

Damage to Field Corn by Symphylans¹

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Abstract

During the past two years infestations of symphylans have been found in eight corn fields in five counties: Clinton, Shelby, Ohio, Harrison and Randolph. All were the garden symphylan, *Scutigerella immaculata* Newport, except for those from Clinton County where *S. nodiceros* Michelbacher was the species concerned. Although only areas of 1 to 15 acres were attacked, damage within these areas was extensive. The roots of young corn were attacked soon after plant emergence and the plants died or were severely stunted within a week. Surviving plants remained stunted throughout the season and few produced even small ears. Populations of 50 to 100 symphylans feeding on the fine roots were not unusual. The infestations were usually on sloping land with high humus content and uncompacted soil. In two fields where a 6-row planter was used, rows 2 and 5 which had been compacted by the tractor fields produced many more normal plants than the other rows. In 1967 no symphylans were found in soil samples taken to a depth of 9 inches on May 2 and at planting time on May 27, but 10 days after planting there were up to 100 symphylans per plant and many young plants were dying. This increase in numbers was probably due to migration from deeper soil rather than hatching of eggs. Plots treated with a fumigant and six different insecticides had only slightly fewer damaged plants than did the untreated areas.

The garden symphylan, *Scutigerella immaculata* (Newport), is not a new pest in Indiana, but only in the past three years has it been found in destructive numbers around the roots of field corn. Known under such names as the greenhouse centipede, the "white elephant," and the "galloping dragon," this small animal was studied by Riley of this Department in the years from 1927 to 1931. In the late 1940's vegetable growers in the Indianapolis area reported damage to crops both inside greenhouses and on adjacent land outside. The first complaints of damage to field corn came from Shelby and Clinton Counties in June of 1966, although later conversations with farmers indicated that they had seen injury as early as 1964. The senior author has worked with soil insects around corn roots since 1951, but observed few symphylans prior to these outbreaks. During the past two summers infestations were found in 10 corn fields in five widely separated counties: Clinton, Shelby, Ohio, Harrison, and Randolph. All infestations were the garden symphylan, *Scutigerella immaculata*, except those from Clinton County where *S. nodiceros* Michelbacher was the species concerned.

The purpose of this paper is to review the known information on

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these small animals and to report on their habits and destructiveness in Indiana fields.

Symphylans were first recognized as economic pests by Woodworth (11) in 1905 on field-grown asparagus in California. Davis (1) found them in Illinois greenhouses where as early as 1908 they were damaging fern asparagus and smilax. Their importance as greenhouse pests was reflected in the extensive research on biology and control in the late 1920's in Ohio (3, 4) and Indiana (8, 9). Control recommendations included steam sterilization of the soil, fumigation with carbon disulfide, sanitation, and the use of raised benches. Wymore (12) in California found that flooding of fields for 30 days would check symphylans for several years. Michelbacher (5) did a thorough study on their biology, host range, and ecology. Morrison (7) in Oregon found that this pest caused serious damage in the field to the roots and underground portions of many crops, including potatoes, beans, beets, strawberries, corn, mint, hops, asparagus, rhubarb, and caneberries. Several fumigants were satisfactory in Oregon, while parathion and Zinophos^R (0,0-diethyl 0-2-pyrazine phosphorothioate) gave only temporary protection.

The U.S.D.A. Cooperative Economic Insect Reports (10) since 1960 have carried numerous records of symphylan damage to field corn from the western States of California, Oregon, Washington, Utah, and Colorado and the Province of British Columbia. The first records from the midwest and east were from Iowa, Ohio, and Pennsylvania in 1963. Virginia and Indiana reported damage in 1966 and Maryland, Connecticut, and "the eastern half of Pennsylvania" in 1967. The 1964 Report (pages 467 and 790) stated that symphylans were known from 14 Iowa counties and were serious pests on corn or soybeans wherever they occurred. The 1966 Report (page 694) recorded their presence in seven counties of Ohio and stated that it "occurred over the State."

Details of symphylan life history under field conditions are not well known. Morrison (7) reported that eggs, nymphs, and adults could be found any month of the year in Oregon, but most eggs occurred during the winter and early spring. Nymphs and adults became active in the spring and were present in peak numbers in the upper six inches of soil during July and August. They remained in the upper soil until cold, rainy weather or extreme dryness drove them deeper. Their habit of descending to very deep soil under such conditions made control difficult, as only a small proportion were near the surface at one time. Complete development required two to three months, so there was one and possibly two generations each year. Individual symphylans were long-lived and in the laboratory lived for five years, molted regularly, and produced eggs periodically during this time.

Filinger (4) stated that symphylans were terrestrial in habits and lived in earthworm burrows, in natural crevices in the soil, and in openings left by decaying roots. With the approach of warm weather in the summer they migrated, in the greenhouse, to the subsoil 24 to 36 inches below the surface. The optimum temperature for activity was found to be 65°F. He demonstrated the inability of the symphylan to make its own burrows by placing moist loam soil in two stender dishes.

Both were tamped down to make a smooth surface and five individuals were placed in each. Leaf lettuce for food was placed in each dish and in one, two small earthworms were added. In the dish with earthworms the symphylans had followed the earthworm burrows into the soil by the second day, while in the other dish four of the five individuals (one died) were still on the surface at the end of six months.

Wymore (12) discussed possible sources of infestation and methods of dissemination in the field. In certain areas he observed a possible association with flooding, but noted that new infestations often became evident in small, slightly elevated spots, such as in one corner of a field or in a circular area adjacent to moist soil. The principal spread was in the direction of the rows with a rather slow lateral movement. Many farmers felt that barnyard manure was a serious source of infestation, but Wymore found no symphylans in the main manure pile and enormous numbers about plant roots around the edge of well-decomposed manure. Filingner also mentioned that manure was often piled outside a greenhouse and symphylans were taken wherever the rotted manure was used.

The garden symphylan, also known as the greenhouse centipede, is a centipede-like animal belonging to the Class Symphyla. It is not a true centipede (Class Chilopoda) nor an insect (Class Insecta), but is regarded by some as ancestral to both groups. Symphylans are delicate, white, soft-bodied animals from 0.2 to 0.3 inches in length. Adults have 15 to 22 body segments, 11 or 12 pairs of legs, and paired cerci. *Scutigereella immaculata* is recorded throughout the United States and is generally distributed throughout the world. Distribution records include most of Europe, Algeria, Mexico, Argentina, and Canada.

Scutigereella nodicercus is closely related to *S. immaculata* and is distinguished from it by the shape of the dorsal scuta, the cerci, and the chaetotaxy. This species was originally described from Germany and has been recorded only from the west coast of the United States. Although *S. immaculata* is the species usually described as causing economic damage, most species of *Scutigereella* feed on plant roots. In a survey of cultivated sites Edwards (2) found several economic species and stated that such forms may be dominant in some areas and cause more damage than *S. immaculata*. Much more thorough surveys are needed to determine the distribution and damage caused by the various species. Preliminary identification of the genus *Scutigereella* in the United States can be made in the keys by Michelbacher (6). Currently specimens of Symphyla from the midwest are being examined and the distribution of the various species may be clarified in the near future.

The first indication of a symphylan infestation destructive to corn in Indiana was a call to the Entomology Department in early June of 1966. The location was a farm adjacent to the sewage disposal plant at the edge of Shelbyville in Shelby County. Here young corn plants on some 12 acres in a higher area of the field and adjacent to an old barn were stunted in size and purplish in color. These plants were 4 to 8 inches in height and had the purplish color typical of phosphate deficiency. Normal plants in the same rows, but out of the infested area, were 12 to 15 inches tall and bright green in color. Digging in

the soil around the corn roots revealed 10 to 25 of the small, white symphylans around each plant. The fine rootlets had been eaten and the entire root system was less than an inch across as compared with 2 to 3 inches in the healthy plants. The soil at this time was moist and quite loose.

This field had been planted with corn for several years and in the spring of 1966 had received an application of aldrin for control of rootworms and other soil insects. The infested area, although on higher ground, was slightly depressed and held moisture longer than adjacent land. The farmer reported that a small area in another field had the same problem. In the past sludge from cleaning out the sewage plant had been spread over part of the field.

The second call in 1966 was received in late June from a farm near Manson in Clinton County. Again, the infested area was on sloping land. The fence around this 10-acre sod field was removed in the spring and the area became a part of a 240 acre corn field. Aldrin for soil insect control was broadcast over the entire field before seed was planted. As the young plants emerged and started to grow, the symphyllan attack became apparent on some 200 rows. In the first few weeks, many plants were killed, while the survivors remained stunted and grayish in color throughout the remainder of the season. On the early cultivation the farmer had to lift the cultivator shovels out of the ground to keep the soil from covering the small plants. Weeds, especially giant foxtail, were not seriously affected by the symphylans.

Typical healthy plants in this field on July 1 were 60 to 70 inches tall and had no symphylans around their roots. Surviving plants in the infested area were 15 to 20 inches tall and were wilted and gray in color, typical of severe drought symptoms. A four-inch soil sample taken in this area showed from 25 to 100 symphylans around the roots of each surviving plant. Throughout the season certain rows in the infested area showed stunting and wilting and yet were taller than adjacent rows. These better rows were explained by the farmer as being planted by boxes 2 and 5 on a 6-row planter. Thus, these two rows were planted in soil compacted by the passage of the tractor wheels. This soil was quite loose, as the farmer had plowed to a depth of 10 inches and then had used a field cultivator between the tractor and corn planter. Earthworm burrows were quite abundant and about 4 inches down there was an almost continuous layer of the plowed-under sod.

After a 6-inch rain the field was examined again, on August 9th. Plants in the uninfested areas were growing well and the differences between the healthy and the damaged were quite pronounced. Normal plants were in full tassel and were 8 to 9 feet tall, whereas plants in rows 2 and 5 of infested areas had few tassels and were only 3 feet tall (Figure 1). Plants in the other four infested rows were few in number and were about 2 feet tall with no tassels. Weeds, primarily foxtail, had taken over the uncultivated areas and often were as tall as the stunted corn plants. Roots on these plants showed little increase in size, although the number of symphylans present was down to 5 to 10 per plant.



Figure 1. The damage resulting from symphytan feeding on corn roots—a healthy plant on left and a survivor from the infested area on right.

In mid-September, differences in growth were still quite apparent. Plant and ear counts showed the following numbers per 100 feet of row:

Normal corn	105 plants	90 large ears
Rows 2 and 5 in infested area	90 plants	70 nubbins
Rows 3 and 4 in infested area	59 plants	3 nubbins

The symphytan count around infested roots had dropped to 4 per plant.

Reports of symphylan infestations in Harrison County were received in early August. Upon investigations three farms were found to have these pests. On the one farm, three fields including one planted to popcorn were involved. Populations at this time were light and the number of seriously injured plants low. Again, it was noted that these soils were loose and had many earthworm burrows.

In 1967, symphylans were found on a second farm in Clinton County located three miles north of the first infestation. Immediately, a similarity of farming operations was noted: both raised corn on most of their land; both used a field cultivator in their corn planting operation; both raised beef cattle in feed lots and hogs in confinement feeding; and both spread manure on their fields. The areas infested with symphylans were near the feed lots and had received heavy applications of manure. As on the other farm, corn planted in rows 2 and 5 was better than that in the other four rows.

During 1967, farms in Randolph and Ohio Counties were found to be infested with symphylans. In the first county the infestation was on high sloping land adjacent to a vegetable garden. The farmer reported that injury to vegetables and adjacent corn had been observed for at least the last three years. Manure from a cattle feed lot operation had been spread on the symphylan-infested area for several years. In Ohio County injured corn plants were visible in three fields from the highway. In each instance the infestation was located on sloping land and the injured area small.

The infested Harrison County fields were checked again in 1967, and were found to have only slight damage. Barley planted in one field had no recognizable damage from symphylan feeding. In Shelby County the infested field had been planted to soybeans. Rainfall during the summer months was quite low and the plants in the infested area were suffering in early September from both the drought and the feeding of symphylans. This area was recognizable by smaller plants with fewer leaves and more signs of maturity than the nearby normal plants. Digging in the hard, dry soil revealed a poor root system and only one or two symphylans per shovelful of dirt. At harvest in early October plants in the infested area were still holding some yellow leaves, while normal plants were bare.

On the first Clinton County farm six chemicals were applied in 1967 in an attempt to control the symphylans. Since the area of high populations was not known for certain, treatments were made in the higher sloping land in the center of the field. A fumigant (Vorlex[®]) containing methyl isothiocyanate and chlorinated C₈ hydrocarbons was applied May 2 with equipment supplied by the manufacturer. The soil had been plowed to a depth of 12 inches and disked, but was still lumpy and moist. The applicator with chisel shovels placed the liquid fumigant at a 4 to 6 inch depth and then the soil surface was smoothed by a heavy log chain dragged behind the applicator. Areas on either side of the fumigation were left untreated or were treated with insecticides broadcast at planting time on May 27. These materials in a granular formation were applied with an applicator on the front of the field cultivator

which was mounted in front of the planter. The granules were covered by the soil stirred by the cultivator shovels.

Soil sampled on April 19, May 2, and May 27 in the infested area of 1966 showed no symphylans. On June 7 when corn plants were 3 or 4 inches tall, the area was already showing wilting and dying plants and as much as 50 feet in some areas was bare of plants. Later samplings showed a gradual increase in the symphylan population to 50 to 100 around the roots or surviving plants. Regardless of the treatment used rows 2 and 5, in general, had more and better plants than the other four. The last stand count, on July 25, showed that many of the 500-foot rows had over 100 feet with no plants.

The pattern of the infestation indicated little or no population of symphylans on the west 72 rows and the east 100 rows. Three untreated areas were left across the field and rows 85 to 90 had an average of 70 feet with no plants, rows 145 to 174 with 104 feet and rows 205 to 210 with 84 feet. The various treatments did not reduce the symphylan to any great extent, although some improvement was noted. For instance, rows 121 to 144 in the fumigated area averaged 62 feet of blank space, while rows 175 to 198 treated with Bux^R (a 1:4 mixture of M-(1-ethylpeopyl) phenyl methyl carbamate and M-(1-methylbutyl) phenyl methyl carbamate) had an average of 83 feet blank. Because of low infestations comparisons of other treated areas with the untreated check were not considered reliable.

Summary

Symphylan damage to corn was found on 10 farms in Indiana during 1966 and 1967. The feeding of these small animals on the roots killed many corn plants before they were 12 inches high. Plants surviving this early attack were stunted and had a grayish color throughout the remainder of the season. These survivors reached a height of two to three feet and seldom produced an ear. The areas of infestation within a field were irregular and were not necessarily identical in the two years. At present these infestations are small, ranging in size from 2 to 15 acres. However, they do occur on highly productive land and appear to be spreading. Factors influencing abundance in corn fields include loose, moist soils, high organic content, and the presence of many earthworms. Tests in 1967 with chemicals for control were not successful, perhaps due in part to improper methods of application.

The two species of symphylans found in Indiana corn fields were *Scutigera immaculata* (Newport) and *S. nodicerus* Michelbacher. This is the first record of the latter form outside of California. The discovery of *S. immaculata* feeding on the roots of corn in the field is a major change in habitat from that of the greenhouse.

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