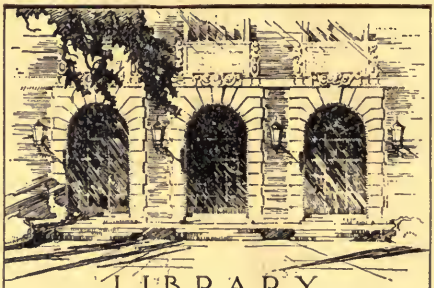

AGRICULTURE

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THE CORN BILL-BUGS IN ILLINOIS.

By S. A. FORBES, State Entomologist.

The corn "bill-bugs" are snout-beetles of various size and color, but averaging rather large, the majority of them dull black, with the surface much marked with small pits and narrow grooves. In form they are somewhat regularly oval, with thick bodies, rounded above and beneath, and with rather long "snouts" or "beaks" of medium strength, bent downward from the front of the head. They injure and often kill young corn in spring by thrusting the beak into the stem of the plant near its base and eating out the inner tissue beneath the point of puncture. Their presence in the field is very soon made manifest by the appearance of circular or oblong holes running in rows across the blade of the leaf, each row resulting from a single thrust of the beak when the leaves were closely rolled together in the young plant. The injury done varies from insignificance up to complete destruction of practically every plant in several acres of corn and for two or three successive plantings.

In the Sixteenth Report of this office, for the years 1886–88 (but published in 1890), is an article on these insects summarizing briefly the results of observations then the most recent and the

contents of previously published articles on the subject, but proposing no preventive or remedial measure except a single one for the prevention of injuries to corn by the clay-colored bill-bug, *Sphenophorus ochreus*, on newly drained and freshly broken swampy fields. This preventive measure consists merely in planting the ground broken up from the swamp grasses to some other crop than corn for the first year, flax being especially suggested.

For the ordinary injuries to corn on old ground I had at that time no definite measure to propose, but a fuller knowledge of the life histories and habits of the bill-bugs and some observations lately made in both recently subdued swamp lands and old upland fields have furnished a sufficient basis for a highly useful method of prevention of the worst of these injuries, and this fact has made desirable a new treatment of the subject as a whole.

Usual Conditions of Injury to Corn.

While there is in Illinois a little general and unclassifiable injury to corn by the bill-bugs, by far the greater part of it occurs under one of three conditions. If swamp lands are broken up from grass in spring and planted to corn the same year, and especially if the common reed or the club-rush or other thick-stemmed grasses with bulbous roots are common in the turf, the corn is extremely likely to be badly injured if not wholly destroyed by one of the swamp-loving species of this group. If such land is poorly cultivated, allowing these bulb-root grasses to grow up again, the injury may continue for at least another year. If an old timothy sod, either pure or mixed with some other grass, is plowed in spring and planted immediately to corn, this crop is likely to be severely injured by other and smaller species than those which attack the crop in swamps. I have known but one case of any considerable injury by these insects to a field of corn in Illinois except under one of the above conditions.

General Features of Life History.

The explanation of these facts is to be found in the life history of the various species commonest in our region, and in the food and feeding habits of the larvæ. The largest of our bill-bugs breed mainly and naturally in the bulbous roots of two or three large, grass-like swamp plants, sedges, rushes, and the like. The majority of the species of medium size live chiefly in fields of timothy, the larvæ feeding on the root bulbs of that grass; and one or two of the smallest species may feed either on timothy bulbs or on roots of blue-grass in meadows, pastures, and lawns.

So far as I know the bill-bugs pass the winter in the beetle stage, in the ground, under rubbish, or in other protected situations, and all whose life history has been at all closely observed in Illinois make their appearance in spring, chiefly in fields in which they have lived as larvæ and where they have fed on the roots of grasses the preceding year.

As the adult beetles feed in nature on the same plants as their larvæ there is little to tempt them to migrate from one field to another, and the facts lately collected in this state concerning the previous history of badly injured fields clearly indicate that the beetles pass the winter, as a rule, in the same fields in which they passed through their earlier stages, provided that these fields have been undisturbed.

General Preventive Measure.

From this it follows—and experience has amply confirmed the conclusion—that if a field of grass infested by corn bill-bugs be plowed in fall before the time of insect hibernation has begun it will be but lightly infested by them, if at all, the following year. Early fall or summer plowing of grass lands intended for corn is thus an effective measure of prevention against injury to that crop the following year.

Injury to corn by these beetles has now become so frequent and in some cases so severe, and the facts concerning the species are so little known, that a full detail of our present knowledge which bears on the subject in a practical way seems to be particularly desirable.

The Little Brown Bill-bug; the Blue-grass Bill-bug.

(*Sphenophorus parvulus* Gyll.)

Sphenophorus parvulus, one of the smallest of the bill-bugs, is essentially an upland species, breeding commonly in the ordinary cultivated grasses, especially in blue-grass and timothy. It is sometimes abundant in city lawns ; it is one of the species responsible for a considerable injury to timothy meadows; and it frequently infests corn following upon the meadow grasses, although, owing to its small size, its injuries to this crop are comparatively slight except while the plant is young.

This little bill-bug is better represented in our collections than any other species, and as we have repeatedly reared it from the larva to the imago in confinement we have a comparatively full knowledge of its life history. On this account it will be convenient

to treat it first in this discussion in order that it may be used as a standard of comparison for the species whose life histories are less fully known.

DISCUSSION OF LIFE HISTORY.

Occurrences of the Adult Beetle.—We have forty-one Illinios collections of the adult beetle of this species recorded, extending from March 18 to October, and representing thirteen years between 1882 and 1901. A serial account of these collections, in order of the calendar but disregarding the years, will enable us to trace the species fairly well through the season and to note the variations and transformations of its habits and its food.

Our earliest collection was made March 18, 1882, at Kappa, in Woodford county, where living beetles were found among dead leaves in woodlands, evidently still in hibernation. Next, April 7, 1897, it was collected at Urbana on blue-grass sod under boards lying where they had been placed as an attraction to cutworms seeking shelter by night. On this same date in 1882 it was obtained in a woodland lot south of Bloomington. April 14, 1897, it was collected under boards on grass at Normal, and April 16, 1887, at Edgewood, in Effingham county, in a badly damaged old timothy meadow. It was here hidden on the ground under dead vegetation, and was apparently still in its hibernation quarters. Occasional bulbs of this timothy had been hollowed out the year before in the manner characteristic of the work of *Sphenophorus* larvæ, but this injury was comparatively insignificant.

On April 17, 1894, it occurred at Urbana in a tuft of volunteer wheat, apparently having left its winter quarters at this time and resorted to the growing wheat for food. April 19, 1887, a single specimen was found under a fence rail lying on the grass, the head of it covered with mites (*Gamasidæ*) of the kind which frequently infest old beetles. This specimen was certainly not fresh, but must have hibernated as an adult. On the 24th and 25th of April, 1884, it was obtained in the course of miscellaneous entomological collections at Normal and Bloomington, in McLean county; and again on the 30th of the same month and year, in sweeping blue-grass at Normal with the insect net. In this last case, again, it had apparently begun to feed. May 4, 1892, it was brought in at Urbana from under boards, and May 6, 1887, was found at the same place on grass.

Our earliest date for an injury to corn is May 15, 1891, reported by S. P. Campbell, of Loami, Sangamon county, Ill. "These beetles," says Mr. Campbell, "insert the proboscis and each leg

into the stalk and absorb all the sap, leaving small holes in the plant, weakening it very much." This injury seemed to be general in Mr. Campbell's neighborhood, as he says that "considerable interest is taken in the matter," and that "an answer to my inquiries will gratify many."

May 19, 1887, it was found at Champaign doing a very considerable injury to corn on sod. A single specimen was taken just below the surface of the soil with the beak inserted in the stalk. At Jerseyville on the 20th of May, 1891, another specimen was taken from about an inch below the surface on a stalk of corn three or four inches high, which it had injured sufficiently to cause the leaves to wilt. At Champaign May 21 and 22, 1888, it was obtained from corn plants in a field which had lately been plowed from grass. As these beetles had often been said to suck the sap of the stalks they pierce, one of these specimens was dissected to determine the nature of its food, and this was found to consist of bits of the characteristic epidermis of grass-like plants and of parallel-veined vegetation containing spiral vessels—evidence, of course, that its injuries to corn are done by biting and swallowing the substance of the plant and not by sucking the sap. This specimen was a female, well filled with fully matured eggs.

On the 24th of May, 1897, at Union Grove, Whiteside county, it was found very abundant on corn below the surface; and at Urbana, May 24, 1889, a specimen was taken from a stem of grass which it had punctured through the sheath of the second leaf from the ground. May 25, 1901, at Knoxville, in Knox county, several specimens were taken from corn growing in sod. The beetle was doing a rather serious injury throughout the field. On the 26th of May, 1885, one was taken with its beak thrust into a stalk of young corn about three inches high, the puncture being made an inch above the ground. The beetle was so engrossed with its feeding that it remained attached after the corn was pulled up and until it was forcibly picked away. On the 27th of May, 1887, a specimen was found under a board on the grass, and on the same day of the month in 1901 another was taken from young corn at Oneida, in Knox county. On the 28th of May, 1901, specimens were brought in as injuring young corn at Buda, Bureau county, and also on the 31st of that month in 1887 at Rankin, in Vermilion county.

June 7, 1884, a beetle was taken near Du Quoin with its snout inserted in a stalk of wheat close to the ground. June, 8, 14, and 16, 1882, it occurred in miscellaneous collections in McLean county; and on the 28th of June, 1900, it was seen at Griggsville, Illinois, feeding on a corn plant eighteen inches high. It was at the sur-

face of the ground with its beak thrust far into the stalk. At the same place on the next day it was taken from timothy, many of the plants at this time being infested by the larvæ of this species. July 1 to 10, 1883, it was collected at Normal, Illinois, and on the 19th and 21st of July, 1891, it was obtained at Urbana. On the 30th of July, 1900, it appeared in a breeding-cage, reared from larvæ which had been taken in timothy bulbs at Griggsville June 26. The transformations of this lot of larvæ were not yet complete July 30, the earth containing on this date eight beetles, one pupa, and four larvæ—all alive. In August, 1892, it appeared in a breeding-cage of Professor Webster, in Ohio, bred from larvæ of that year. September 20, 1893, a specimen was found on the ground in a corn field near Urbana; and on the 24th of September, 1885, one was seen in a breeding-cage which had been stocked with larvæ from timothy bulbs at Normal July 13. The date of transformation is unknown as this breeding-cage had been neglected, no examination having been made since August 3.

September 25, 1882, a specimen was taken at Elmira, in Stark county, in the course of general collections of insects on corn. In October, 1882, it was found at Normal, the conditions not being recorded; and on the 5th of October, 1885, it was taken from a breeding-cage of timothy larvæ established July 13, but which had not been previously disturbed since August 11.

From these data it is plain that this bill-bug hibernates as a beetle in ordinary situations; that on coming out from its winter quarters it takes its first food from blue-grass, young wheat, and similar vegetation; that it transfers its attentions to corn with the first appearance of the plants, affecting that crop most generally and injuriously on timothy or blue-grass sod; that it may continue to feed on corn as late as the latter part of June, even when the plant is eighteen inches high, but that it distributes its attentions also over the grasses and grains; and that the beetles of the new generation—which begin to appear as early as August—emerge, at least in part, from their subterranean cells, and secrete themselves for hibernation as reported above.

Occurrences of Immature Stages.—Larvæ of *S. parvulus* have been noted in the course of our work at various dates from June 11 to October 22, the last a single instance of what was perhaps delayed pupation in a neglected breeding-cage. The intermediate dates are June 13, 16, 26, 27, and 28, July 4, 13, 21, and 30, and August 10. The larva taken at this last date was boring the crown of a timothy bulb on the grounds of the Experiment Station at Urbana. It was transferred to a breeding-cage, where it re-

mained without special attention until October 22, at which time it was still feeding on the timothy. All our specimens have been taken from the root bulbs of timothy, but the larva is reported by Webster ('93) to occur occasionally in wheat, and by Bruner ('92) sometimes to infest blue-grass lawns in sufficient numbers to kill large patches of sod.

Pupæ have occurred in the course of our work on July 24 and 30, but eggs have not been seen by us at all. Webster ('92) observed oviposition as late as July 1, and inferred that the eggs are mainly laid late in May and in June.

I find in these data no definite indication of more than a single brood, unless the facts reported concerning the larva brought in August 10 should be so interpreted. It seems to me more likely, however, that this was a belated member of the same brood as the other larvæ reared by us, and that its pupation was retarded by neglect. Our failure to find pupæ except in the middle of the season is negative evidence of the absence of a second brood. It is of course true, on the other hand, that in the absence of numerous continuous experiments in the breeding of separate individuals, no final statement can be made with respect to the number of generations.

Briefly stated, as now understood, the life history is substantially as follows: Hibernating in the imago, the beetle lays the eggs in early summer, beginning probably in May; larvæ hatch in June and doubtless for some weeks thereafter; pupation begins in July, and the final transformations to the adult, beginning late in that month, continue into August and possibly for some time thereafter.

INSTANCES OF INJURY TO CORN.

The most definite and serious case of the destruction of corn by this beetle which has come to my knowledge was reported to me by Mr. Dalbey, of Taylorville, late in June, 1902.

A visit to this place made June 30 by Mr. E. S. G. Titus showed that in a field of forty acres the injury was decidedly unequal but still very general. In one part of the field nearly every stalk on several acres had been injured, while in other parts the damage varied from twenty-five to fifty per cent. of the plants. This field had been in timothy for the four preceding years, and was broken up in April, 1902, and planted almost at once to corn.

Some twenty timothy fields in this neighborhood were carefully examined, and the root bulbs in all were more or less infested by the larvæ of this bill-bug. Fields two years in timothy after

corn or wheat showed ten to twenty per cent. of the plants infested, while in those three and four years old from fifty to seventy-five per cent. were more or less injured, and contained larvæ varying in size from medium to apparently full grown.

A second field of corn on timothy sod, plowed early last fall and planted at the same time as the one first mentioned, contained not a trace of bill-bug injury, although dead timothy bulbs still in the ground showed distinctly that they had been hollowed out by bill-bug larvæ. The contrast between these two fields of corn growing on old timothy sod infested with the larvæ of *Sphenophorus* the previous year, one of the fields having been plowed in April and the other in early fall, was particularly significant, and amounted in fact, to a demonstration of the preventive effect of the fall plowing of such lands.

Sphenophorus placidus Say.

This species has been several times taken on corn in Illinois, but the most notable instance of its injuries to that crop was given me by Mr. Joseph Carter, of Rankin, Vermilion county. In a letter dated May 1, 1887, he incloses a specimen of this beetle with the statement that he found it below the surface of the ground eating into a corn plant, and that where the injured leaf appears above ground it is crossed by parallel rows of holes. He finds the beetles, he says, on every plant on an acre or two of corn, and in a letter of June 5 he adds that the beetle is destroying some five or ten acres in an eighty-acre field. The corn in this field was planted on fall plowing after oats. The ground was dry and sandy and tiled every hundred feet. Subsequently I learned that this eighty lay adjacent to an old and run-down meadow of timothy with a little redtop intermixed, and that the injured patch of corn was near this meadow. It is to be inferred from this statement that the bill-bugs had scattered out from this field of timothy to the adjacent corn in search of food.

The life history of this species is not definitely known, its immature stages never having been distinguished so far as my information goes. Our earliest collection of the beetles was made April 8, 1892, from overflowed land on a creek bottom near Urbana—evidently a hibernating specimen. The next date of its occurrence is May 21, 1888, in lately plowed sod near Champaign ; and the next, May 31, 1887, as given above. June 1, 1895, it was found injuring corn in Leroy, in McLean county ; June 5, 1887, it was still at work in the field at Rankin ; June 14, 1882, it was taken at Normal in miscellaneous collections ; June 19, at Spring Valley, from young

corn ; June 30, 1888, from driftwood in a small creek near Urbana after a flooding storm ; and July 7 of the same year, from corn at Bement, Ill., where it was doing considerable injury. June 19, 1902, it came to us from northern Illinois near Savanna ; June 20, 1888, from corn fields in Whiteside county ; and August 5, 1887, from Fourth Lake, in northern Illinois, where it was taken from bulrushes along shore. So far as our data go they indicate a life history similar to that of the better-known species ; hibernation in the imago ; and an early attack on corn, with probably a midsummer breeding period of a single generation.

The Clay-colored Bill-bug

(*Sphenophorus ochreus* Lec.)

Injury to Corn in Ford County, 1888.—My first knowledge of the habits and life history of this species began with a letter written June 21, 1888, by Mr. J. A. Montelius, of Piper City, Ford county, to Professor G. E. Morrow, Dean of the College of Agriculture at the University of Illinois. In this letter, which was accompanied by four specimens of *S. ochreus*, Mr. Montelius reported that these beetles were destroying the corn on new ground in his locality by eating into the stalk and boring to the heart of it with the effect to kill the plant. They were present in great numbers, and had destroyed a large part of the crop—some of it several plantings in succession on the same land.

Visiting these fields on the 23d of June, 1888, I found them in a swamp area which had been recently drained by a large ditch. Some of these fields had been broken up and cropped the preceding year, but most of them were planted for the first time in 1888. On the farm of Mr. Montelius, six miles north of Piper City, a field of twenty-five acres had been once destroyed, and the second planting was so badly damaged that the crop had been abandoned and the ground was being sown to millet at the time.

The injury consisted of long slit-like punctures of the stalk, beneath which the interior leaves and the stalk itself—that is to say, all the more succulent and softer parts of the plant—were irregularly but often completely eaten out. In the worst cases the plant was killed ; or, if the injury was less severe, the leaves were finally marked with more or less regular oblong holes extending lengthwise of the blade but forming rows across it.

The injury thus done varied in position from a little below the surface of the ground to the middle or upper two thirds of the larger leaves. The beetles were often seen at work on young

stalks, head downward, with the beak inserted its full length. They were always on the lower part of the plant from an inch above the ground to a little below it, and as many as three of them were sometimes seen on a single stalk. They were not easily alarmed, but the plant might even be cut away, if care were used, without disturbing them. Although they clung closely to the plant, they could readily be picked off by the fingers; and when thus disturbed they would feign death for a little time.

The damage in this field was heaviest near the drainage ditch, where nearly every hill was badly eaten. This ground had been broken from swamp sod that spring, and the injury was slight except where two coarse grass-like plants were abundant, the common reed, *Phragmites communis*, and the club-rush, *Scirpus fluviatilis*. An examination of these plants showed an injury to both which was precisely similar to that done to corn, but affected the wild grasses much less seriously than the cultivated plant. The injury to the reed had apparently ceased, but the club-rush in unbroken sod adjacent was still infested, the beetles being there found at the upper part of the plant piercing the terminal row of leaves and eating out the interior as in corn. None were on these wild plants growing in the plowed fields, the beetles apparently preferring the corn as food.

In a field separated from the foregoing by two or three rods of sod, and bearing now its second crop of corn, no appreciable damage had been done by these beetles, and here the reeds and rushes were wanting, having been completely killed by the second year of cultivation.

The sexes were pairing at this time, but no eggs were discovered by a careful search of punctures and excavations in all kinds of injured plants.

On another farm, occupied by Mr. Dennis, a field of fifteen acres of corn was even more seriously injured This also had been broken up the same spring, and the reeds and rushes were very abundant in the lower ground, growing up through the sod. In such situations the corn had been completely destroyed, although replanted several times.

In still another field, two miles away, belonging to Mr. Sullivan, which had been broken from sod that spring, no damage by bill-bugs had been done, but in this field, which had been used as a pasture for several years, neither reeds nor rushes had grown.

July 27, 1888, these same farms were visited by an assistant of the office, Mr. John Marten, who found the bill-bugs still pres-

ent in small numbers and injury still in progress, although evidences of fresh work were few.

In a field of a hundred and fourteen acres, belonging to Mr. Dennis, eighty acres had been sown to millet after the destruction of the corn, a pulverizer being used to prepare the ground. Here the millet had been considerably injured — the lower part of the stem punctured by the beetle and cut off with the effect to kill the plant. In parts of the field the damage thus done amounted to eighty per cent. of the yield, although the plants had rallied to some extent by throwing out new shoots from the root. Even the fox-tail grass (*Setaria*) had been similarly attacked to a small extent, and with the same result.

On the next day, July 28, a visit was made to a field of swamp land which was then being broken up for the first time. Many of the bulbs of the rushes were cut in two by the plow, and more than half of these had been excavated by the larvæ of the bill-bugs, two of which were brought to the office alive. A considerable number of adult *S. ochreus* were crawling in the furrows and over the fresh sod, and one dead bulb was found with the remains of an adult in the burrow.

Experiment with Bill-bugs on Corn.—July 3 a lot of these beetles from Piper City, sent from there June 29, were placed on hills of corn growing under large frames covered with wire gauze, the bases of which were sunk four inches in the earth. By July 5 several of these beetles had begun to feed, and on the 14th the corn was already badly eaten. On the 17th a stalk of this damaged corn was removed and critically examined, but no eggs were found. All the beetles were still alive except one male. The injuries to the corn were at this time numerous and severe, but the plants seemed rapidly growing away from them, and the beetles had moved from the base of the stalk, which had doubtless become too hard for their jaws, to the terminal leaves and other growing structures, including the young ears an inch to an inch and a half in length. The young husks had been perforated and the ears were excavated lengthwise, practically destroying them. Tassels and terminal leaves showed great recent injury, and the sheaths of leaves near the deeper punctures and excavations of the stem had often been gnawed into but not far enough to go through the sheath, the beetles having apparently found the tissues here too tough. On the 24th additional search was made for eggs on several stalks which were taken out of the earth for the purpose, but without success ; neither eggs nor trace of breeding operations could be found in or about any part of the plant. The usual punc-

tures and slits were abundant about the base of the stem, with some small discolored excavations also, but nothing else.

September 10, the remaining contents of this cage were finally overhauled, but neither live beetles, eggs, nor larvæ were found The stalks, roots, leaves, ears, and tassels had been much injured, the tassel and the upper part of the stalk perhaps most seriously so.

The method of feeding was carefully observed by both Mr. Marten and myself. Placing itself head downward, with its stout legs embracing and firmly grasping the stalk, the beetle applies the tip of its beak straight against the surface, cutting the outer tissue with the mandibles, the action of which is distinctly audible. Gradually, with an occasional twisting motion of the head, it sinks two thirds or more of its snout into the stalk, and then, slightly rolling its head from side to side with clock-like regularity, it uses its beak as a lever to split the stalk and pry the edges of the slit apart. It pauses from time to time to eat out the soft tissues within, and by moving forward and backward and twisting. to the right and left it often hollows out an interior cavity much larger than the surface injury would indicate. Then pulling the head strongly backward with the compressed beak inserted, the stalk is split upward as a boy would split a stick with a knife. In this way a slit an inch long may be made in the stalk of corn, beneath which all the softer parts have been eaten out.

Injuries in 1889:—The following year, 1889, similar and equally serious injuries were done by this beetle in the Piper City district, according to a letter received from Mr. Montelius under date of May 21. At that time forty acres of corn belonging to Mr. Towers had already been destroyed, while on the place occupied by Mr. Dennis the injury done was apparently fully as great as that of the preceding year.

A letter recently received from Mr. Montelius, dated August 8, 1902, reports that injuries by the swamp-land bill-bugs ceased with the second year, and that nothing has been seen of them during the thirteen years since. The temporary nature of their attack on newly subjugated swamp-lands is thus definitely proven.

Observations on Life History.—Other occupations made it impossible to return to this place, but late in the season the life history of the species was taken up at Urbana by observations in a swampy field where the club-rush was common.

July 2, nine specimens, two of which were copulating, were found in a large sedge, *Cyperus strigosus*, at the margins of a pond near Urbana. July 16, two eggs and larvæ which proved later to be those of this species were discovered by Mr. Marten behind the leaf

sheaths and in stems of *S. fluviatilis*. Both were placed from two to four inches above the bulb, the eggs in the softer part of the stalk just inside the hard woody outer layer. One larva brought in on this day had already burrowed irregularly downward for about three inches from the place of its hatching. The following day two more eggs and another larva were found similarly placed. On the 22d of July one of these eggs had hatched and the larva from it had burrowed downward within the stem, and on the 23d two more eggs had hatched. Unfortunately no further progress was made with these specimens, both plant and larvæ having died by August 20.

July 22, three more larvæ of this bill-bug were found at Urbana in the club-rush, and August 1 several more of various sizes, from those recently hatched to one four tenths of an inch in length. One egg was also found on this same day. Two of the larvæ were in one stem. August 14, three more larvæ were brought in, practically full grown. One had burrowed completely through a small bulb of the club-rush, the channel through the bulb being continuous with that in the stalk. August 20, three other full-grown larvæ were obtained from the same swampy field, and all had burrowed downward from the place of deposit of the egg to the bulb, a distance of about three inches, and had passed out of this into a bulb of last year's growth, in which they were imbedded at the time. The plant first attacked was killed in every case. September 10 one of these bulbs was opened and a pupa found within, and on the 16th of September the pupal cavity contained an adult *S. ochreus*. On the 17th of September another beetle of this species was taken from a second of these bulbs. Three specimens were brought in August 28 in essentially the same condition as those collected August 20; that is, in each case, young larvæ hatching from the egg had burrowed downward through three or four inches of the stem and to the young bulb at its base, and had passed from this into that of last year's growth, traversing a quarter of an inch or so of earth to reach the older bulb.

Injuries in Whiteside, Adams, and Schuyler Counties.—A case similar to the foregoing, also from a district recently drained, was reported to me June 25, 1895, by M. D. John, of the "Sterling Evening Gazette," in Whiteside county. According to his statement whole fields of corn were almost completely destroyed in the vicinity of Deer Grove, sixteen miles south of Sterling, by the clay-colored bill-bug (*Sphenophorus ochreus*) together with a black species of similar size, in all probability *S. pertinax*. These bill-bugs, he says, seem to be at home in the water as well as on

land. Two or three thousand acres of corn along Green River were reported to have been destroyed at this time, and most of the farmers were replanting so-called ninety-day corn, hoping still to secure a crop.

The next report of serious injury to corn by this species which has reached me came by letter dated May 24, 1901, from H. D. Hill, of Lima, Adams county, Ill., who sent a specimen of this beetle with the statement that it was destroying the young corn on his farm on bottom-lands which were originally overflowed, but which had been reclaimed and cultivated for about twelve years.

Another letter of June 25, 1902, from Rushville, Ill., written by H. E. McLaren, reports these beetles as present in the bottom-lands of a drainage district about the 24th of May, or as soon as the corn was large enough to afford them food. They made their appearance, he says, in new ground the previous year, but were still more numerous and destructive in 1902.

Extraordinary Injury to Corn in Greene County.—Under date of May 28, 1902, I received the following letter from John C. Bridgewater, of Bridgewater, Greene county, Ill.:

"I am sending you to-day about three hundred bugs which we call elephant bugs. We give them this name because of their color, the enormous size as compared with that of other pests in this section, and the trunk or bill. Their destructiveness is unparalleled, as you may judge for yourself when I say that farmers are paying five cents a dozen for them and the boys are bringing them in by the thousand. More than ten thousand have been captured and put to death in less than two days on the Hartwell ranch alone, the foreman paying five cents a dozen for every one of them On Saturday last he was looking over the ranch and thought that he had one eighty-acre field of corn secure, but on the Tuesday following there was not enough left to plow.

"The bugs will lock their legs around a stalk of corn and run their trunk right through it as if it were a spike driven through a pine board.

"It is costing us hundreds of dollars as tribute to bug-hunting expeditions, plowing our land over and replanting where a week ago we had as good a stand as heart could wish."

Mr. Bridgewater also gives an amusing account of contests between his "elephant bugs" and young chickens, and on this point his statements are corroborated by a letter from another correspondent received in June, 1900, and accompanied by a specimen. In both cases chickens had undertaken to devour these beetles, but the latter had saved themselves by clasping their legs around the

beak of the bird, and holding on so vigorously as to make it impossible for the chicken to open its mouth.

The box of beetles accompanying Mr. Bridgewater's letter were mainly *S. ochreus*, although a few *S. pertinax* were among the lot.*

In consequence of this letter I sent Mr. E. S. G. Titus to Bridgewater early in June to study the outbreak there, and again early in July. He spent the 11th and 12th of June on the Hartwell ranch, which is situated on the Illinois River at the mouth of Hurricane Creek, seven miles west of Roodhouse, in Greene county. This ranch contains five thousand acres, mostly bottom-lands redeemed for cultivation by changing the course of Hurricane Creek, building eleven miles of levee, and excavating drainage ditches. One of these ditches, twenty-five feet wide and six feet deep, drains a large bottom-land lake, the bed of which forms a considerable part of the property. About 4,500 acres of this tract had been broken up, much of it in the spring of 1902, and 2,500 acres were planted to corn this year. The 500 acres not under cultivation comprise swamp-lands still unbroken, bluff-lands mainly covered with trees, and the eleven miles of ditch which drains the ranch.

Several hundred acres of the corn on this place were more or less infested, and in some of the fields the first planting was completely ruined and the second also badly eaten. Plants attacked by *S. ochreus* were usually killed, the effect of the work of *pertinax*, a smaller species, being rather to dwarf and distort the growth than to kill the plant outright.

On one ten-acre piece of corn which the manager wished especially to save, the beetles had been picked off by boys at a cost of from three to five cents a dozen, and 10,400 were brought in. In badly infested fields from one to five beetles were found on every stalk of corn. Careful search of several hundred plants failed to discover any eggs in the stalks or about the roots.

An observation of special interest was made at this place with respect to the effect of fall plowing. Owing to a temporary lack of employment for the teams on this plantation a piece of sod had been broken up the preceding fall, the remainder of the tract lying unbroken until the following spring. On this fall-plowed land, which was merely a part of an undivided field, the only injured corn was in the first two or three rows adjoining the land plowed in spring, and the harm done here was evidently due to bill-bugs which had come in from the adjacent ground.

*See also the discussion of *S. pertinax* in the present article.

The commonest plant on the unplowed lands was the club-rush (*Scirpus*), and this often grows in considerable quantity on cultivated land that has been broken only a year. Eggs and young larvæ, evidently those of *Sphenophorus ochreus*, were found in the bulbs of these rushes June 12, and the females were still heavy with fully developed eggs.

July 3, when this place was visited again, larvæ were still common in the bulbs, owing no doubt to continued hatching, and the average size was little if any greater than at the previous visit. Beetles also were still abundant, and as much of the corn land was now overflowed,—owing to extraordinary high water in the Illinois River,—most of the bill-bugs had been driven to the higher and drier ground. Many of them, however, were still on the rushes and on corn under water, apparently little disturbed by their submersion.

Such of the second planting of corn as had survived the bill-bug injury was in bad condition—dwarfed and much deformed in growth. One field which had been planted the third time was already practically destroyed, and the bill-bugs were still present on the corn. The crop on the field plowed in fall was in excellent condition, but considerable damage had been done in some fields which had been broken up from sod in the spring of 1901 and plowed for corn again this spring. Their condition was evidently due to insufficient cultivation last year, many rushes being left to grow with the crop. This of course kept the bill-bugs in the fields and enabled them to breed there last year.

From the general condition of this region it is to be inferred that fall plowing for two successive years with clean cultivation of the crop will afford substantially complete protection against this bill-bug injury, except as the beetles from adjacent unbroken ground may occasionally enter a corn field in search of food.

Summary of the Life History.—Our earliest collections of this beetle were made on the 21st of May, at which time the sexes were seen *in copulo*. It has been taken by us in swamps and corn fields at many later dates up to July 27, although by the 17th of that month it had practically disappeared from the corn.

Eggs were found by us June 11, but as young larvæ were present at the same time oviposition must have begun as early as the first of June. Indeed, Webster has found the eggs in Indiana late in May.* Other eggs have occurred in the course of our work, either in the field or in breeding experiments, July 4, 16, 17, 22, 23,

* Webster, F. M., 1890.

and 30, and also August 1, thus covering an interval of about two months.

The growth of the larvæ seems to be rather slow, none of those observed by us having reached full size before the 20th of July. Other examples of the larval stage were found at intervals to August 28; and in Webster's experiments, to August 30.*

Pupæ were taken from our breeding-cages September 10; and in Webster's observations, from August 21 to 30. Imagos from our September pupæ were observed September 16 and 17, and as our experimental work was done in the open air, the plants being protected only by wire screens, no acceleration of the transformations could have taken place. Webster ('90) found adults, together with larvæ and pupæ, from August 21 to 30. Our collections contain no specimens of this species taken later in the year, but as no search of suitable situations has been made in localities where this bill-bug is abundant this negative evidence has no special value. It seems probable that the species is single-brooded, with a long breeding period extending through about four months, and that hibernation occurs mainly, if not altogether, in the imago stage. There is, however, nothing definite to show that the beetles emerge from their underground quarters before the spring of the following year. As other species of bill-bugs more abundant in ordinary situations but having apparently a similar life history do occur abroad in fall, it is likely that *Sphenophorus ochreus* will be found to have a similar habit.

Descriptive Notes.—A description of what was doubtless the full-grown larva of *Sphenophorus ochreus* was published by me in the Sixteenth Report of this office, page 56, but some descriptive notes made from a living half-grown specimen July 15 may assist in identification.

Length, extended in crawling, 6 mm. Head light mahogany-color, with mouth parts dark brown, almost black. First segment behind the head tinged with brown, deepest in the middle. Body thickest just back of the middle, and sloping somewhat abruptly to the tip of the abdomen, which is provided with a circlet of weak brownish bristles; the two preceding segments with similar but weaker bristles. Lateral folds, extending from the head to the tip of the abdomen, are quite distinct. The color of the skin is dirty white, and sufficiently translucent to show the brownish internal organs.

The egg of *Sphenophorus ochreus* is 3 mm. long and about half

* Webster, F. M., 1890.

as wide, swelling somewhat after it is laid. It is at first decidedly curved, but later assumes an oval form. Color opaque white, with a faint creamy tinge. Shell transparent, shining, smooth.

SPHENOPHORUS PERTINAX OLIV.

This beetle is evidently a lowland or swamp species in great part, often breeding, like the clay-colored bill-bug, in the stems and bulbous roots of coarse semiaquatic vegetation. Dr. Kellicott reared it repeatedly to the imago several years ago in July and August from larvæ and pupæ found in New York in the common cat-tail flag, *Typha latifolia*. "The larva cuts an oblique burrow near the base of the plant, and pupates in the same.*" Dr. John Hamilton has found it common in the salt marshes of New Jersey, and believes that it breeds in grasses daily wet by the tide.

In Illinois it has been most frequently collected in swampy regions or along the borders of lakes, and in corn fields has been most abundant on lands recently drained, associated there with the clay-colored bill-bug. Our Illinois collections were all made in the central and northern parts of the state, and range from April to August of several years.

The injury to corn is similar to that of the clay-colored species, but less severe owing to the smaller size of the beetle. The plant injured by *pertinax* is less frequently killed outright, but is commonly dwarfed, often becomes badly twisted as it grows, and rarely forms an ear. The beetle attacks the corn plant at the crown below the surface, and is usually nearly or quite buried in the earth. At Bridgewater. Ill., in 1902 it was about as common on corn as the larger species, but was frequently overlooked because partially concealed by its mode of feeding. In swamps it has been found on young rushes just beneath the surface, making holes in the ground like minute gopher holes to get at its food.

Parrott ('99) reports it as destructive to corn in Nebraska, the injured stalks failing to produce ears. The beetles were still at work on the corn plant July 27, and when not eating were to be found in underground burrows. In this article, published in the "Kansas Farmer" for May 11, 1899, he says that the eggs of *pertinax* were deposited June 24 to 26 in burrows about an inch under ground and touching the roots of the corn, and that these eggs were hatching July 18. His experiments satisfied him that it thrives equally well in a blue-grass sod. He assumes that it hibernates in the pupa, the evidence on that point being the receipt of

* Letter, December 3, 1888.

specimens early in May, 1898, some of which had the peculiar pinkish color characteristic of beetles just from the pupa.*

The life history of this species seems thus not to differ materially from those of the others treated in this paper, although our data are too scanty for satisfactory generalization. Parrott's statement with regard to the breeding of the species in corn, based as it seems to be on experimental data, is of special interest, since we have no other observation of a northern species laying its eggs on the corn plant. It will be noticed that in this case the beetles were under confinement, and that no positive inference can be made as to their choice of plants for breeding in the field.

Sphenophorus cariosus Oliv.

This bill-bug, though not common in our collections, has been taken by us in central and southern Illinois from Pekin to Cairo. It is primarily a southern species, abundant in the Gulf States and injurious to corn in South Carolina. Through the kindness of Mr. B. F. Johnson, of Champaign, I received in June, 1888, fifty living specimens of it from that state, with the information that it was there very destructive to young corn. Some of these beetles laid eggs in captivity June 4.

In Illinois it has been taken but once on corn so far as I am aware. May 1, 1891, Mr. John Marten, an assistant in my office, found a specimen of it in Urbana at the base of a very young plant, where it had gnawed a cavity in the stalk just below the surface of the ground, and kept over night in a breeding-cage it left the stalk and made its way into the seed kernel.

The imago has been found by us at various dates from April 23 to September 16. The earliest specimens, collected at Champaign April 23, 1892, were under boards and driftwood on wet ground. May 1, 1891, a single beetle was taken on very young corn at Urbana; June 30, 1888, it was obtained from a deposit of driftwood beside a creek; and July 9 of the same year, from a similar situation after a flooding rain. July 26, 1892, it was brought in from Savanna, in northern Illinois, among collections made in the Mississippi bottom; and August 16, 1891, it was found on the bank of the Ohio River near Metropolis. On the 23d of August, 1899, a number of these beetles, recently transformed, were found at Urbana, still in their underground pupal cells at the base of stalks of *Cyperus strigosus*; and, finally, September 16, 1879, it was

*Letter of July 29, 1902.

obtained in the course of general entomological collecting from the bottoms of the Ohio River opposite Cairo, Ill. It seems thus to be essentially a lowland species, and probably breeds, like *S. ochreus*, in coarse grasses and similar vegetation of swamps and bottomlands.

My knowledge of the life history of the species is based mainly on Mr. Marten's observations in 1889. On the 25th of July, 1889, four larvæ which proved to be those of this species were found in the stems of a large sedge (*Cyperus strigosus*) growing in a corn field near Champaign. The larvæ were just at the crown of the bulb, which they had almost completely excavated, the largest of them having, in fact, entirely cut off the stem, and lying in a cavity formed by the bases of the leaf sheaths.

On the 29th of July others were found in the same situation apparently very nearly full grown, together with some quite young which were just commencing to burrow the stalks. No evidence could be found that they passed from one stalk to another, but each apparently got its growth within a single plant. August 8 nearly all the larvæ in this field were about full grown, but no pupæ were detected; and eight days later all had apparently gained their growth, but again no pupæ were found. In several plants empty excavations were seen, and August 20 pupæ were detected at the base of the stem and in the small root bulb. They were too large for the larval cavity, which had been opened out by eating away one side, the pupal cell being completed by gnawed chips and excrement closely packed. On August 23d larvæ of various ages, together with pupæ and adults of this beetle still in their pupal cells, were brought in by Mr. Marten from stalks of *C strigosus* in this same field. Sometimes the pupal cells were found among the fibrous roots of the plant quite outside the cavity formed by the larva in the stem, the walls of the cell being then formed of compact earth often intermingled with chips from the stem. On the 26th of August larvæ of all ages were obtained, some of them scarcely twice as large as when first hatched, and others fully prepared for pupation. Pupæ and adults were likewise found, the latter still in their underground cells which, in some cases, were still contained within the stem of the sedge, the fragments of the plant having been tightly packed together to make a compact case, so smooth within as to suggest that it had been lined by a larval secretion.

September 6, half-grown and full-sized larvæ, together with pupæ in various stages of advancement, were still to be found, and also eggs, apparently of this beetle, placed in the lower part of the outer sheath or inserted into that and the second leaf also.

Small round holes were seen in the ground from which adults had apparently emerged.

From these observations it is to be inferred that the breeding period of this species is very long, the eggs being laid at intervals through many weeks. The largest larva noticed July 25 could not have hatched from the egg later than the middle of that month, and the very young of August 26 could have been at most but a few days old. Pupation and the formation of the adult by August 23 and the subsequent disappearance of imagos from the ground, together with their occurrence in the field as late as September 16, warrant us in assuming the hibernation of the imago, although it is of course possible that some observed as larvæ may have hibernated in the pupa stage. There is no evidence in these data for more than a single generation of this species in our latitude.

Description of Larva.—Head pale yellowish brown, darkened toward mouth parts, mandibles black, other mouth parts brown, body white except cervical shield, which is slightly embrowned, paler than head; spiracles pale brown, first very large, remaining eight small but gradually larger from before backward, the last, however, about twice as wide as preceding; sutural grooves very distinct below, where they are cut at the sides by about five or six longitudinal grooves, becoming fainter downwards. Several long soft hairs on head and inferior thoracic region, and some shorter, stouter ones at tip of abdomen; elsewhere, body nearly or quite naked. Form of body short and thick, gradually swollen posteriorly, segments 7–9 being thickest; anal segment with quadrate excavation above, between the last two spiracles. Tubercles beneath thorax broad, low, shining, not especially hairy.

Clypeus membranous; labrum obtusely angled in front, with two spines on the surface at about middle of antero-posterior diameter, about equally distant from each other and from the margins; two similar spines at front angles, and two other marginal ones a short distance within. Two of the inferior spines near the middle of the margin are furcate. Labium largely membranous, palpi two-jointed, basal segment a little longer than wide, terminal one slightly oval, about half as wide as the other. Ligula membranous, densely hairy in front, basal part of maxillæ bisinuate without, bearing two long hairs, one near palpus, the other at basal third; palpus two-jointed, basal joint broader than long, second small, ovate, half as wide as preceding; lobe of maxillæ semi-oval, with about ten dagger-like and furcate spines on terminal edge. Man-

dibles triangular, almost equilateral, acute and slightly hooked at tip, biting edge with a single triangular median tooth.

Length of larva, 15 mm. ; greatest depth, 5 mm. ; greatest width, 5 mm.

Additional Species.

Sphenophorus scoparius Horn, found by us but rarely on corn and grass, has occurred in our collections from June 16 to July 7, and from northern to central Illinois.

Sphenophorus sculptilis Uhler, described as *zeæ* in 1867 because of its injuries to corn, has been surprisingly rare in our collections, and has never been taken by us from the corn plant in Illinois. June 7, 1884, specimens were found on blades and heads of timothy at Du Quoin, in southern Illinois, and July 9, 1888, a single one was taken in a flood collection on the bank of a small creek at Urbana. It has appeared in our general collections from Chicago to Villa Ridge in extreme southern Illinois, and on various dates from June 7 to November 26. It is, however, doubtless locally destructive to corn in this state since it has been reported by entomologists as injurious to that crop in Massachusetts, New York, New Jersey, Delaware, Maryland, North Carolina, South Carolina, Florida, Alabama, Pennsylvania, Indiana, Ohio, Missouri, Arkansas, Iowa, and Kansas.

In most cases where definite statements have been made concerning its injuries the fact has been noted that the injured crop was growing on timothy sod.

The larvæ and pupæ have been seen by Hopkins, (W. Va.), who calls this species the timothy bill-bug, and thinks that it is one of the prime causes of the early failure of meadows. He finds the larva from June to September, and pupæ and adults from August to October. In these points of its life history it apparently agrees very well with *Sphenophorus parvulus*.

Sphenophorus robustus Horn occurs in our collections but six times, and in but two of these with a date, one in June and the other July 1. Although an abundant and destructive species in the Southern States and ranging with us to extreme northern Illinois, it is apparently too rare in this state to have any economic significance.

RECENT BIBLIOGRAPHY.

1889.

WEBSTER, F. M.—Life History of one of the Bill-bugs, *Sphenophorus ochreus* Lec. (Insect Life, Nov. 1889, Vol. 2, p, 132.)

Quotes statement of Forbes in 1888 (see '90) concerning injuries to young corn on newly drained swamp lands. Believes serious injury in several situations has been done for several years in Indiana, hundreds of acres being thus destroyed. Beetles hibernate as adults, coming forth in spring, feeding on inner parts of stems of reeds, rushes, and young corn. Eggs laid in or about roots of *Scirpus* late in May and early in June. Larvæ live within the bulbous roots, and beetles appear in August and September. Has reared adults from the egg in *Scirpus* bulbs kept in dry earth from the middle of June until the 25th of August. Infers that larvæ cannot be starved by midsummer plowing.

1890.

FORBES, S. A.—The Corn Bill-bugs (*Sphenophorus* sp.). (16th Rep. State Ent. Ill., for the Years 1887 and 1888, pp. 58–74.)

Contains an analysis of literature concerning each of the species of the genus, with description of the genus *Sphenophorus* and an analytical key to Illinois species; the original description of *S. minimus*; a description of the larvæ of *ochreus* and *parvulus*; and an account of the life histories of species so far as known, of their injuries to corn and other vegetation, of their natural enemies, and of preventive and remedial measures. It is followed by an economic bibliography of sixty-one titles, ranging from 1808 to 1888. The paper is illustrated by twenty heliotype figures of imagos on three plates.

WEBSTER, F. M.—Notes upon some Insects Affecting Corn. (Insect Life, Nov. 1890, Vol. 3, p. 159.)

Reports finding of eggs of *Sphenophorus ochreus* in stems of *Scirpus*, which eggs resemble those obtained from ovaries of females. Concludes that eggs may be deposited in stems of the plant and not always in the root.

1891.

SMITH, J. B.—Notes of the Year in New Jersey. (Insect Life, Oct. 1891, Vol. 4, p. 44.)

Reports appearance of corn bill-bug, *Sphenophorus sculptilis*, in large numbers in three New Jersey counties. Destroyed many acres of corn by drilling holes in young plants at or near the surface of the ground. The second crop, replanted after short delay, was undisturbed. The beetles were most numerous on old sod, but not confined to such land.

MCCARTHY, GERALD.—Some Injurious Insects. (Bull. 78, N. C. Agr. Exper. Station, p. 18.)

Paragraph on troublesome bill-bug or corn curculio, *Sphenophorus zeæ*. Says mature bug bites into young plants near the ground and deposits its eggs in the place bitten, the eggs soon hatching into grubs which burrow into the pith, dwarfing the plant or killing it outright. Characterizes this species as a semi-aquatic insect, and seldom troublesome except upon very wet land. Advises hand-picking, drainage, and thorough cleaning of the fields in fall.

1892.

OSBORN, HERBERT, and GOSSARD, H. A.- Corn Bill-bugs. (Bull. Iowa Agr. Exper. Station, Aug. 1892, No. 18, pp. 507-509.)

Describes injuries to corn and other crops by the clay-colored bill-bug, *Sphenophorus ochreus*, and the little brown bill-bug, *S. parvulus*. Quotes from Webster ('89) and copies his figures of *S. ochreus*. Also quotes from Forbes ('90) with respect to failure of beetles to breed in corn. Advises that bulbous roots of shrubs on recently drained land be examined, and that if larvæ of *S. ochreus* are found the ground be broken as early in summer as possible, preferably before June 1. Quotes Webster's statement ('89) concerning early plowing. Regards *S. parvulus* as likely to become a much more permanent and serious pest than the preceding. Quotes life history from Forbes ('90) and summarizes facts concerning injury to wheat and rye from Webster ('92). Says losses to corn due to this species are often serious, and quotes letter giving description of injuries to field of corn near Massena, Iowa, 1892. Damaged crop was planted on old timothy sod broken up in March. First planting taken almost entirely; second planting, finished June 17, seriously injured, but not entirely destroyed. Osborn concludes that the bill-bug had developed in the timothy or perhaps in other grasses near the affected fields. Probably in most cases found largely in the immediate locality where issuing. Regards outlook for preventive measures as by no means encouraging. Suggests, however, that since worse injuries are likely to occur on land previously in grass or adjacent to such land plowing should be done as early in the previous season as possible, and that such ground should be planted late and rather heavy at first. Crop of sod corn might be raised by breaking ground first of June and planting at once.

OSBORN, HERBERT.—Notes on Injurious Insects of 1892. (Insect Life, Nov. 1892, Vol. 5, p. 112.)

Bill-bugs have for the first time caused serious injury in Iowa, *Sphenophorus parvulus* being the most wide-spread and destructive. Seems to have increased rapidly in late years, and threatens to become a very serious pest. *S. ochreus* often seen, but not likely to cause extensive damage in Iowa because of comparative scarcity of swampy land bearing rushes.

BECKWITH, M. H.—The Corn Bill-bug, *Sphenophorus sculptilis*. (5th Ann. Rep. Del. Coll. Agr. Exper. Station, p. 102.)

Describes injuries to corn. Says life history is not known. Supposes that eggs are deposited among the roots of timothy grass, and that the larva feeds upon such roots. Describes injury to corn field in Delaware observed May 20, corn being about three inches high. Experiments with London purple applied to corn, and with poisoned bunches of clover placed between the rows produced no apparent result. Cultivation of corn began May 24, and this seemed to arrest injury June 1. Scarcely any beetles could be found in corn fields, although considerable numbers were seen among the roots of timothy on a field adjoining. Believes that beetles may be driven out of field by cultivation.

WEBSTER, F. M.—Insects which Burrow in the Stems of Wheat. (Bull. 40, Ohio Agr. Exper. Station, p. 72.)

Brief article on *Sphenophorus parvulus*, here called the grain Sphenophorus. Speaks of it as doing a little injury in the larval state to wheat, oats, and barley, also having eaten the bulbous roots of timothy, and puncturing the young roots of corn. Says female lays eggs in or a little above the roots, probably late in May or in June, but oviposition had been observed as late as July 1. Larva feeds with-

in straw until it becomes too large for its burrow, and then passes to the roots, often destroying a whole stool of the grain in this way. Pupates beside the roots, and after two or three weeks transforms to the adult. Has reared these beetles from wheat stubble in August.

BRUNER, LAWRENCE.—Report on Nebraska Insects. (Bull. 22, U. S. Div. Ent., p. 99.)

Discusses *Sphenophorus parvulus* under the name of the blue-grass weevil. Says it has been increasing quite rapidly in numbers, and is one of the commonest beetles in the city of Lincoln, Neb. Feeds on roots of common blue-grass, and in some lawns has killed large patches of sod. Beetles appear in early fall and spring. Thinks the insect is probably double brooded, but says that some of the beetles may come out in fall while the remainder may lie over the winter as pupæ. Found fully mature larvæ early in June and others in October. Damp and well-watered lawns infested as badly as those that are dry, although they do not show the injury so quickly.

SMITH, J. B.—Report of the Entomologist. (12th Ann. Rep. N. J. Agr. Exper. Station, for the Year 1891, pp. 394–395.)

Gives report of correspondents concerning injuries to corn. One says "Very much worse where there is wire-grass or quack-grass." Another says that he hears much complaint of them, confined principally to old mowing-lands. Another says the beetle is commonly known as the timothy bug, as it only seems to be bad after an old timothy sod is turned down; and still another reports it as sometimes very destructive to young corn when planted on timothy sod plowed in spring or late winter. Said also to be very injurious in Chester county, Pa. Injuries reported from May 25 to June 17. Smith says nothing is positively known concerning early stages. Reason to believe that larva lives in timothy sod. Found no eggs in punctured corn plants. Mentions use of arsenical poisons and kerosene, but is skeptical as to their value. Thinks it poor policy to replant only hills killed by the beetles, because these would be killed in turn. Recommends plowing sod for corn in fall and early winter with a view to killing out the insects living in or under the sod.

1893.

SMITH, J. B.—Report of the Entomologist. (13th Ann. Rep. N. J. Agr. Exper. Station, for the Year 1892, p. 390.)

Mentions corn bill-bug as again troublesome in some counties, frequently necessitating the replanting of corn. Injury minimized when fall plowing has been practiced. Period of injury short; replantings generally unharmed.

WEBSTER, F. M.—(Ohio Farmer, July 20, 1893, Vol. 84, p. 57.)

Reports on larva of a *Sphenophorus* sent him by a correspondent who found it in a root of growing wheat. Probably *S. parvulus*. Describes injuries by this insect to wheat and corn. Says field of corn near Jefferson, Ohio, was seriously injured by it in 1893, and refers to other corn-eating species. Says that in wheat fields the eggs, which he figures, are deposited just above the roots, but that the young, after hatching, works its way upward; and that as it gets larger it crawls down and eats its way out of the straw, finishing its growth among the roots. Often eats the underground portion of a whole stool, causing it to wither and die before the kernels have filled. Mentions occurrence in timothy, and says that injuries to corn are usually local and not frequent. Surmises that fall plowing would probably result in the diminution or prevention of the trouble, and sug-

gests planting some other crop than corn where the occurrence of this injury is very probable. In Indiana, rye is used in this connection to advantage.

1894.

OSBORN, HERBERT.—Corn Insects, their Injuries, and how to treat them (Bull. Iowa Agr. Exper. Station, No. 24, p. 997.)

Says clay-colored bill-bug, *Sphenophorus ochreus*, sometimes causes considerable injury to corn. Refers briefly to this species and to *S. parvulus*, discussed in previous bulletins, and mentions also *S. sculptilis*, which sometimes becomes numerous enough to eat the whole stool to the root. Refers to suggestion that sand saturated with kerosene be placed around each hill. Regards it as of doubtful value. Advises killing corn with kerosene if necessary to destroy the beetles, replanting afterwards, thus arresting their increase.

1895.

WEED, HOWARD EVARTS.—Insects Injurious to Corn. (Bull. Miss. Agr. Exper. Station, Nov. 1895, No. 35, p. 154.)

Brief note on corn bill-bugs, with copied figures. Recommends hand-picking when beetles occur in small numbers, and spraying with Paris green when on the base of the stalk if they are numerous. Says second planting of corn will be but little if at all attacked, and that when sod has been broken up in fall, the beetles will do but little damage the following spring.

1898

HOPKINS, A. D.—Some Notes on Observations in West Virginia. (Bull. 17, U. S. Div. Ent., p. 45.)

Refers to *Sphenophorus sculptilis* as the timothy bill-bug, and ascribes to it considerable injury to timothy plants during past three or four years. Thinks it is one of the prime causes of early failure of meadows. Believes permanent injury can be largely prevented by liberal applications of stable manure, tobacco dust, lime, or other suitable fertilizer to the sod immediately after hay harvest. Larvæ of this species occur in June to September, and the pupæ and adults in August to October.

1899.

PARROT, PERCY J.—Bill-bugs on Corn. (Kansas Farmer, May 11, 1899, p. 314.)

Reports *Sphenophorus pertinax* as injurious to corn in Nebraska. Experiments show that it thrives equally well in blue-grass sod. Injured corn often fails to produce ears. Experiments with kerosene are mainly unsuccessful. Advises destruction of infested canes if larvæ are found in the field, rooting up and burning over corn stubble in fall to destroy pupæ, and cultivation of swamp tracts to destroy beetles. Reports deposit of eggs June 14 to 26 in the burrows of beetles about one inch below the surface of the ground and touching the corn. Eggs hatching July 18; beetles still at work July 27. When not eating, the beetles were to be found in burrows under ground, either at the base of the corn or elsewhere.

LUGGER, OTTO.—Beetles (*Coleoptera*) Injurious to our Fruit-producing Plants. (Bull. Univ. Minn. Agr. Exper. Station, Dec. 1899, No. 66, pp. 269 and 301.)

Incidental mention of *S. parvulus* as very numerous in the roots of grasses several years previous in Druid Hill Park, Baltimore, Md. Expelled from sod by application of malodorous manure followed by heavy rain. "The next day im-

mense numbers of beetles (*S. parvulus* Gyll.) could be seen upon all the sidewalks and seats on and about the lawn; they were evidently driven out of the ground by this offensive manure." Quotes Professor Smith concerning injury to corn by bill-bugs. Corn so injured called "Frenchy" in eastern Maryland and in Virginia.