast of *M. aquifolia* has irregular thickenings not dissolved by nitric acid as shown in black in Pl. XLI, Fig. 31, A and C. Other deposits within the cell are soluble in nitric acid. These deposits were not found in the *B. vulgaris* parent. The hybrid has deposits soluble in nitric acid in greater abundance than in the *M. aquifolia* parent. The irregular thickenings not soluble in nitric acid were not observed in the hybrid. Thus one unisexual character was inherited but the other was not.

Cork arises in the outer parenchyma of the pericycle just beneath the primary bast in both parents and the hybrid. In rapidly growing stems of *M. aquifolia* the cork arises in the seventh internode or thereabout. In *B. vulgaris* cork arises as early as in the second internode. In the hybrid cork was found in the second internode, thus showing this character to be inherited from the *B. vulgaris* parent. The growth of cork in the *M. aquifolia* parent is irregular because of the discontinuous bast-fiber ring. Cork arises both beneath and between the groups of bast, thus completely cutting them off. The epidermis and cortex of the stem hold several bast groups together, but between these groups they break apart in large longitudinal strips, a fact recognizable at the surface. In the *B. vulgaris* parent the bast-fiber ring is continuous and the cork arises beneath it as a continuous ring, later cutting it off. The bast breaks at the narrower places but still persists as narrow longitudinal strips on the outer bark. The hybrid shows a very close resemblance to the *B. vulgaris* parent in the occurrence and growth of cork and its effect upon the stem.

The parenchyma of the pericycle was studied from cross sections of the stems. In *M. aquifolia* the cell walls of this area are unevenly thickened and perforated and the cells retain their shape, though flattened somewhat, for many years (Pl. XL, Figs. 22-E and 25-E). I did not find any sections in which these cells were crushed. The cell walls of this area in the stem of *B. vulgaris* are somewhat thickened, although not as much as in *M. aquifolia*. The hybrid very closely follows the *M. aquifolia* parent in the irregularly thickened and perforated cell walls.

The number of rows of cells radially in the parenchyma of the pericycle shows a very irregular number in the *B. vulgaris* parent due to the undulations in the bast-fiber ring. Later, as the stem grows and the undulations in the bast-fiber ring become straightened out, the corner areas are flattened and the narrower places in the parenchyma are elongated radially, with many intercellular spaces forming, thus making a somewhat uniform width of parenchyma cells of the pericycle. The *M. aquifolia* has a fairly uniform area of pericycle and maintains it. The hybrid clearly follows the *B. vulgaris* parent in the arrangement of cells in the parenchyma of the pericycle (Pl. XXXIX, Figs. 17-D and 20-D). In number of rows of cells radially, the hybrid has an average of 6, closely following *M. aquifolia*, which has from 5 to 6 rows. *B. vulgaris* has an average of 9 rows of these cells radially.

The primary phloem of all three consists of sieve tubes and also of septate prosenchyma cells tapering at both ends. These tapering ends overlap and the side walls are pitted or have thin areas. No distinct differences were observed in the primary phloem of the parents or the hybrid except the amount of primary phloem in proportion to primary xylem is greater in *M. aquifolia* than in *B. vulgaris* or the hybrid. The latter two are very similar. Also numerous intercellular spaces are formed in the older phloem by the breaking apart of the cell walls showing in the walls on edge as lenticular intercellular spaces. These intercellular spaces are less frequent in the *B. vulgaris* parent than in *M. aquifolia*. The hybrid is very similar to *B. vulgaris* in the number of intercellular spaces appearing in the septate prosenchyma of the phloem, but the walls are thickened more nearly like those in *M. aquifolia.*

No secondary bast fibers were observed in *M. aquifolia.* The cell walls of the septate prosenchyma are perceptibly thickened (Pl. XXXVIII, Fig. 35) and serve a similar function of strengthening as is served by secondary bast. In *B. vulgaris*, secondary bast fibers resembling rod cells occur singly in the outer phloem, but in tangenital rows in the inner phloem (Pl. XL, Fig. 27-D). This may be considered a unisexual character as it occurs in only one parent. In the hybrid secondary bast fibers are found in greater abundance than in *B. vulgaris.* Pl. XL, Fig. 26-E shows these bast fibers just before the walls are thickened. They are completely thickened by the end of the second growing season. Pl. XL, Fig. 26-O, shows a cross section of these mature bast fibers. The hybrid is thus dominated in the occurrence of secondary bast by the *B. vulgaris* parent, but exceeds it in amount of bast.

No differences were observed in the primary xylem of all three subjects as studied from cross and longitudinal sections and macerated sections of stems. It is surrounded toward the pith by parenchyma with thickened walls, septate prosenchyma, and prosenchyma with pointed ends and thickened walls. There is more of this bundle sheath in *B. neubertii* than in either parent as shown in Pl. XL, Fig. 23-P, as compared with Pl. XL, Figs. 22 and 27. These cells are usually stored with food and the cell walls are thickened and pitted. In *B. vulgaris* the amount of thickening of cell walls is less than in *M. aquifolia.* The hybrid follows the *M. aquifolia* parent in the thickening but exceeds it in the amount of sclerenchymatous medullary sheath abutting on the primary xylem.

Cross, longitudinal, tangenital, and macerated sections were made of the xylem areas of the three subjects. The secondary xylem is made up in all three of tracheal tubes, tracheids, wood fibers, wood parenchyma, and septate prosenchyma. All of these cells have thickened walls and pits. The tracheids have bordered pits, and the tracheal tubes have both elongated pits as shown in Pl. XLI, Fig. 28-B, and circular pits as shown in Pl. XLI, Fig. 29-B. The circular pits have a narrow slit opening as shown in Pl. XLI, Figs. 29-B and 30-B. Many of the smaller tracheal tubes have spiral thickenings of the wall in addition to bordered pits, which occur in all three subjects, but especially in *M. aquifolia.* The comparison of the xylem elements is difficult because of the great similarities between the three subjects.

The tracheal tubes of the secondary xylem in *M. aquifolia* are relatively smaller and fewer than in *B. vulgaris*. The hybrid has tracheal tubes intermediate in size between those of the parents but more nearly approaching the number of *B. vulgaris*. Compare Pl. XL, Figs. 25-I, 26-I, and 27-I.

Wood fibers from macerated tissues of all three subjects show a general similarity in shape and pits. The *M. aquifolia* parent has wood fibers somewhat longer than those of the *B. vulgaris* parent. The wood fibers of the hybrid are intermediate in length between those of the parents. The average length of *M. aquifolia* wood fibers was found to be .38 mm., of *B. vulgaris* .34 mm., and of the hybrid .36 mm.

The tracheids are found in groups bordering either a group of wood fibers or the medullary rays. The average length of tracheids of the *M. aquifolia* parent was found to be .22 mm., in *B. vulgaris* average was .27 mm., and in the hybrid .247 mm. This very closely approaches the intermediate length between those of the parents, .254 mm.

The wood parenchyma is very little developed in the *M. aquifolia* parent, is more common in the *B. vulgaris* parent, and still more common in the hybrid. A definite comparison is difficult to make as to amount of wood parenchyma.

The wood prosenchyma with delicate cross walls across the lumen is common to all three subjects, but more common to *B. vulgaris* than to *M. aquifolia*. The hybrid follows the *B. vulgaris* parent in this character.

Broad primary medullary rays separate the individual vascular bundles from each other in all three subjects. The cell walls are perforated as shown in Pl. XLI, Figs. 28-F, 29-F, and 30-F. As stated by Solereder, the primary medullary rays are not closed by inter-fascicular wood. The length of medullary rays is somewhat greater in *B. vulgaris* than in *M. aquifolia*. The hybrid follows the *B. vulgaris* parent in this character. The vertical distance between rays is greater in *M. aquifolia* than in the *B. vulgaris*, and in this character the hybrid follows the *B. vulgaris* parent.

The pith of *M. aquifolia* is homogeneous and its walls are uniformly thickened throughout. The pith in *M. aquifolia* is never crushed, so far as I was able to observe. *B. vulgaris*, as observed by Solereder, has a heterogeneous pith with two areas, the outer thick-walled and remaining alive, while the inner thin-walled area soon dies (Pl. XL, Figs. 24 and 27, K and L). The hybrid has a heterogeneous pith similar to that found in the *B. vulgaris* parent, but the thick-walled area which remains alive is wider than in *B. vulgaris.* Compare Pl. XL, Figs. 23 and 26, of the hybrid with Figs. 24 and 27 K and L, of the *B. vulgaris* parent. The central dead area in the hybrid is smaller than in the *B. vulgaris* parent. This may be considered a bisexual inheritance in which the pith of the hybrid inherits characters partly from the *M. aquifolia* parent and partly from the *B. vulgaris* parent.

CONCLUSION.

The *Berberis neubertii* plant from which this study was made is undoubtedly a true hybrid of the *B. vulgaris* and *M. aquifolia* parents. It agrees with what we may expect from hybrids from previous studies. No new characters appear in the hybrid which do not occur in the parents.

B. neubertii is usually considered a bigeneric hybrid. In some characters it behaves as an interspecific hybrid, in others as an intervarietal hybrid, and in others as neither. It therefore belongs to the group which "affords no decision." (De Vries.)

Those characters common to one parent only, called unisexual by MacFarlane and De Vries, may behave as intermediates. The network of thickenings found on the lower epidermis of the *M. aquifolia* leaf, but not found on the leaf of *B. vulgaris*, are found in the hybrid much reduced.

The evergreen leaf of *M. aquifolia* and the deciduous leaf of *B. vulgaris* are inherited in the hybrid as semievergreen. The stiff xerophytic appearance of *M. aquifolia*, differing from the graceful, mesophytic appearance of *B. vulgaris*, is inherited as a semixerophytic appearance in the hybrid.

Papillose epidermal hairs found on *M. aquifolia* stems and lower epidermis of the leaf, but not on *B. vulgaris*, do not appear in the hybrid. Epidermal hairs in *Lonicera* in the hybrids studied behave as intermediates.

The amount of secondary bast in *Berberis neubertii* exceeds that found in the one parent only, the *B. vulgaris* parent.

Characters observed in the *B. vulgaris* parent only in which the hybrid closely approaches this parent are: spines, which are morphologically leaves, with the foliage leaves borne on short stems in their axils; jointed petiole; diagonal pits in the primary bast; the size, shape, and thickness of walls of secondary bast.

Characters observed in the *M. aquifolia* parent only in which the hybrid closely approaches this parent are: second and third row of palisade cells of the leaf; the perforations and thickened walls of the cortex parenchyma; and certain deposits and longitudinal thickenings in the primary bast fibers.

Cases of bisexual heredity were not common in this hybrid, as they were not in those studied by MacFarlane. The heterogeneous pith of the *B. vulgaris* parent and the thickened-walled homeogeneous pith of *M. aquifolia* are both partly inherited by the hybrid. Some of the pith area in the hybrid shows thickening of cell walls and the central pith area is thin-walled as in *B. vulgaris*. Another example of apparent bisexual heredity is in the primary bast. Diagonal long pits are inherited from the *B. vulgaris* parent, and longitudinal thickenings and soluble deposits in the cell walls from the *M. aquifolia* parent. Both of these characters appear in the hybrid.

Bisexual characters are those common to both parents (MacFarlane and De Vries). Those characters in which the *M. aquifolia* parent dominates are: texture of the leaf, margin of the leaf, number of rows of palisade cells of the leaf, and number of pericycle parenchyma cells radially. Those characters in which the *B. vulgaris* parent dominates are: habit of indefinite growth; size of stipules; color, shape, and venation of the leaf; shape of guard cells; number of bundles in the midrib; general character of the cortex of the stem; features in the primary bast, cork, and parenchyma of the pericycle.

Many characters common to both parents behave as intermediates. The hybrid has an intermediate number of stomata of the leaf; length of epidermal hairs; length of cortex cells, wood fibers, and tracheids; amount of thickening of cell walls of parenchyma of the pericycle and septate phloem prosenchyma.

There are some characters common to both parents in which the hybrid exceeds both parents; as, size of the leaf epidermal cells, length of palisade cells of the leaf, number of schlerenchyma cells of the midrib transversely, thickening of the sides of the blade as compared with the midrib, number of primary bast fibers as shown by the number of rows counted radially, amount of wood parenchyma cells, and amount of sclerenchymatous medullary sheath abutting on the xylem in the stem.

A few characters common to both parents in which the hybrid has less than either parent are number of stomata of the stem and number of cells of the cortex radially.

While anatomical study increases greatly the number of characters observable, it also increases the complexity and difficulty of the study in its interpretation of the laws of heredity. It is generally recognized that microscopic details as well as macroscopic characters are heritable and it seems well established that they should be considered in any study of the transmission of characters in hybrids.

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PLATE XXXVII.

FIG. 1. Leaf of *Berberis vulgaris,* showing general type of venation. Drawn from leaf cleared with chloral hydrate. $\times$ 1.

FIG. 2. Leaf of *Berberis neubertii.* $\times$ 1.

FIG. 3. Leaflet of *Mahonia aquifolia.* $\times$ 1.

FIG. 4. Upper epidermis of leaf of *B. vulgaris,* showing nuclei and upper end of palisade cells. $\times$ 312.

FIG. 5. Upper epidermal cells of *B. neubertii,* showing nuclei and upper end of palisade cells. $\times$ 312.

FIG. 6. Upper epidermis of *M. aquifolia* leaf. $\times$ 312.

FIG. 7. Lower epidermis of leaf of *B. vulgaris,* showing stomata and nuclei. $\times$ 312.

FIG. 8. Lower epidermis of leaf of *B. neubertii,* showing stomata and nuclei, also network of thickenings. $\times$ 312.

FIG. 9. Lower epidermis of leaf of *M. aquifolia.* $\times$ 312.

FIG. 10. Two stomata of *B. vulgaris* in cross section, showing guard cells, epidermal cells, and air space. $\times$ 312.

FIG. 11. Two stomata of *B. neubertii.* $\times$ 312.

FIG. 12. Two stomata of leaf of *M. aquifolia.* $\times$ 312.

PLATE XXXVII.

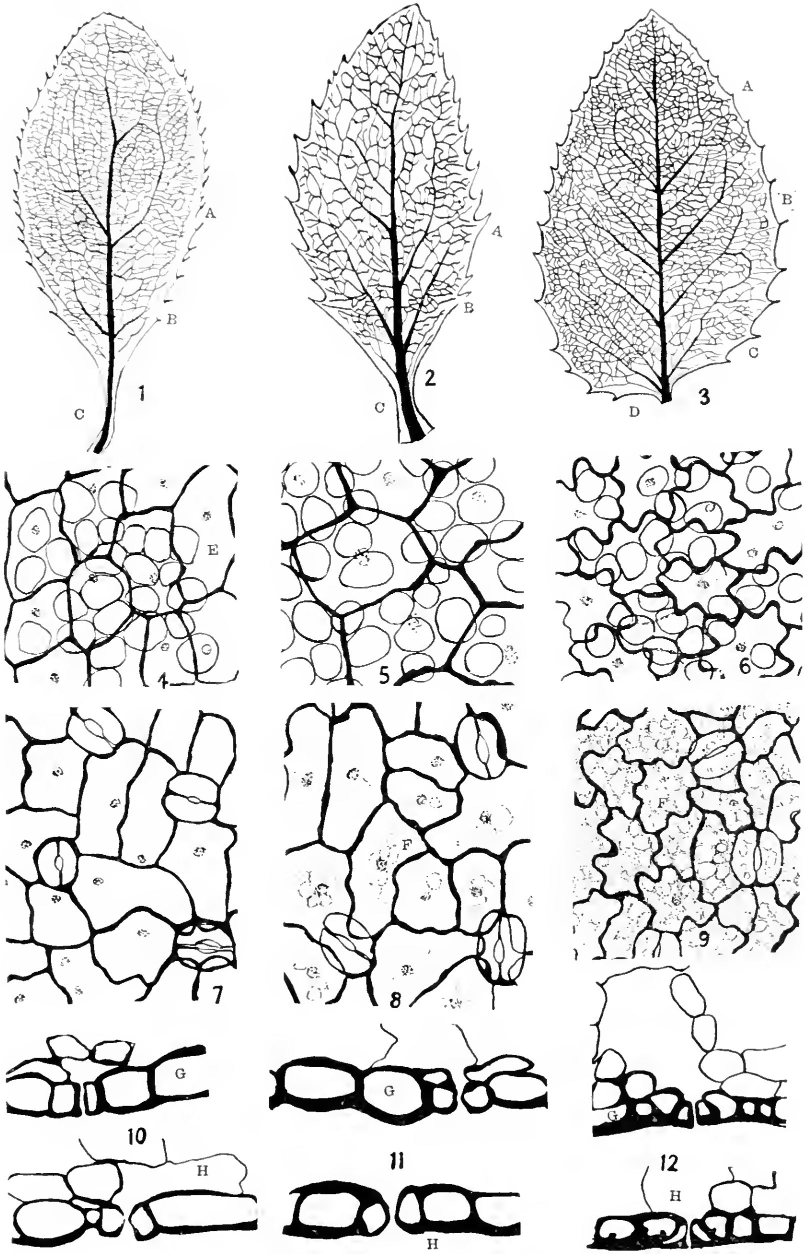


PLATE XXXVIII.

FIG. 13. Cross section of leaf of *Mahonia aquifolia* near center of leaf. × 208.

FIG. 14. Cross section of leaf of *Berberis neubertii,* near center of leaf. × 208.

FIG. 15. Cross section of leaf of *B. vulgaris,* near center of leaf. × 208.

Index of parts of above drawings:

A, Upper epidermis.
B, Upper row of palisade cells.
C, Second row of palisade cells.
D, Third row of mesophyll showing gradual transition to spongy parenchyma.
E, Spongy parenchyma.
F, Lower epidermis.
G, Phloem of midrib bundle.
H, Xylem of midrib.
I, Cortex.
J, Air space.
K, Sclerenchyma cells forming bundle sheath.

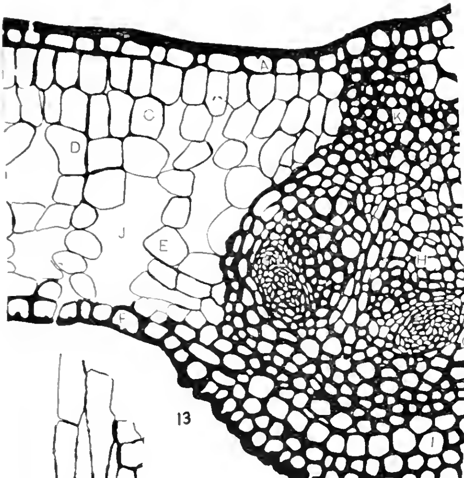
FIG. 34. Phloem prosenchyma of *M. aquifolia* stem showing cell walls just beginning to thicken.

FIG. 35. Same as Figure 34, after cell walls have thickened and air spaces have formed between them.

FIG. 36. Cork A, phellogen B, parenchyma of pericycle C, all of *B. neubertii* showing perforations in the cell walls of the pericycle.

FIG. 37. Septate phloem prosenchyma of *B. neubertii* stem. Similar cells are found, also, in the phloem of *B. vulgaris.*

PLATE XXXVIII.



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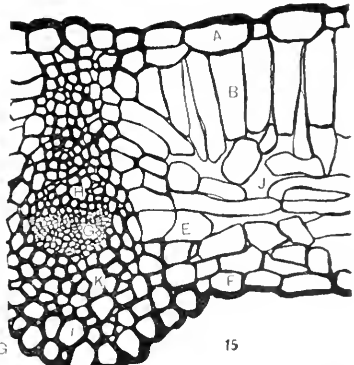

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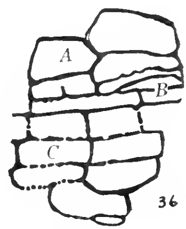

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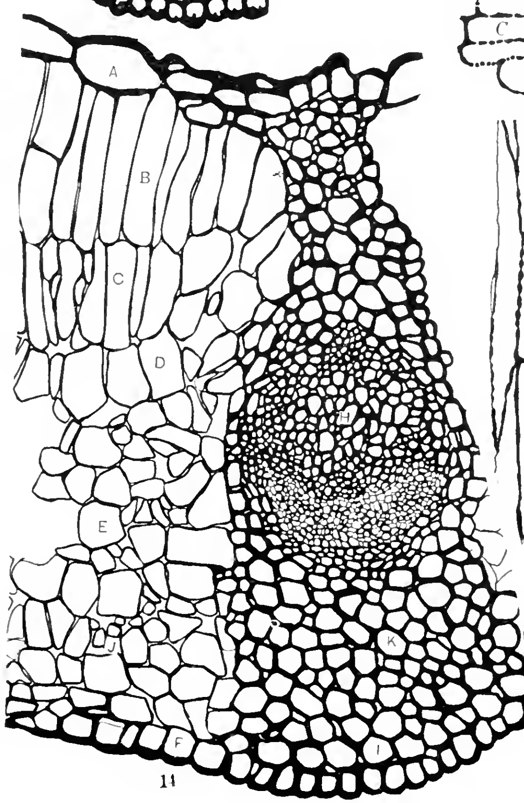

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PLATE XXXIX.

FIG. 16. Cross section of second internode of rapidly growing stem of *Mahonia aquifolia.* × 115.

FIG. 17. Cross section of rapidly growing stem, second internode, of *B. neubertii.* × 115.

FIG. 18. Cross section of second internode of rapidly growing stem of *B. vulgaris.* × 115.

FIG. 19. Cross section of fifth internode of rapidly growing stem of *M. aquifolia.* × 150.

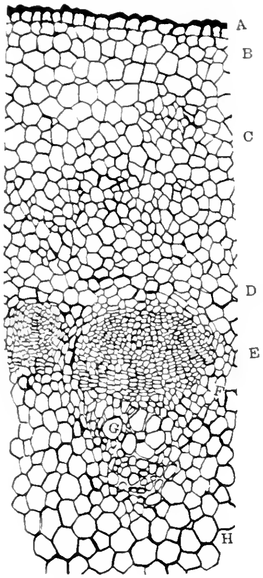
FIG. 20. Cross section of rapidly growing stem of *B. neubertii,* third internode. × 150.

FIG. 21. Cross section of rapidly growing stem of *B. vulgaris,* third internode. × 150.

Index for above figures:

A, Epidermis.
B, Parenchyma of the cortex.
C, Bast fibers or sclerenchyma of pericycle.
D, Parenchyma of the pericycle.
E, Primary and early secondary phloem.
F, Medullary ray.
G, Primary and early secondary xylem.
H, Pith.

PLATE XXXIX.



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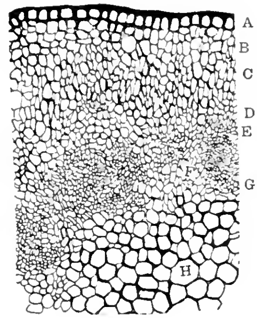

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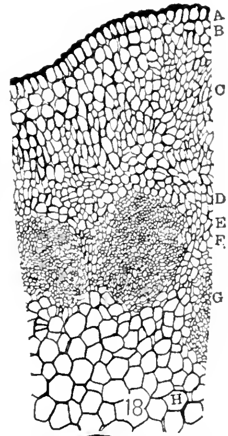

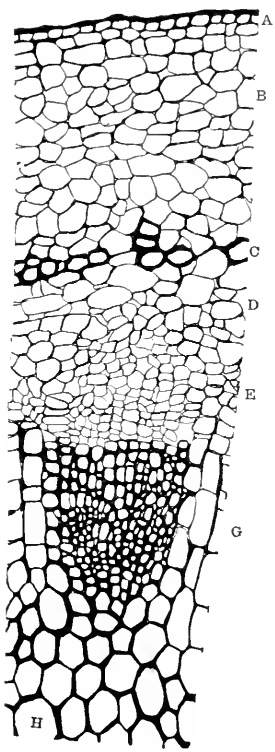

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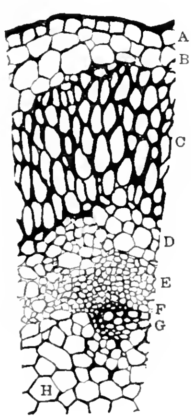

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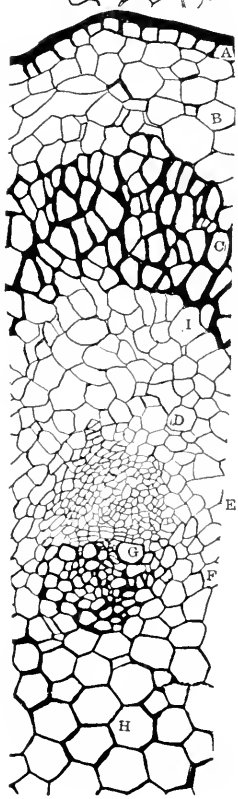

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PLATE XL.

FIG. 22. Cross section of one-year-old stem of *Mahonia aquifolia*. $\times 75$.
FIG. 23. Cross section of same age of *Berberis neubertii* stem. $\times 75$.
FIG. 24. Cross section of same age of stem of *B. vulgaris*. $\times 75$.
FIG. 25. Cross section of two-year-old stem of *M. aquifolia*. $\times 75$.
FIG. 26. Cross section of two-year-old stem of *B. neubertii*. $\times 75$.
FIG. 27. Cross section of two-year-old stem of *B. vulgaris*. $\times 75$.

Index for above figures:

A, Epidermis.
B, Parenchyma of the cortex.
C, Bast fibers or sclerenchyma of the pericycle.
D, Cork formed by the phellogen of the cork cambium.
E, Parenchyma of the pericycle.
F, Primary phloem.
G, Secondary phloem.
H, Medullary ray.
I, Secondary xylem.
J, Primary xylem.
K, Central pith. (In *B. vulgaris* and *B. neubertii* without thickened cell walls.)
L, Outer pith. (In *B. vulgaris* and *B. neubertii* with thickened cell walls.)
M, Phellogen or cork cambium.
N, Secondary bast just beginning to thicken its walls.
O, Secondary bast. (In Fig. 26, cross section. Fig. 27, longitudinal section.)

PLATE XL.

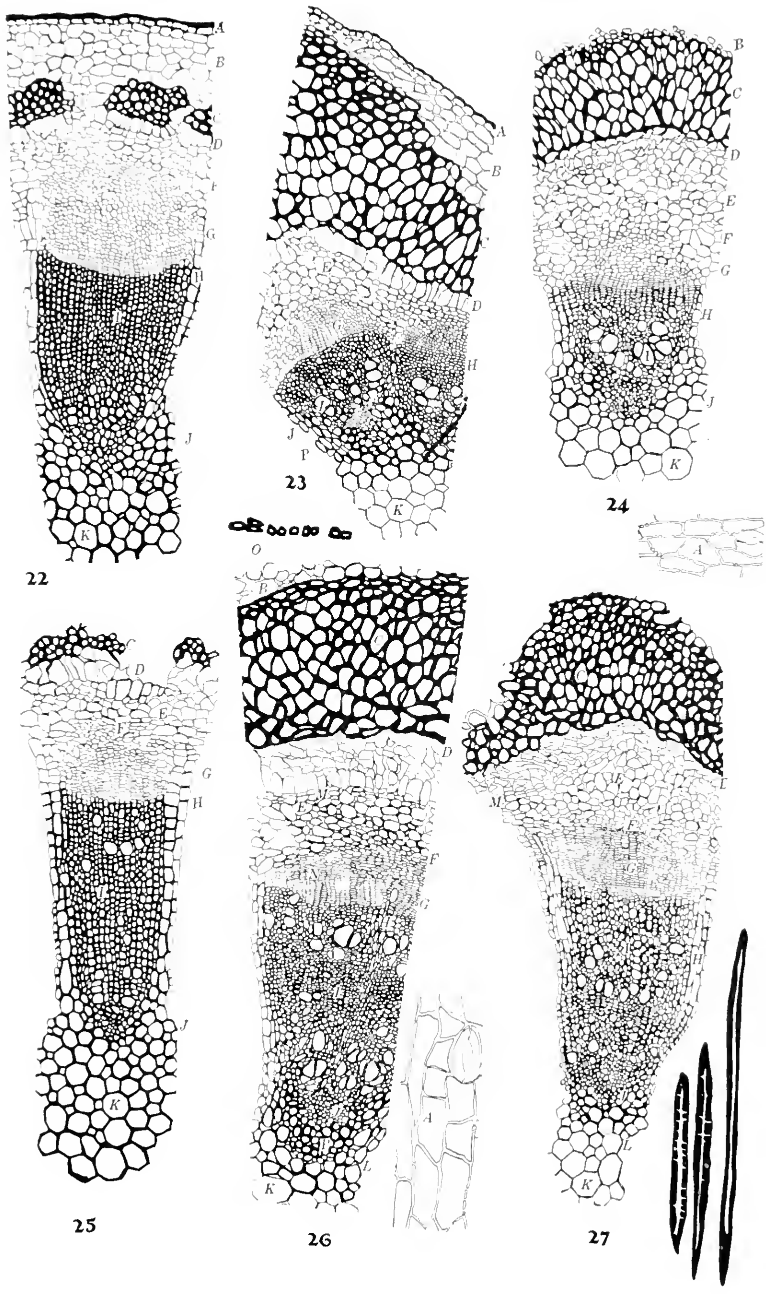


PLATE XLI.

FIG. 28. Tangential section from wood area of *Mahonia aquifolia* stem $\times$ 208.

FIG. 29. Tangential section from the wood area of *Berberis neubertii.* $\times$ 208.

FIG. 30. Tangential section from the wood area of *B. vulgaris.* $\times$ 208.

Index for above figures:

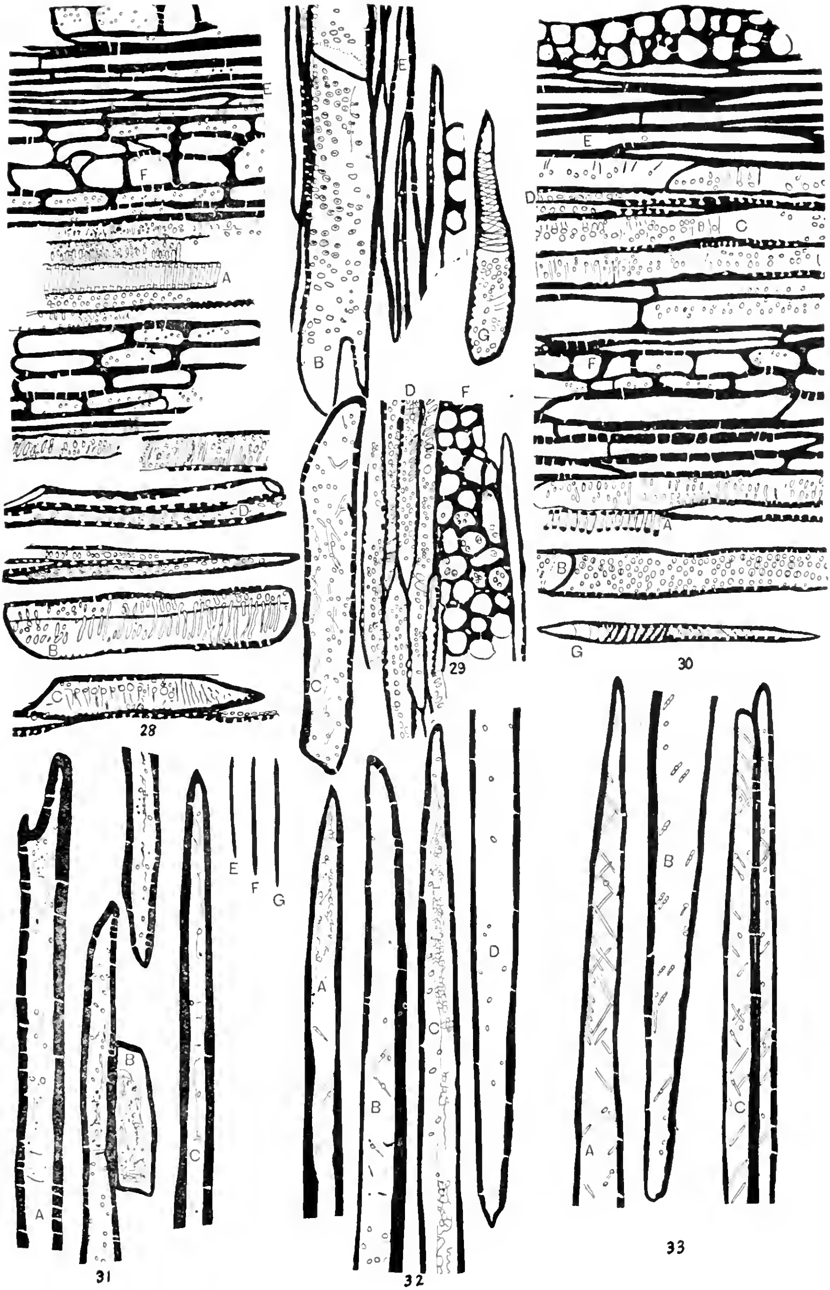
- A, Primary xylem tracheal tube, showing thickening of cell wall.
- B, Secondary xylem water tube, showing pits.
- C, Water tubes of secondary xylem, showing pits and spiral thickenings.
- D, Tracheids, showing bordered pits.
- E, Wood fibers, showing simple pits.
- F, Medullary rays in cross section, showing perforations.
- G, Tracheal tube, showing spiral thickening in one part and simple pits in another. (Not common in this subject.)

FIG. 31. Individual primary bast fibers of *Mahonia aquifolia,* showing longitudinal thickenings and soluble deposits. $\times$ 208.

FIG. 32. Individual primary bast fibers of *B. neubertii,* showing longitudinal thickenings, soluble deposits, elongated pits, and circular pits. $\times$ 208.

FIG. 33. Individual primary bast fibers of *B. vulgaris,* showing elongated pits and circular pits. $\times$ 208.

PLATE XLI.



THE UNIVERSITY OF KANSAS
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On the Occurrence of *Bison latifrons* in Comanche County, Kansas.

HANDEL T. MARTIN, Department of Vertebrate Paleontology.

FOR two years prior to September, 1925, Mr. James O'Connel, the owner of a large cattle ranch twenty-five miles southeast of Coldwater, Kan., had noticed, projecting from the sandy bank of the creek that flows through his home pasture, an object which looked like the dead root of an old cottonwood tree, both in color and texture. Early in September, 1925, he made a closer examination of the object and found that these appearances had been misleading, as the object proved to have a bony structure, though somewhat different and older looking than the old bison bones usually met with in such situations.

Mr. O'Connel's interest and curiosity being aroused, he at once commenced digging to unearth the specimen, and, if possible, to find out to what sort of animal it had belonged. The loose, sandy matrix soon yielded to his efforts, and in a short time there was exposed to view the fine pair of horn cores, together with parts of the skull, which have furnished the material for this paper.

The resemblance of the specimen to the head of a modern bison was at once noticed and commented upon, and credit must be given to Mr. O'Connel and his family for the ability to recognize in this huge specimen with a spread of horn cores of six feet five inches, a distant relative of our living bison. Credit is also due them for the careful way in which the specimen was removed from the sandy bank.

When found this specimen was embedded in a layer of loose, sandy Pleistocene gravel, about fifteen feet above the present bed of the creek, and directly on top of the red beds, where a shallow, basinlike depression had been formed by the previous action of the creek during high-water freshets. Into this depression the head and horn cores had been washed, settled to the bottom, and been buried by the sedimentary deposits of the stream. At the point where the specimen was deposited, the creek at that time had evidently turned directly west, along what was then the foot of the high bank of red-bed formation, but which now stands about 300 feet to the south of and parallel to the present course of the creek. From the base of this 35-foot bank the present surface slopes rapidly to the north until, at the exact point where the skull lay, the sandy material had been reduced by erosion until only a feather edge remains, and the tip of one of the horn cores was fully exposed above the surface. That water had played an important part in the deposition of the matrix surrounding the specimen is evidenced by the many thin layers of fine silty sand, interspersed with other layers of black oxide of manganese, which lie in horizontal bands all through the basin, and the sloping mass of debris from the high bank—the whole tinged a rusty-brown color.

Late in September, 1925, the writer paid a short visit to the locality, hoping to find other parts of the specimen, as the nature of the broken parts of the skull suggested that some of the missing pieces might possibly be found, either in the talus of the sandy bank, or in the old bed of the creek, but a thorough search of the immediate vicinity disclosed no indications of the missing parts of either the skull or the rest of the skeleton. It is hoped, however, that sometime in the near future a more thorough examination of the exposures along the banks of the creek may be made. For, prior to the laying down of this Pleistocene deposit of coarse sandy gravel, the creek had gouged out a deep course in the red beds, which later was filled with Pleistocene material, and this in turn is undergoing a secondary erosion, every freshet exposing to view fresh surfaces of likely fossil-bearing strata.

Bison latifrons.

Of the ten or more species of fossil bison described from North America, *Bison latifrons* is the largest and seems to be the rarest, and consequently the least known of all. There appear to be not more than three or four specimens of this species positively known, the finest of which is the pair of magnificent horn cores first described by Harlan, later by Lucas and Hay, which is in the museum of the State Historical Society at Cincinnati, Ohio. In view of the rarity of this species, the additional information and measurements secured from a study of the Coldwater specimen, together with the figures illustrating it, will, I hope, be received with approval.

As will be seen from an examination of the figures, reproduced from photographs of the specimen from different points of view, it consists of a very fine and almost complete pair of horn cores, together with a sufficient amount of the adjoining skull attached to supply several measurements hitherto not recorded, which may be of value in the study of other and less complete material.

Apparently the Cincinnati specimen lacks a sufficient amount of the adjoining skull to give a positive determination of the general contour and angle of the horns. On the other hand, the Coldwater specimen, as shown by the photographs, reveals clearly the exact angle, as there is firm contact of the horn cores with the skull. A comparison of the size and curvature of the horn cores of the Coldwater specimen with the description and figure of the Cincinnati specimen as given in Lucas' Fossil Bison of America, leaves no room to doubt that they belong to the same species. The suggestion of Hay that the skull and horn cores of the American Museum specimen, described by him as *Bison regius,* may prove to be those of a female of *Bison latifrons*, is well worth consideration, since the sharp upward curve of the horn cores is very much like that in the female of *Bison bison*, where there is a more general inclination towards an upward curve of the horn cores than in the case of the male. Unless later discoveries of the association of horn cores of *Bison latifrons*, like those of the Cincinnati and Coldwater specimens, with the teeth unlike those of *Bison regius*, should be made, it seems probable that sex alone is sufficient to account for the differences between the *Bison regius* of Hay and indubitable *Bison latifrons.*

As shown by the figures, the Coldwater specimen is by no means complete, yet there are sufficient skull parts present to supply additional measurements of the ventral surface of the preoccipital region, as well as of the upper part of the skull from the occipital crest to the level of the frontonasal sutures. As there is perfect contact at the breaks between the horn cores and the skull, there is no doubt as to the correct angle of the horns, whether or not that angle is of any specific value.

In all measurements of the horn cores, as well as of the distance across the skull between their bases, the rough ring at the base of the core is used in each case as the starting point.

With the exception of the tip of each horn core, no attempt has been made to restore the skull, since it is hoped that eventually the missing parts will be found when the contemplated visit to the locality is made, and more time can be given to a more thorough search of the vicinity of the original find.

There is little to be added to the description of the skull by other authors from data supplied by the Cincinnati specimen, except that as the ventral surface of the Coldwater skull appears to be more complete, it may be worth while to append a series of measurements which may be of value in the study of other material.

One noticeable feature of *Bison latifrons* is the great thickness of the horn cores, together with the intricate network of longitudinal and transverse pillars in the interior of the cores at the base; these result in greater strength for the support of the massive horns which this animal carried. This network of trusses extends for a distance of 15 to 18 inches up the otherwise hollow core.

THE FRONTAL PORTION OF THE SKULL.

From the frontal eminence to the fronto-nasal sutures the surface of the frontal bone has the form of a rather level plane, with a slight longitudinal elevation along the median line; in this respect *Bison latifrons* parallels the condition in *Bison occidentalis*, but has no such prominent eminence as has *Bison bison* along the center of the frontal in line with the constriction between the bases of the horn cores and the upper rim of the orbital ring.

It is unfortunate that in the Coldwater specimen both of the horn cores were broken and the tips lost. The right core, with a vertical diameter at the distal end of the fragment of 72 mm., and a transverse diameter at the same level of 56 mm., has been restored only approximately to its original length with a total of 921 mm. Judging, however, from the taper of the distal ends of the Cincinnati specimen, this is too short, and the restored portion of the Coldwater specimen appears to be too stubby and to end too abruptly, so that the probabilities are that it was several inches longer than as restored. It is likely that the distance from tip to tip of the horn cores was originally not less than 6 feet 8 inches, or 2,000 mm.

	Coldwater specimen.	Cincinnati specimen.
Dimensions of horn cores:	mm.	mm.
Length of right horn core, upper curve	810	...
Length of right horn core, as restored	921	828
Length to end of broken core, lower curve	860	.....
Diameter of core at broken end, vertical	72	......
Diameter of core at broken end, transverse	56	...
Diameter of horn core at base, vertical	170	167
Diameter of horn core at base, transverse	155	148
Circumference of right core at base	510	507
Length of restored part of right horn core	111	..
Length of left horn core to broken end, upper curve	730	..
Length of left horn core to broken end, lower curve	700	
Diameter of left horn core at broken end, vertical	95	..
Diameter of left horn core at broken end, transverse	80	
Diameter of left core at base, vertical	170	
Diameter of left core at base, transverse	165	
Circumference of left core at base	512	
Length of restored part of left core	192	
Tip to tip of cores, as restored	1,950	1,800
Tip to tip along upper curve, as restored	2,150	
Width of skull between basal rings of cores	360	382
From line joining tips, to frontal eminence	340	
From same line to condylar foramen	480	
Thickness of core walls at base	60	

	Coldwater *B. latifrons.*	*B. occidentalis.*	*B. alleni.*	B. *bison.*
Dimensions of dorsal surface of head:	mm.	mm.	mm.	mm.
Occipital crest to fronto-nasal suture	345	270	287	225
Width of constriction between cores and orbit	390	302	286	248
Width of nasals at widest part	100			
Occipital crest to posterior level of orbits	310	233	232	202
Greatest width (at process over meatus)	300			..
Width at articulation of lower jaw	270	258	253	225
Width between rings at base of cores	360			
Dimensions of under surface of skull:				
Width across occipital condyles	115			135
Condylar crotch to basioccipito-sphenoidal suture	185			145
Diameter of foramen magnum, transverse	45			14
Diameter of foramen magnum, vertical	47			50
Width across condylar foramen, transverse	40			
Width across condylar foramen, vertical	45			
Length of tympanic bulla	70			50
Width of tympanic bulla	25			21
Upper border of foramen magnum to supra-occ	116			90
Width across glenoid fossæ (outside)	272			230
Width at auditory meatus	308			240
Width in line with upper margin of foramen magnum	309			245
Articular surface of glenoid fossa	40			33
Height of occipital crest above lower lip of foramen magnum	222			145

Through the kindness of Earl O'Connel, a son of Mr. James O'Connel, I am able to give the following description of the location of the land on which the specimen was found:

On Cottonwood creek, in section 6, township 35, range 17 west, Comanche county, Kansas, 1½ miles north of the Kansas-Oklahoma state line.

To one of the graduates of the University of Kansas, Mr. Horace Rich, an attorney of Coldwater, I wish here to express my thanks and appreciation of his kindness in generously devoting a whole day to the task of driving me out to the O'Connel ranch and around over the immediately surrounding country, to make an examination of the geological formations in the neighborhood, upon the occasion of the trip to Coldwater made to investigate a newspaper report of the find.

In conclusion I should like to add that this specimen was very graciously presented to the writer for friendship's sake by Mr. O'Connel, to be retained as my personal property, and I hereby extend to him publicly my appreciative thanks and acknowledgment of his generosity.

PLATE XLII.

Photographs of horn cores and part of skull of *Bison latifrons*, from Coldwater, Kan.

UPPER FIGURE. Full front view showing degree of angle of the horn cores, with the vertical face of the skull.

MIDDLE FIGURE. The horn cores slightly tilted backward to show the approximate curvature of the horn cores, if the animal stood in an attitude of rest.

LOWER FIGURE. Part of skull of full-grown *Bison bison* for comparison.

PLATE XLII.

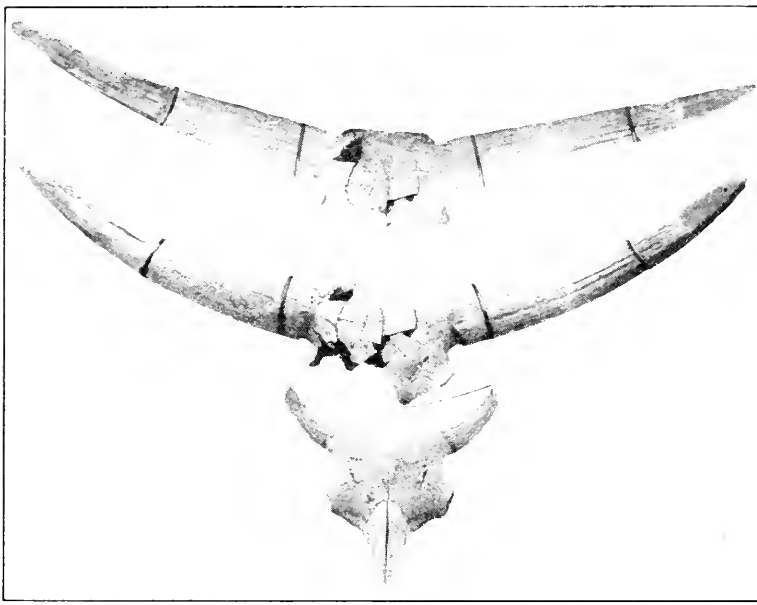
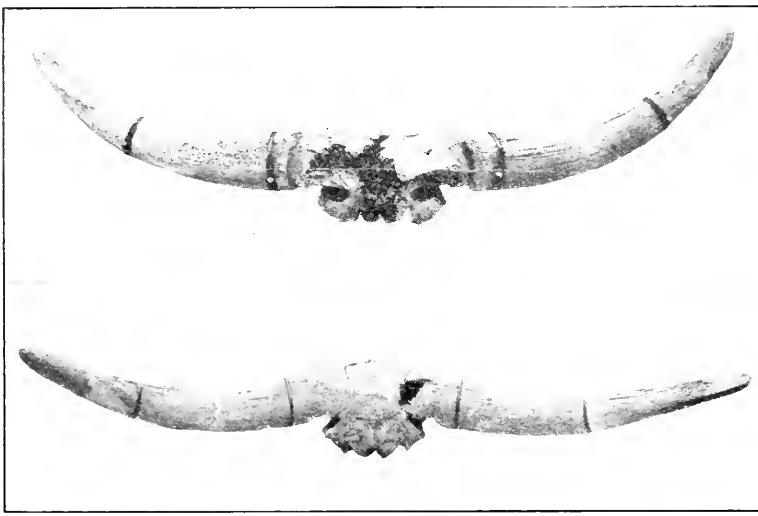


PLATE XLIII.

UPPER FIGURE. Front view of horn cores of *Bison latifrons* from Coldwater, Kan., in a position to show full curvature of the horns.

LOWER FIGURE. Back view of the Coldwater specimen of *Bison latifrons*, showing the occipital condyle and horn cores. Note the angle of the horn cores with reference to the flattened plane of the frontal bone.

PLATE XLIII.



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