MR. GEORGE G. AINSLIE: That is one thing that we haven't been able to decide—how they spend the winter. Undoubtedly, moths are taken through the winter, but we have never been able to carry moths emerging late in the fall through to the next spring. Insects that went into the winter as pupæ and emerged during the winter were exposed and would remain through the latter part of the winter and late in the spring. Another thing—the moths that emerged late in the fall, we were totally unable to get eggs from. There are three or four generations a year, but those emerging in September never did mature the same season. Those emerging late in the winter produced eggs as soon as conditions were favorable in the spring.

MR. FRANKLIN SHERMAN: It is certainly well established that the adults do pass the winter. In what other stages they pass the winter I do not know. It has been suggested that the pupæ also pass the winter. That may be.

PRESIDENT W. C. O'KANE: The next paper is "The Life History, of Some Kansas *Lachnosterna*," by W. P. Hayes.

THE LIFE HISTORIES OF SOME KANSAS LACHNOSTERNA¹

By WILLIAM P. HAYES, Assistant Entomologist, Kansas State Agricultural Experiment Station

INTRODUCTION

The present study of the life histories of the more important species of Kansas *Lachnosterna* was begun in 1916. It is being carried out under the immediate direction of Mr. J. W. McColloch, to whom the writer's thanks are due for his kindly aid and criticism. The life history of one species, *Lachnosterna lanceolata* Say, a diurnal form has been previously published (Hayes, 1919). The data herein reported deal with observations on seven species of *Lachnosterna* found in the vicinity of Manhattan, Kans., five of which have been discussed by Davis (1916) in his notable report on the life-cycle of 18 different species. The two species considered in this paper and not dealt with by him are *L. rubiginosa* and *L. submucida*. The former, in point of numbers, ranks second among the night-flying species in the vicinity of Manhattan, and *L. submucida* ranks sixteenth.

In rearing, the eggs were obtained in small, soil cages and transferred to moist soil in salve boxes in much the same manner as described by Davis (1915, pp. 137-138). On hatching, the grubs were reared to maturity in individual salve boxes and kept in the insect cave described by McColloch (1917). Daily observations could thus be made to

¹Contribution No. 39 from the Entomological Laboratory, Kansas State Agricultural College. This paper embodies the results of some of the investigations undertaken by the author in the prosecution of project No. 100 of the Kansas Agricultural Experiment Station.

determine the length of the prepupal stage, heretofore unrecorded, and the exact dates of pupation and transformation to the imago.

In general, it may be said that the results corroborate those of Davis in that a decided variation of length of the larval stage occurs in most of the species observed. Thus, some species have in the latitude of Kansas either a two or three-year life-cycle.

SPECIES CONCERNED AND RELATIVE ABUNDANCE

The seven species under consideration are *L. crassissima* Blanch. (fig. 1a), *L. rubiginosa* Lec. (fig. 2), *L. futilis* Lec. (*gibbosa* Horn), *L. rugosa* Mels., *L. implicata* Horn, *L. vehemens* Horn, and *L. submucida* Lec., named in the order of their abundance at Manhattan.¹

Sanders and Fracker (1916, p. 256) have shown that a remarkable variation in the distribution of the different species of this genus may occur within a distance of thirty or forty miles. The data herein given may thus be only applicable to the vicinity of Manhattan, Kans.

L. crassissima.—This species is the predominating one of the night-flyers in the area under consideration. During the past four seasons 15,655 specimens, or 32 per cent of the total collections of all species (47,494 specimens) were collected at lights, on food plants and in the soil. Over 99 per cent of these beetles have been taken at lights, although regular collections have been made on some forty species of plants.

L. rubiginosa.—Ranking second among the nocturnal *Lachnosterna* of this locality, this

Fig. 11.—*Lachnosterna crassimana* Blanch; A, adult; B, egg; C, larva; antenna of female and male.

¹ *L. lanceolata* is the most prevalent species in this vicinity. It is excluded from the above list and following discussion because of its diurnal habits, although its collection numbers are included in the total collections and percentages based thereon.

species comprises 13 per cent of the collections with a total of 6,191 specimens taken. The collections show that *L. rubiginosa* is more abundant on food plants than at lights, where 69 per cent of all taken were found.

L. futilis (gibbosa).—A total of 5,680 specimens of *L. futilis*, or 11 per cent of the total collections have been made in the last four seasons, giving to this species third place in point of numbers. In all, 4,521

Fig. 12.—*Lachnosterna rubiginosa* Lec.; A, male; B, female.

beetles, or 79 per cent were collected at lights, 1,150 on food plants, and five in the soil.

L. rugosa.—This species stands fourth in abundance with a total of 2,379 beetles, of which 79 per cent were taken at lights.

L. implicata.—The collections of *L. implicata* amount to 827 individuals which places the species fifth in importance. The majority, or 68 per cent, were taken on food plants.

L. vehemens.—Two other species of Kansas *Lachnosterna* (*L. hirticula* and *L. bipartita*) not considered in this paper stand, in point of numbers, ahead of *L. vehemens* which ranks eighth with a total of 437 specimens collected. Of these 429 were taken at lights.

L. submucida.—Among the 23 species of *Lachnosterna* collected in the area under consideration, *L. submucida* ranks sixteenth. It is represented by only 18 specimens, but one of which was taken on food

plants. The following biological observations on the species were made possible by the collection of a number of eggs in 1917 which, when reared to maturity, proved to be those of *L. submucida*.

Table I gives a comparison of the numbers collected during the past four seasons. An attempt was made to make the collections uniform by collecting nightly from the opening to the close of the season of flight. During the 1916 season, tree and food plant collections were neglected for light collections and in 1919 the reverse was true, light collections being neglected for food plants, so on the whole, the collecting is thought to be somewhat uniform for the four years.

TABLE I.—SUMMARY OF TOTAL COLLECTIONS

Species	1916 Brood C	1917 Brood A	1918 Brood B	1919 Brood C	Total
<i>L. crassissima</i>	3,412	10,244	856	1,143	15,655
<i>L. rubiginosa</i>	104	5,176	802	109	6,191
<i>L. futilis</i>	1,192	3,217	381	890	5,680
<i>L. rugosa</i>	571	1,301	188	319	2,379
<i>L. implicata</i>	395	214	131	87	827
<i>L. vehemens</i>	77	341	11	8	437
<i>L. submucida</i>	11	4	1	2	18
					31,187

LIFE HISTORY

Adults

Period of Flight.—The flight season begins as early as April 18 in the vicinity of Manhattan, and with the species concerned may last until the middle of August. The maximum period of flight occurs in May and June, except in the case of *L. submucida*, which is a late flying species that pupates in June and July and flies soon after becoming adult. It does not pass the winter in the adult stage as do the other species. In general, it can be said that *L. futilis*, *L. rubiginosa*, and *L. vehemens* appear first with *L. crassissima* and *L. rugosa* soon following. Specimens of *L. implicata* have not been taken before May 6, and *L. submucida* does not fly until July. Table II shows the earliest and latest dates on which the species have been found either at lights or food plants.

TABLE II.—PERIOD OF FLIGHT

Species	Earliest collection	Last collection	Period of flight. Days
<i>L. futilis</i>	April 18	July 21	94
<i>L. rubiginosa</i>	April 18	Aug. 8	112
<i>L. vehemens</i>	April 18	June 23	66
<i>L. crassissima</i>	April 22	Aug. 17	117
<i>L. rugosa</i>	April 23	July 12	80
<i>L. implicata</i>	May 6	July 21	76
<i>L. submucida</i>	July 7	Aug. 17	41

Proportion of Sexes.—The sexes of *Lachnosterna* are commonly known to differ somewhat in their habits of flight. It is generally stated that males are more abundant at lights and females more numerous on food plants. Males of the seven species under consideration with the exception of *L. implicata*, have been found more plentiful at lights. In the case of *L. implicata*, it is to be noted that males are proportionately rare and not found to any extent in any situation. Table III shows the proportions of sexes of the seven species collected during the 1917–1918 seasons, and of all reared individuals.

In sex ratios, the collections on food plants show different relations in the different species. More males were found than females of *L. crassissima*, *L. futilis*, *L. rugosa* and *L. vehemens*, while *L. rubiginosa* and *L. implicata* females were the more numerous.

Two noticeable points are brought out by the table. It can be seen that *L. crassissima* is represented on food plants by less than one per cent of the total collections, while 71 per cent of *L. rubiginosa* beetles were collected on food plants. Although the most abundant, the absence of *L. crassissima* on food plants indicates a preference for some food which has not yet been found. Schwarz (1891, p. 241) states that adults of *L. crassissima* probably feed on grass or low herbage.

Eggs

The eggs (fig. 11, b) are white in color and when freshly laid are oval in shape, varying slightly in size with the different species. The eggs of *L. futilis* are somewhat smaller than those of the other six species, with an average measurement of 1.7 mm. in length and 1.2 mm. in width, while *L. rugosa* eggs, when freshly laid, are about 2.6 mm. long and 1.8 mm. wide. An enlargement, accompanied by a slight increase in weight, occurs as development proceeds, causing the eggs to assume a more globular appearance. Daily measurements of the eggs show a gradual increase in size during the earlier periods of development until both dimensions have increased about .5 to .7 mm.

Table IV gives a summary of the length of the egg stage of the seven species during four seasons under observation.

The *L. submucida* eggs were collected in a field soon after laying and represent a somewhat longer period of development than is given in the table. The maximum length of egg stage varies from 20 to 38 days with the various species, and the minimum ranges from 9 to 19 days. General averages of the seven species range from 14 plus in *L. submucida* to 20.8 days in *L. futilis*.

The preoviposition period was determined in the case of *L. crassissima* at about 12 days. The number of eggs laid by an individual female is reported by Davis (1916, p. 263) as from 50 to 100. In no

TABLE III.—SUMMARY OF PROPORTION OF SEXES

	L. crassissima			L. rubiginosa			L. futilis			L. rugosa			L. implicata			L. vchemens			L. submucida		
	♀	♂	Total	♀	♂	Total	♀	♂	Total	♀	♂	Total	♀	♂	Total	♀	♂	Total	♀	♂	Total
Collected at Lights.....	2,510	9,592	12,102	462	1,265	1,727	326	3,028	3,354	414	920	1,334	51	3	54	52	300	352	0	4	4
Collected on Food Plants.....	41	53	94	2,217	2,096	4,313	488	643	1,131	192	264	456	353	23	376	1	7	8	1	0	1
Collected in Soil.....	20	29	49	18	29	47	3	0	3	6	13	19	2	0	2	0	0	0	2	1	3
Reared from Collected Grubs.....	51	49	100	29	19	48	7	9	16	24	29	53	14	0	14	0	0	0	1	1	2
Reared from Egg.....	40	38	78	14	15	29	7	9	16	9	12	21	19	3	22	1	0	1	5	8	13

TABLE IV.—LENGTH OF EGG STAGE

Species	1916				1917				1918				1919				Total			
	No. of eggs	Max. days	Min. days	Aver. days	No. of eggs	Max. days	Min. days	Aver. days	No. of eggs	Max. days	Min. days	Aver. days	No. of eggs	Max. days	Min. days	Aver. days	No. of eggs	Max. days	Min. days	Aver. days
L. crassissima.....	466	26	9	18.2	126	21	11	13.9	77	19	9	14.1	159	20	13	15.6	828	26	9	15.4
L. rubiginosa.....	42	18	14	16.3	269	21	9	12.3	110	24	11	17.	13	21	12	17.9	434	24	9	15.8
L. rugosa.....	42	24	9	15.6	60	29	9	14.9	2	18	11	14.5	73	22	14	18.6	177	29	9	15.9
L. implicata.....	28	31	11	24.5	16	21	13	17.2	86	20	11	17.6	65	20	13	16.3	195	31	11	18.9
L. futilis.....	110	31	16	23.	145	38	18	24.5	33	19	11	15.4	610	30	14	20.1	888	38	11	20.8
L. vchemens.....					2	28	19	23.5									2	28	19	23.5
L. submucida.....					83	20+	13+	14.+									83	20+	13+	14.+

instance, in the present study were more than 46 eggs laid by any female in laboratory cages. They are deposited singly in the soil and surrounded by a small earthen ball which is held in shape by a secretion from the female. The earliest date on which eggs were found in the cages was May 22. In most instances, the first species to oviposit has been *L. futilis* and it has been observed to continue egg laying until July 12.

During three seasons of the four under discussion, eggs of *L. futilis* have been the first to hatch at dates ranging from June 18 to June 27. The exception was in 1918 when eggs of *L. crassissima* were the first to hatch at a somewhat earlier date, June 10.

Larvæ

The larvæ, or grubs (fig. 11, c), of this genus are adequately described by Davis (1916, p. 265) as "white or cream white, the dark contents of the intestinal tract being plainly visible through the skin of the last few abdominal segments. The head is light tan in color, smooth and shiny and the body is covered with reddish brown hairs, those on the dorsum of the folds or ridges being short and more thickly placed. The ventral surface of the anal segment, which shows the most prominent character, bears a triangular patch of brownish hairs which are hooked at the tip, with an intermixing, especially at the borders of the patch, of fine, long hairs, and with a median longitudinal double row of coarse hairs or spines inclined more or less inwardly. These rows may be straight and parallel or more or less curved; short or long; and the spines in the rows may be sparsely or closely placed according to species. The anal slit is in the form of an obtuse angle." The young larva, when freshly hatched, is pure white, but the head soon assumes the characteristic brownish tinge.

Davis (1916, p. 262) and others have shown that latitude bears an important influence on the life-cycle of species of this genus. The farther northward a species is found the longer is the life-cycle. Smyth (1916, p. 47) in Porto Rico reared *Lachnosterna* from egg to adult in 324 days—less than one year—while Davis states that in northern Wisconsin four years are required to complete development. Davis has likewise shown, and the present data confirm his observations, that a difference of one season may occur in the time of development of grubs of the same species. This difference is due to variation in the length of the larval stage. In Table V, the larval periods from time of hatching to the attainment of the prepupal condition of some 230 individuals are considered.

The species under consideration all pupate in the fall and pass the winter as adults, except *L. submucida*, which transforms in the spring.

TABLE V.—LENGTH OF LARVAL STAGE FROM HATCHING TO PREPUPE

Species	Two-year grubs			Three-year grubs			Totals					
	No. of grubs	Max. days	Aver. days	No. of grubs	Max. days	Aver. days	No. of grubs	Max. days	Aver. days			
<i>L. crassissima</i>	71	459	406	423.4	35	823	732	752.8	106	823	406	598.4
<i>L. rubiginosa</i>	4	497	402	454.5	43	798	742	770.8	47	798	402	686.1
<i>L. futilis</i>	18	424	389	408.2	1	773	773	773.	19	773	389	466.1
<i>L. rugosa</i>	5	412	399	406.2	17	778	750	758.8	22	778	399	582.5
<i>L. implicata</i>	21	429	393	404.3	1	743	743	743.	22	743	393	421.9
<i>L. vehemens</i>					1	770	770	770.	1	770	770	770.
<i>L. submucida</i>	13	687	658	668.6					13	687	658	668.6

TABLE VI.—LENGTH OF THE PREPUPE STAGE

Species	1916 Generation				1917 Generation				1918 Generation				From collected grubs				Totals			
	No. of pre-pupae	Max. days	Min. days	Aver. days	No. of pre-pupae	Max. days	Min. days	Aver. days	No. of pre-pupae	Max. days	Min. days	Aver. days	No. of pre-pupae	Max. days	Min. days	Aver. days	No. of pre-pupae	Max. days	Min. days	Aver. days
<i>L. crassissima</i>	65	19	7	12.1	28	10	3	7.8					76	12	3	7.3	169	19	3	9.
<i>L. rubiginosa</i>	5	9	4	7.2	32	11	3	7.1					28	11	3	5.7	65	11	3	6.6
<i>L. futilis</i>	15	9	5	7.1	2	8	3	7.5					17	9	5	7.3	17	9	5	7.3
<i>L. rugosa</i>	5	9	3	6.2	16	30	6	12.3	2	11	6	8.5	46	15	4	8.3	67	30	3	8.9
<i>L. implicata</i>	20	11	3	7.8									10	10	4	7.	32	11	3	7.7
<i>L. vehemens</i>					1	7	7	7									1	7	7	7.
<i>L. submucida</i>					13	11	5	7.9					1	6	6	6.	14	11	5	6.9

This difference in time of pupation produces a longer larval period in such species than in the normal forms. Perusal of Table V shows that the maximum length of the period in two-year grubs was 497 days (*L. rubiginosa*) and the minimum period 393 days (*L. implicata*) with averages for the different species ranging from 404 to 454 days. In the case of *L. submucida* (all two-year grubs), 687 days was the maximum and 658 days the minimum period of development with an average of 668.6 days, giving differences between the averages ranging from 214 to 264 days. In other words, from seven to eight months longer are necessary for larval development in two-year species of this type.

The three-year grubs pass through two winters and pupate the second season. A maximum period of 823 days was required for development in the case of *L. crassissima*, and a minimum of 732 days with averages for the different species varying from 743 to 773 days. A difference of 339 days is noted between the minimum larval stages of the two and three-year grubs.

From the data at hand, there appears to be an alternation in the appearance of the two and three-year grubs; *e. g.*, among the generation of *L. crassissima* hatching in 1916, 85 grubs were reared. Of these, 71 were two-year grubs and 5 were three-year grubs. The generation hatching in 1917 produced only three-year grubs. This difference in the case of *L. rubiginosa* was not so marked. In the case of *L. rugosa*, only two-year grubs were raised from the 1916 brood and the 1917 brood produced only three-year grubs. Field collections made during the time of this study indicate a close correspondence to the broods A, B, and C, described by Davis (1918, p. 16) with 1917 as the time of appearance of brood A; 1918 brood B, and 1919 brood C. The alternation in the appearance of the two and three-year grubs in rearing cages, if true in nature, may be a contributing factor to the explanation of variations in size of the minor broods B and C, as for example, brood C is generally considered to be smaller than B. The 1916 brood C at Manhattan was on the whole much larger than the 1918 brood B, and may be due to the variation in time of appearance of the greater number of two and three-year grubs.

The Prepupæ

The prepupal stage begins near the close of larval development when the grub sheds its meconium and assumes a quiescent stage preparatory to pupation. This stage was found to vary from 3 to 30 days with averages for the different species varying from 6.9 to 9 days. The maximum, minimum and average prepupal periods for the seven species are shown in Table VI.

TABLE VII.—SUMMARY OF LENGTH OF LARVAL AND PREPUPAL STAGES COMBINED

Species	Maximum days		Minimum days		Average days	
	Two-year grubs		Two-year grubs		Two-year grubs	
	Three-year grubs		Three-year grubs		Three-year grubs	
<i>L. crassissima</i>	478	842	409	735	432.4	761.8
<i>L. rubiginosa</i>	508	809	405	745	461.1	777.4
<i>L. fulvipes</i>	433	782	394	778	415.5	780.3
<i>L. rugosa</i>	442	808	402	753	415.1	767.7
<i>L. implicata</i>	440	754	396	746	412.	750.7
<i>L. vehemens</i>		777		777		777.
<i>L. submucida</i>	698		663		675.5	

TABLE VIII.—LENGTH OF PUPAL STAGE

Species	1916 Generation			1917 Generation			1918 Generation			From collected grubs			Totals		
	No. of pupae			No. of pupae			No. of pupae			No. of pupae			No. of pupae		
	Max. days	Min. days	Aver. days	Max. days	Min. days	Aver. days	Max. days	Min. days	Aver. days	Max. days	Min. days	Aver. days	Max. days	Min. days	Aver. days
<i>L. crassissima</i>	56	16	37.4	22	25	25.8				100	49	19	178	58	30.5
<i>L. rubiginosa</i>	3	30	27.6	26	35	27.7				48	35	22	77	35	27.7
<i>L. rugosa</i>	5	50	32.2	16	26	29.7				53	36	25	74	50	30.3
<i>L. implicata</i>	20	28	24.4				2	23	18	14	28	21	36	28	22.2
<i>L. fulvipes</i>	14	33	28.4	2	24	23.5							16	33	25.9
<i>L. vehemens</i>				1	23	23.							1	23	23.
<i>L. submucida</i>				13	19	24.8				2	19	19.	15	29	21.9

A combination of the maximum, minimum, and average periods of the larval and prepupal stages representing the complete larval stage is shown in Table VII.

Among the two-year grubs, the combined maximum of the two stages was greatest in the case of *L. rubiginosa* with a period of 508 days, excepting *L. submucida* which required 698 days, and the minimum was 394 days. The minimum for *L. submucida* was 663 days with an average of 675.5 days. The averages of the other two-year species vary from 411.7 to 461.1 days.

The three-year grubs averaged from 761.8 to 780.3 days, with a maximum of 842 days and a minimum of 735 days in *L. crassissima*.

Ecdysis occurs twice before the pupal molt. As observed, the two molts previous to pupation in the two-year grubs occur, as a rule, during the same season that the egg is hatched, but rarely the second molt may be delayed until the following summer. Among the three-year grubs, one molt occurs during the season the egg is hatched, and the second occurs the following year. To illustrate: two-year grubs hatching in 1916 molted twice in 1916 as a general rule, but in a few instances the second molt was delayed until 1917. The three-year species hatching in 1917 molted once during the summer of 1917 and once in 1918. All of the grubs molt at pupation, and generally the pupa lies within the cast-off exuvium.

Pupæ

Besides the data obtained on a large number of reared individuals, the records on the length of the pupal stage are augmented by the addition of records of a somewhat larger number of specimens reared from grubs collected in nature. In general, no striking difference is to be noted between the periods of development of those reared and those collected, except in the case of specimens of *L. crassissima* reared from the 1916 brood in which the general average of 37.4 days for 56 pupæ was much higher than averages of other seasons or species.

Table VIII shows a comparison of the time of development in the seven species reared since 1916.

From the table, it can be noticed that the longest period of development occurred in the 1916 brood of *L. crassissima* where a single individual required 58 days to mature and in the same brood a minimum period of 16 days was required. The averages of the different species vary from 21.9 days in the case of *L. submucida* to 30.5 days in *L. crassissima*.

LENGTH OF LIFE CYCLE

L. crassissima.—Of 106 individuals reared through the larval stage, 71 were the so-called two-year grubs and 35 three-year forms. The

egg period was found to average 15.4 days. The two-year larval and prepupal stages averaged 432.4 days and in the three-year larvæ 761.8 days. The pupal stage of 106 individuals averaged 30.5 days. Combining the averages of the egg, complete larval, and pupal stages, an average period is obtained in this species of 478.3 days in the two-year forms, and an average of 807.7 days for the three-year individuals was required from egg to adult.

L. rubiginosa.—Forty-seven beetles of this species were reared from egg to adult. Four of them were two-year and 43 three-year grubs. The average egg period was 15.8 days. The complete larval stage averaged 432.4 days, and 761.8 days in the two and three-year beetles, respectively. The average pupal period of 77 pupæ was 27.7 days. Combining these figures, averages are obtained of 475.9 days for the two-year and 805.3 days for the three-year individuals.

L. futilis.—One three-year grub and 18 two-year grubs of this species were reared. The average egg period was 20.8 days, the combined larval stage averaged 415.5 days for the two-year, and 780.3 days for the three-year grubs, and the pupal average was 25.9 days. Averages of 462.2 days and 827 days are obtained for the different periods of growth by adding the above figures.

L. rugosa.—The egg stage of this species averaged 15.9 days, the two complete larval periods 415.1 and 767.7 days, and the pupal average 30.3 days. For five two-year beetles an average of 461.3 days and for 17 three-year adults an average of 813.9 days were required to complete development.

L. implicata.—The combined averages of this species show a two-year life cycle of 452.8 days and a three-year cycle of 791.8 days. The averages of the stages were computed as follows: egg 18.9 days, larva 411.7 and 750.7 days, and pupa 22.2 days.

L. vehemens.—One specimen reared from egg to adult required 845 days to mature.

L. submucida.—This species was reared in two years and grubs of the same brood are now passing the winter indicating also a three-year cycle. The egg stage averaged something over 14 days, the complete larval stage 675.5 days and the pupal 21.9, giving a two-year cycle of slightly over 711 days as the average of 13 individuals.

FOOD PLANTS

ADULT.—Regular nightly collections on certain designated food plants have been made throughout the flight seasons of the adult beetles during the past four seasons to determine, if possible, the preferred food of the adults. Table IX shows the different food plants upon which the various species were collected.

TABLE IX.—LIST OF FOOD PLANTS

<i>L. rugosa</i>	<i>L. foetida</i>	<i>L. rubiginosa</i>	<i>L. crassissima</i>	<i>L. implexata</i>	<i>L. setemena</i>	<i>L. submucida</i>
Willow	Hackberry	Hawthorn	Strawberry	Willow	Hawthorn	Bluestem grass
Locust	Hawthorn	Horse-chestnut	Elm	Apple	Horse-chestnut	
Hawthorn	Horse-chestnut	Locust	Oak	Silver poplar	Hackberry	
Hackberry	Linden	Hackberry	Catalpa	Cottonwood	Plum	
Elm	Elm	Oak	Apple	Locust	Ash	
Locust	Locust	Elm	Linden	Hackberry		
Box elder	Cherry	Coffee tree	Locust	Linden		
Cherry	Birch	Linden	Birch	Elm		
Norway maple	Norway maple	Birch	Hackberry	Hawthorn		
Coffee tree	Spiraea	Norway maple	Dock	Hawthorn		
Coffee tree	Coffee tree	Redbud	Hawthorn	Redbud		
Oak	Oak	Tulip tree	Box elder	Horse-chestnut		
Box elder	Box elder	Box elder	Horse-chestnut	Cherry		
Ash	Ash	Ash	Ash	Dock		
Norway maple	Plum	Apricot	Cottonwood	Privet		
Peach	Plum	Cherry	Cottonwood			
Peach	Rose	Cherry	Aconitum			
Pear	Blackberry	Peach	Aconitum canescens			
Silver poplar	Myrtle	Strawberry	Spiraea perfoliata			
Spiraea	Spiraea	Silene	Pepper grass			
Catalpa	Catalpa	Silver poplar	Silene			
Ash	Apple	Tamarack	Silene			
Spiraea	Privet	Privet	Ironweed			
Apple	Tamarack	Catalpa	Tamarack			
Chinese sand-plum	Chinese sand-plum	Hickory				
Tulip tree	Tulip tree					
Raspberry	Raspberry					
Peach	Peach					
Chinese sand-plum	Cottonwood					
Tamarack	Tamarack					
Siberian pea	Siberian pea					
Blue grass	Blue grass					
Dock	Dock					
Sunflower	Sunflower					
Pepper grass	Pepper grass					
Thistle	Thistle					
Raspberry	Raspberry					
Retunia	Retunia					

GRUB.—The grubs were reared in the life history cages throughout their period of growth on grains of wheat which were replaced weekly in the warmer months and entirely removed during the winter. The frequent change of food was necessary because of the development of fungi and as a result, until the grain germinated, no roots were available. The larger grubs would often consume the grain before germination.

The records in this study show the following food plant locations of the different species, based on the rearing to adults of grubs collected in the fields.

L. crassissima.—Three situations have yielded the largest number of this species. Thirty-one per cent of all reared have been taken in corn fields, 25 per cent in bluegrass sod, and 17 per cent in garden tracts where a variety of food was available. This species has also been reared from grubs collected in pastures, oat fields, strawberry beds, crab grass roots, a rhubarb bed, sunflower roots and bindweed roots.

L. futilis.—No grubs of this species have been reared from any of the collecting regions around Manhattan, despite the prevalence of the adults.

L. rubiginosa.—Twenty-nine per cent of the grubs of this species which matured were from corn, 21 per cent from bluegrass, and 17 per cent from garden tracts. Other places where the grubs were found consist of pastures, oat fields, strawberry beds, rhubarb beds, sunflower roots and potato patches.

L. rugosa.—The most striking food preference of any of the grubs was exhibited by this species where 41 per cent of all reared were taken from land devoted to gardening. Twenty per cent were taken in corn ground, and five per cent in bluegrass sod. Sorghum, wheat, and oat fields, strawberry and rhubarb beds, sunflower roots, potato patches, petunia roots and ironweed roots have yielded grubs of this species.

L. implicata.—This species has been found in corn, wheat and oat fields.

L. submucida.—This species has been found only at the roots of bluestem pasture grasses. The eggs from which this species were reared were found at the roots of ironweed which may be a preferred food plant of the grubs.

L. vehemens.—No data concerning the food preference of *L. vehemens* grubs are at hand.

NATURAL ENEMIES

Davis (1919) has recently published a comprehensive monograph of the natural enemies of this genus and little need be said here concerning them, except to enumerate the enemies encountered during these studies.

Enemies of the Grubs.—In the vicinity of Manhattan, three of the four species of *Tiphia* commonly parasitic on grubs have been found. The most important species is *T. punctata* Rob. The others, *T. transversa* Say and *T. inornata* occur rarely and *T. vulgaris* although recorded by Davis as occurring in Kansas has not been taken during this study. Among the banded digger-wasps, *Ellis 5-cincta* Fabr., and *E. interrupta* Say are rather common in this region. The Tachinid *Microphthalma disjuncta* Wied. (determined by Aldrich) has also been reared.

Hairworms of the family *Mermethidæ* have been frequently reared from grubs. Nematodes, probably *Diplogaster ærivoræ* Cobb, killed many grubs in rearing cages during the summer of 1919. They were also especially abundant in a collection of grubs, those of which survived proved to be *L. lanceolata*. Attempts were made without success to inoculate grubs from cultures of the nematodes. Mites, fungi and bacterial diseases have likewise proved obnoxious in rearing cages. Asilid larvæ have frequently been observed attacking grubs. So far, none of these have been reared to maturity. Toads, birds, and moles have been noted feeding on grubs.

Enemies of the Adults.—Two dipterous parasites, *Pyrgota valida* Harris, and *Cryptomeigenia theutis* Walk. are apparently the most active enemies of May beetles in this region. In this work, *C. theutis* has been reared from *L. futilis*, *L. implicata*, *L. rugosa*, *L. crassissima*, and *L. crenulata*; and *P. valida* from *L. crassissima*, *L. implicata*, *L. rugosa*, *L. rubiginosa*, and *L. bipartita*. Another enemy, *Eutrizæ exilis* Coq., was reared from *L. rubiginosa*. Miscellaneous enemies, such as mites, toads, cats, birds and spiders have been noted. Two carabid beetles, *Scarites substriatus* Hald., and *Pasimachus* probably *punctulatus* Hald., were observed attacking adults. In the case of the former, two adults were noted chasing and biting at the legs of June bugs under an electric light.

SUMMARY

The life histories of seven species of *Lachnosterna* found in the vicinity of Manhattan, Kansas, are herein considered. Five of these, *L. crassissima*, *L. rubiginosa*, *L. futilis*, *L. rugosa*, and *L. implicata*, in the order named are the most abundant in this locality. The other two, *L. vehemens* and *L. submucida* ranked eighth and sixteenth, respectively. Their flight periods begin about April 18 and may last as in the case of *L. submucida* until Aug. 17.

The egg stages were found to average from slightly over 14 days to 29.8 days. The larval period varied, two and three-year life cycles occurring for the five important species. Only a three-year cycle was observed in the case of *L. vehemens* and grubs now living in rearing

cages indicate a three-year cycle for *L. submucida* besides the two-year cycle discussed.

The prepupal stage averaged from 6.6 days to 9 days for the different species, and the mean pupal stage varied from 21.9 days to 30.5 days.

The averages of the two and three-year life cycles for the different species were 478.3 days and 807.7 days for *L. crassissima*, 475.9 days and 805.3 days for *L. rubiginosa*, 462 days and 827 days for *L. futilis*, 461.3 and 813.9 days for *L. rugosa*, 411.7 and 750.7 days for *L. implicata*, and 845 days for *L. vehemens*. *L. submucida* pupates in the spring instead of the fall, and thus a two-year cycle is produced which nearly equals the period of development of the three-year individuals. The average period for the species was slightly over 711 days.

A list of food plants of the adults, and situations apparently preferable to the grubs are given as is also a list of natural enemies found or reared during this study.

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PRESIDENT W. C. O'KANE: The next is "The Chinch Bug in Montana," by J. R. Parker.

THE CHINCH BUG IN MONTANA

By J. R. PARKER, *Bozeman, Montana*

What is believed to be the first record of the occurrence of the chinch bug (*Blissus leucopterus* Say) in Montana was obtained in 1911 when on May 23 a number of fourth instar chinch bugs were sent in from Glasgow, which is in the Missouri River Valley in the northeastern part of the state. Our observations concerning the chinch bug have been very interesting to us, not only because they concerned an insect