light may have to be kept on for several days, and, unless the storage capacity were great, a man would be required specially to work the retorts. Now, since oil-burners are pronounced practically equal to gas for revolving lights, while for fixed lights a great power is not required. it is probably better economy to multiply lighthouses than to increase the outlay on those existing. Besides, the limit of the power of oil-lamps has certainly not yet been reached, and, urged by the rivalry of gas, it is certain that we shall get more powerful burners. Even before the South Foreland experiments were concluded, new and more effective types of burners had been constructed. In places where both light and power are required, as at Ailsa Craig, where there are siren fog-signals in addition to the lighthouse, gas is pretty certain to be adopted in the future, as it simplifies the attendance on the light, and is always at hand to start the air-compressing machinery in case of sudden fog. The production of gas by the distillation of petroleum is so simple that it can easily be learned by the class of attendants employed in lighthouses, and does not sensibly increase the chance of a break-down. It is a pity that the most interesting quality of gas-illumination, that of sky-flashing, was not more fully investigated. This seems to be full of promise. Often the thickness of a fog, measured vertically, is very small, and an intermittent light projected on to the sky could be readily seen Every one knows how the attention is caught by sheet or summer lightning, in which the arch of the sky is momentarily lit up by a flash which is below the horizon, and therefore out of the range of direct vision. Even if the observer have his back to it, he can scarcely fail to see it. According to Sir L. McClintock, something of the same effect can be produced by a sudden burst of flame, produced by turning gas on for a moment before it is lighted. The condition of a mariner groping his way up channel in a thick fog is so dangerous that every expedient that promises to aid him is worth investigation. There are sufficient lighthouses where gas is used to enable this to be tried with scarcely any expense.

THE ARMY-WORM IN MARYLAND.

IN accordance with Professor Riley's instructions, on May 31, accompanied by Mr. Albert I. Hayward of the Maryland Agricultural College, Mr. William H. Ashmead started for Salisbury, Wicomico County, and Princess Anne, Somerset County, Md., to make such observations on the army-worm (*Leucania unipuncta*), then depredating in the vicinity of these places, as the limited time at their disposal should permit.

During the journey (reported in the September bulletin of the United States Department of Agriculture) they ascertained in conversation that the worms were most numerous in the immediate vicinity of Princess Anne, and so they took the most direct route for that place.

As they approached their destination they began to see the effects of the worms' work. Just before entering the town, they passed by a large field of corn, owned by Mr. H. H. Deshields, containing about twelve acres, that had been devastated by the army-worm, and only a few green plants could be detected here and there in the field.

This field was in marked contrast with another corn-field adjacent, which had been saved from attacks by ditching, as recommended in the "Third Report of the United States Entomological Commission." Another thing observed was that this field was flanked behind with a wood that evidently prevented their ingress that way, whereas the former was contiguous to grass and wheat fields, in which the worms are said to originate.

Just before entering the town, another ten-acre corn-field was passed, owned by Mr. John L. Lormer, that but a short time previously presented a most promising appearance, but which is now completely "cleaned out" by the worms. It may be worthy of record, as the theory has been advanced that insects originate in just such places, that in an adjoining field were three old hay-stacks. Contrary to their expectations, they found the reports of their numbers not at all exaggerated; and the damage done is even worse than was anticipated, the wheat, corn, barley, and timothy of many of the farmers being totally ruined by them.

One of the most interesting places for observation visited was that of William J. Porter, a practical and energetic farmer, who, although he has fought the worms most vigorously, has suffered severely from their attacks. By means of ditching and by burning straw, he has been able to save part of his crops; but several of his fields of corn, timothy, and wheat were already ruined. He reported the worms much less numerous than they had been, but there were many thousands seen in his fields.

During their rambles Mr. Porter took them to one of the ditches he had dug to keep the worms out of a large corn-field. In this ditch he had sunk, every two or three yards apart, deeper pits, where they found the worms two and three inches deep; and the rest of the ditch was black with the dead and living worms. From the dead a fearful stench arose in such strength as to attract the buzzards, which were proudly sailing overhead. Various carrion-beetles, too, seemed to revel in the carnage. Large silphids and staphylinids, besides numerous smaller forms, were quite numerous; while the hard-shelled histerids were quite plentiful, working through the putrid masses. Several carabids were observed running through the ditches, preying on the living and dying; *Scarites subterraneus* Fabr. being particularly noticeable, and no doubt, with its large mandibles, doing efficient service in destroying the worms.

Mr. Porter informed Messrs. Hayward and Ashmead that the worms always originated in the wheat and old grass fields, and during the morning hid themselves from observation, never appearing in numbers until after three o'clock P M., which accorded with their own observations and with those of the other farmers visited.

They ate up the timothy and corn clean, and, after devouring the blades of the wheat, congregated, three or four together, on the heads. After devouring several of the lower grains, they ate the husks and nipped off the upper portion of the kernel of the rest, thus almost entirely destroying it. If the grain is well advanced and somewhat hard, it escapes destruction; but, as most of the wheat visited was still in the milk, the destruction was great, and not less than 75 per cent of the crop had been already destroyed.

Although several parasites are known to prey upon the worms, and a sharp lookout was kept for such, none were seen except a few cocoons of an *Apanteles*, which were discovered, together with the worms, under old trash and logs in a wheat-field. A few were gathered and forwarded to the Department of Agriculture, some of which have since hatched, and prove to be *Apanteles militaris* Walsh.

The corn-fields of all this region were found to be badly infested with the larvæ of two species of beetles; and so numerous are they at times as to entirely destroy the first planting, and necessitate a replanting of entire fields. The farmers call them the "bud-worm," and do not seem to be aware that they are two distinct species that do the injury.

One species is a well-known corn-pest, the larva of *Diabrotica vittata*, widely distributed over the United States; the other is one of the wire-worms, possibly the larva of a common beetle, *Drastarius elegans* Fabr., which also has an extended range, extending into Mexico. So far as known, this latter species has never before been reported as injurious to corn, as the larva is supposed to be predaceous on other insects. It may, though, have dual habits, not an unusual occurrence in some insects. Both of these species are more prevalent in low fields, the higher fields being less subject to their attacks.

Another beetle, found to be seriously injurious to cantaloupes and sweet-potatoes in this region was a chrysomelid, *Systena*

elongata Fabr., which was found swarming in numbers, skeletonizing the leaves, and frequently killing the young plants. Mr. Porter stated that he was compelled to replant on account of them.

On a neighboring farm, owned by Mr. Z. Rouch, almost as much damage had been done by the army-worm as on the former place. A large corn-field and a field of timothy were totally ruined. A wheat-field, further advanced than that of Mr. Porter's, was less seriously affected, although it did not escape entirely, the blades of the wheat and the young timothy being entirely eaten up by them. It was on this place that the effects of the worms on barley were seen. Quite a large field already in head was completely ruined.

In the afternoon probably the largest farm in the county was visited, that of the Hon. D. N. Dennis, comprising five hundred acres or more. No better place existed for the proper study of the pest, as the worms were swarming in all the fields by the millions, and it was just the proper time of day to see them most advantageously, four o'clock P.M. The ground was literally black with the crawling worms. Mr. Dennis had made no especial efforts to destroy them, although, like some of his neighbors, he had surrounded some of his fields with ditches in an attempt to keep them out of adjoining fields. It is believed that it would have been quite practicable to have destroyed many thousands with poisonous washes, or, as Mr. Porter did, by burning straw in the ditches, as the bottom of the ditches were black with worms.

This farm is divided by a central lane, on either side of which are fields of wheat, corn, grass, oats, etc.; and in passing through this lane the worms were found quite plentiful, crawling almost invariably in the direction of the prevailing wind.

One of the first fields passed was an immense wheat-field already in the head, and the worms could be plainly discernible on the ground all through it and on the stalks and heads. The worms, having already devoured the young timothy and other tender plants usually found growing there, the blades of the wheat, the husks, and a goodly portion of the kernels, evidently could not find sufficient food, and were now migrating to pastures new, the sides of the field being black with moving hosts seeking more nutritious food.

These, as well as all the others observed, were moving in a southwesterly direction,—the direction of the prevailing wind. They were apparently in all stages of growth, from little fellows not more than a quarter of an inch long, to the fully matured larvæ, and all got over the ground and every obstacle in their way with the most surprising rapidity. The fences, posts, and other obstacles in their way were no obstruction to their migratory instinct or their search for food. The fence-rails and posts were often covered with crawling worms, sometimes not less than a dozen worms being found on the top of a single tall post, while others were seen going up one side as others were going down the opposite. Some specimens were even found under the loose bark on the posts and rails, where they had probably crept for shelter. One specimen thus found was in the jaws of a large hairy spider, *Saltieus* sp.

Adjacent to this wheat-field was a large field of timothy, containing seventeen acres, the blades of which had been cut off by the worms as clean as cattle could have done. Mr. Jones, the overseer, said that this field would have harvested not less than three tons of hay to the acre, but that now it would not pay for the cutting.

At one side of this field, the side next the wheat, the worms had congregated in countless numbers, every square foot having not less than thirty to fifty worms. The worms were now coming out of this field and going into the adjoining wheat-field, and crossing the lane into the opposite fields in great numbers; and it was here that a flock of the common English sparrows, and a few robins picking out the smaller worms and feeding on them, were observed. Mr. Jones said that the English sparrows had been thus busily engaged for a whole week, and it is a pleasure to record here this fact in favor of the despised bird.

Some distance off from this field was another one of wheat, containing probably twenty acres, in which the worms were even more numerous; and they had already sufficiently injured it to render the crop unprofitable to harvest. A deep, broad ditch had been dug along one side, and it was now, about five o'clock P.M., black with worms. It seemed a pity that these worms were not killed, as many of them were able to crawl up the sides, and escape into adjoining fields.

Facing this field was a large corn-field of probably seventy-five acres, of which fifty acres had already been destroyed; and there was but a slight chance that any of the corn still left would escape, although by ditching an effort was being made to save it. Of the fifty acres destroyed, thirty acres had already been replanted; and in the newly ploughed portion the worms were seen moving about in all directions, having just entered it from the adjoining wheat. It is probable that most of these will die of starvation or from the effects of the hot sun in the middle of the day.

Messrs. Hayward and Ashmead were particularly struck with what Professor Riley has written about the army-worm not feeding on clover. Of the several clover-fields they saw, the worms passed entirely through them, eating the timothy, other grasses, and some weeds, but leaving the clover almost untouched. A few of the leaves and some of the heads were slightly eaten, but no appreciable injury was observed. Only once did they actually observe a worm eating it, and that was a single half grown specimen curled up on the head, devouring the most palatable portions.

The present outbreak seems to be quite local, within a radius of ten to fifteen miles; and of the origin and previous outbreaks but little was ascertained. All the farmers and others interviewed concurred in the opinion that the winter of 1889-90 had been unusually mild and dry, and a few reported having observed the worms feeding on warm days during the winter.

On the following day they visited Salisbury, but found nothing of importance to prolong their stay there. Messrs. L. Malone and W. B. Tighlman said that the army-worm had not as yet appeared on any of the farms in the immediate vicinity, and no serious injury had been done nearer than three miles.

Mr. Tighlman reported the oat-crop of this whole region this year a total failure from the depredations of the grain aphis, *Siphonophora avenæ* Fabr.

WHEAT-SMUT.

THE August Bulletin of the Kansas Experiment Station contains the report of an exhaustive experiment in the prevention of the stinking-smut of wheat, the results of which are so valuable that they should have the widest possible dissemination.

It is a well-known fact that smut and similar growths are due to parasitic fungi, which propagate by spores (similar to seeds of other plants); these spores being, in the case of wheat-smut, the black stinking-powder that is found inside the smutted grains. In threshing, these grains are broken, and the spores are scattered over healthy grains, with which they are planted and on which they take root and grow, sending up in the issues of the young plant microscopic threads, which grow with its growth; and when the wheat heads out, they penetrate the grains, and there absorb the nutriment intended for the grain, and convert it into the fetid smut.

Knowing this history of the smut, it is easy to understand that any treatment that will kill the spores of the smut on the seed-grain will reduce the injury to the following crop. It has long been known that this might be accomplished by soaking the seed-grain in solution of sulphate of copper (blue vitriol), but this process has the disadvantage of injuring the vitality of the seed-grain. The Kansas experiment was undertaken with a view of ascertaining whether the desired object might be accomplished without this injury. In this experiment fifty-one different methods of treatment were employed. Some killed the grain as well as smut; some did little or no good. The most effective treatment was found to be simply scalding the seed,—a method first published by J. L. Jensen of Denmark.

To accomplish this, the seed should be handled in loose baskets, such as will permit the water to pass readily through them. It should first be dipped in water warmed to from 110° to 120°,