CORROSION OF PAINTED STEEL RIGHT-OF-WAY FENCE POSTS

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The history of the Department's interest in right-of-way fence posts goes back to correspondence in 1960 between W. W. McLaughlin and C. B. Laird, in which both the color problem and maintenance problem were discussed. Posts were being furnished in a variety of colors depending on the manufacturing sources of individual orders, with no standard color required by specifications. C. B. Laird in his memorandum of August 16, 1960, to W. W. McLaughlin, expressed concern over the future maintenance problem engendered by the corrosion of painted steel posts and suggested that both the color problem and maintenance problem be resolved by specifying aluminum posts. At a meeting on August 19, 1960, it was agreed that the Research Laboratory Division would make a comparative evaluation of aluminum right-of-way fencing and our current standard, and this agreement was confirmed in Mr. McLaughlin's memorandum of August 22 to Mr. Laird.

On January 11, 1961, representatives of the three principal aluminum producers, Alcoa, Reynolds, and Kaiser, were solicited by letter to present information on aluminum fence posts equivalent in strength to our current steel posts. No written replies were received up to the time of the New Materials Committee meeting on February 21, 1961, but preliminary verbal inquiries indicated that no aluminum fence posts corresponding to our current design were available on the market. This fact was reported to the Committee at its February 21, 1961, meeting with a recommendation that galvanized steel be used instead of either aluminum or painted steel for both fence and sign posts. The Research Laboratory was asked to submit information on the cost of galvanizing.

On April 5, 1961, a memorandum on comparative costs of galvanized and painted steel posts was submitted for the Committee's information. These costs were approximately $1.00 each for painted posts and $1.30 to $1.35 for galvanized. In this memorandum, it was also noted that neither V. G. Burgess of our Department nor G. E. Shuttleworth of the Buffalo Steel Co. believed that galvanizing of steel sign posts was economically justified. At the New Materials Committee meeting on May 24, 1961, H. J. Rathfoot expressed the opinion that painted posts would last 20 to 25 years at least, and that there was no need for the additional expense of galvanizing. After some discussion the Committee recommended

that sign posts be galvanized and fence posts painted. This recommendation ran counter to the original purpose in each case, in that the fence post problem was left just as it was in the beginning, and galvanizing of sign posts, which had not been requested, was approved in principle.

As a result of earlier inquiries new information on the availability and cost of aluminum posts was brought to light and this information was reported in a memorandum distributed to the Committee on July 24, 1961. One company, the Alrectic Division of McGraw-Edison Co., Jackson, Mich., had submitted a deep hat-section and cost quotation of $2.75 per post on July 7, 1961. This post was equivalent in strength and other characteristics to our steel post. Three other companies did not completely comply with our request for information and costs, although one did quote a price of $5.60 per post. Available cost data at this time, then, showed that the galvanized post cost about 35 percent more than the painted one, and the aluminum alloy post about twice as much as the galvanized one. When this information was considered by the Committee on September 12, 1961, it was decided that the cost of aluminum posts was not justifiable and the matter was left in status quo.

Almost a year later, at the Committee's meeting on August 15, 1962, it was decided that "the question of painted posts be reopened and that the present condition of painted posts which have been in the ground four or five years should be investigated and reported to the Committee by the Research Laboratory Division." A survey of existing right-of-way fence post installations in a representative range of environments and ages was made in the Fall of 1962 to determine the seriousness of the corrosion problem. A preliminary pictorial report was presented at the meeting of September 27, 1962, showing evidence of corrosion above ground and posts broken off at the ground line. Additional pictorial evidence was presented at the November 13, 1962, meeting showing rusting primarily at the ground line. H. J. Rathfoot reported at this meeting that he had been able to detect no rusting at the ground line of galvanized line posts on the Ohio Turnpike.

Results of the Survey

The survey results are presented in photographs arranged in two groups. One group shows the condition above ground, and the other shows the condition just above ground, at ground level, and below the ground line to a depth of about 1 ft. In each group, the posts are presented in order of increasing age.

Discussion

The survey of steel right-of-way fence post installations discloses that, in general, deterioration above ground sets in during the first year, becoming progressively worse as the years go by. Severe corrosion is prevalent by the fifth year. Occasional line posts were discovered lying on the ground at all ages starting about the 13th year, deeply pitted and covered with rust.

The greatest deterioration, however, occurs at ground level. It is here, intermittently, that the highest concentrations of dissolved salts may be reached as a result of local accumulations, alternate wetting and drying, and evaporation. It is here that soil moisture contains its largest quantities of dissolved or entrained oxygen. Rain, snow, and ice tend to accumulate on or near the surface. It is at this elevation, too, that the greatest fluctuations of the total environment occur.

Steel fence posts which have been in place only four years show severe corrosion at the ground line. At five years this attack becomes intense. Appreciable amounts of steel are lost at this level by the eighth year. Of the 200-odd posts observed lying on the ground during the survey, all were corroded through at ground level. Only one post, an exceptional case, showed 100-percent deterioration above ground.

Peculiarly, the condition below ground was much better. Original paint was found intact after 8 years and again at 28 years, although the 28-year-old post was severed at the ground line. Below ground, posts as old as 41 years were discovered to be structurally sound, with only surface corrosion evident.

Observations at ground level and below are in keeping with statements by McKay and Worthington (1) that "in one case, 300 miles of (steel) pipe dug up after 35-years' service was in such condition that it was resold for use in other buried service. It has been figured that pipe lines may last as much as one hundred years in some localities.... More intensely corrosive cells, however, seem to be set up at the surface... due to irregular distribution of soil particles, and by variations in oxygen supply from point to point."

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(1) McKay, Robert J., and Worthington, Robert. "Corrosion Resistance of Metals and Alloys." New York: Reinhold Publishing Corp. (1936), p. 241.

Apparently, observed variations in the severity of ground line attack can be attributed in part to diversity of soil type, in that some soils such as sandy loams offer less resistance to the movement of moisture than other soils such as the clays. Differences in the degree of acidity are also known to play an important role. The relatively anaerobic condition of the ground is well known. Below the surface, extremely limited supplies of oxygen should be expected to set an upper limit to corrosion rates of steel.

GROUP 1: ABOVE GROUND

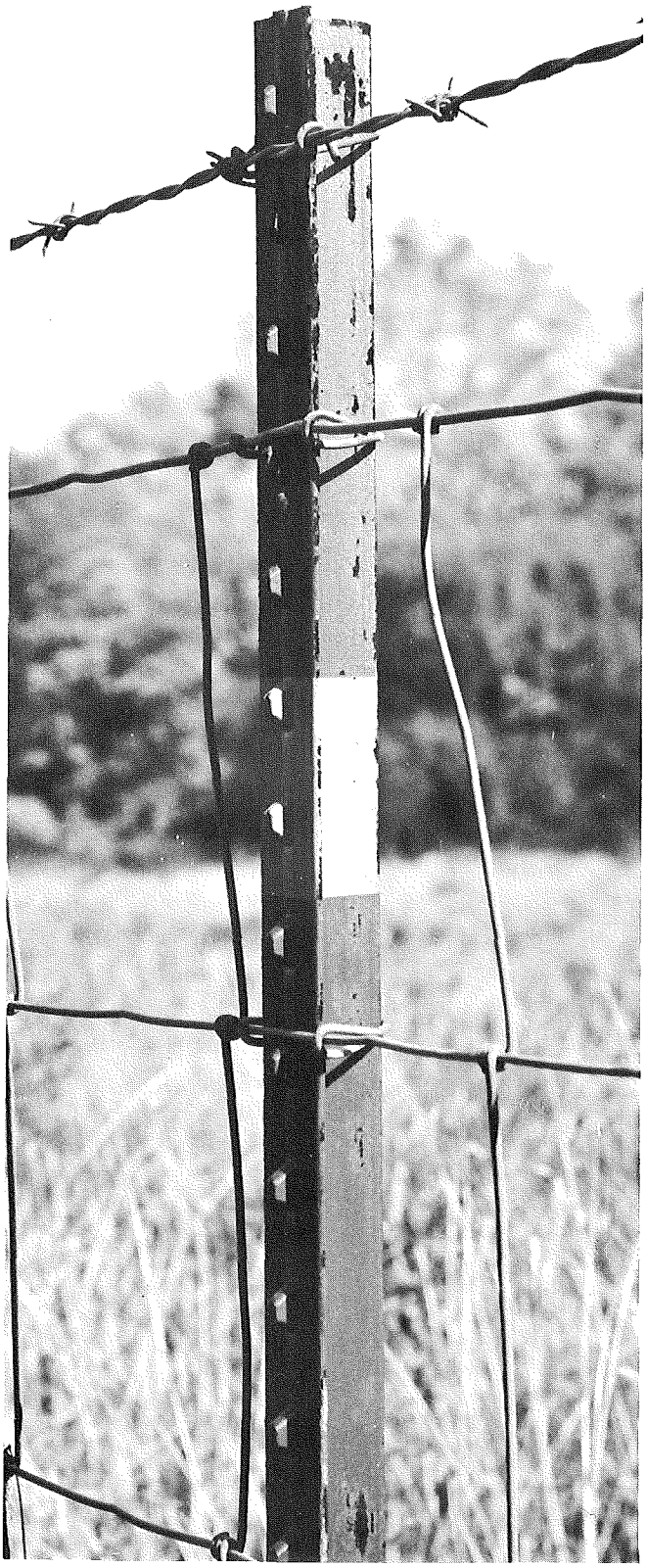

Figure 1. Age: 1 year. East side of I 94 about 2 to 3 miles north of Bridgman at 19-mile sign post marker. Red-yellow-red paint. Localized beginning corrosion.

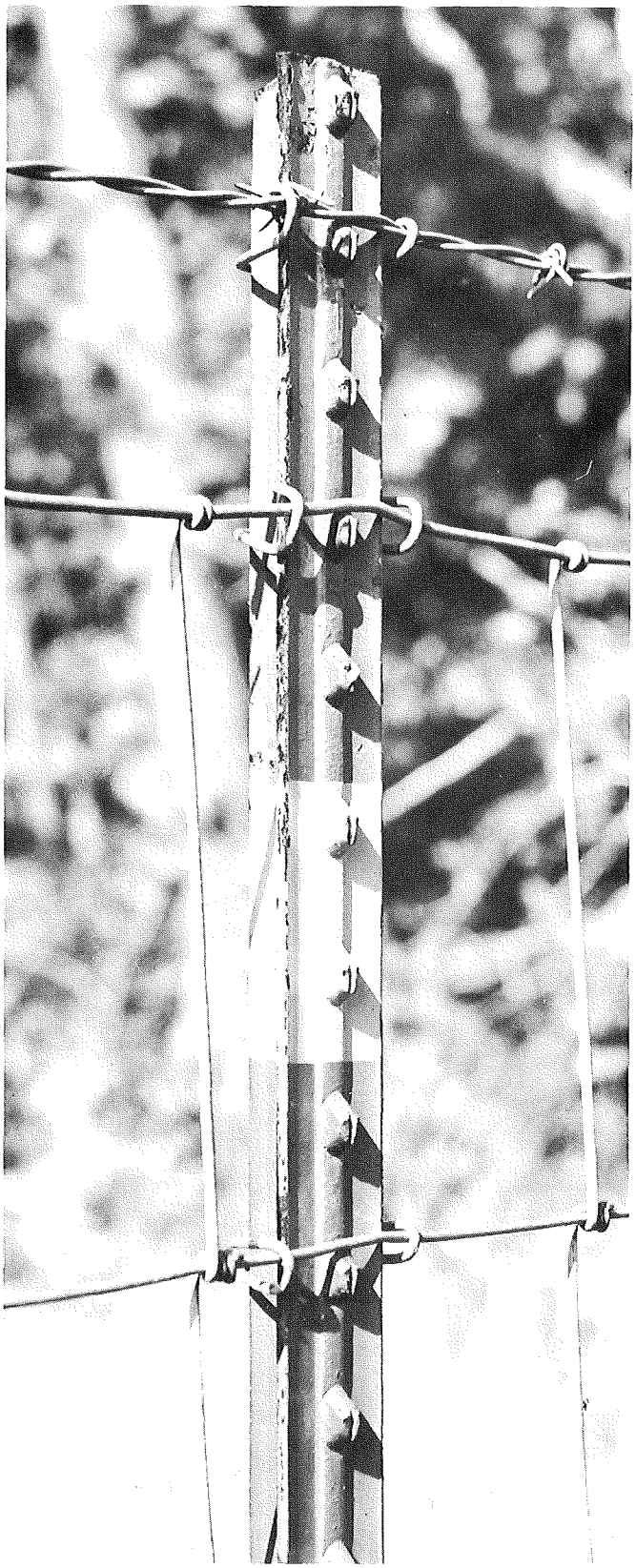

Figure 2. Age: 1 year. West side of I 94 just north of Bridgman exit. Red-yellow-red paint. Localized beginning corrosion.

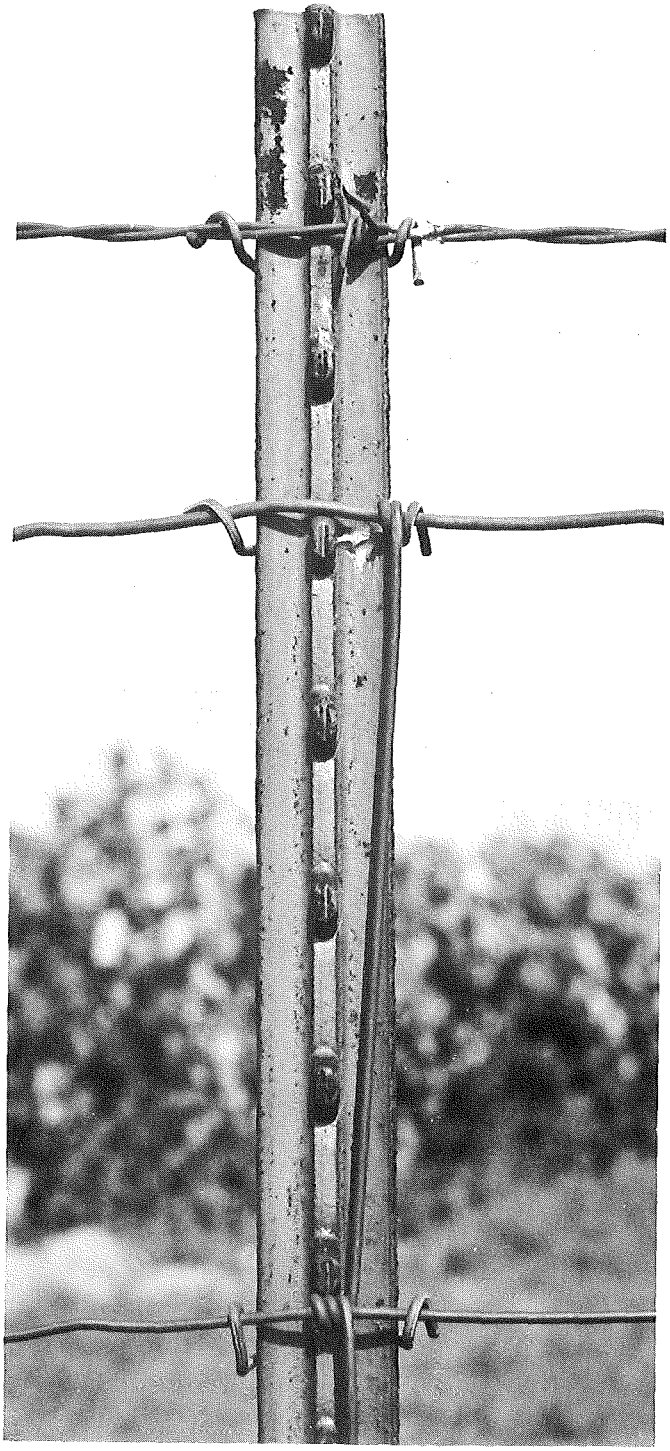

Figure 3. Age: 2 years. East side of I 94 about 2 to 3 miles north of Bridgman at 19-mile sign post marker. Red paint. Localized beginning corrosion.

Figure 4. Age: 3 years. North side of I 94 just west of Kalamazoo, east of Oshtemo exit. Red paint. Localized beginning corrosion.

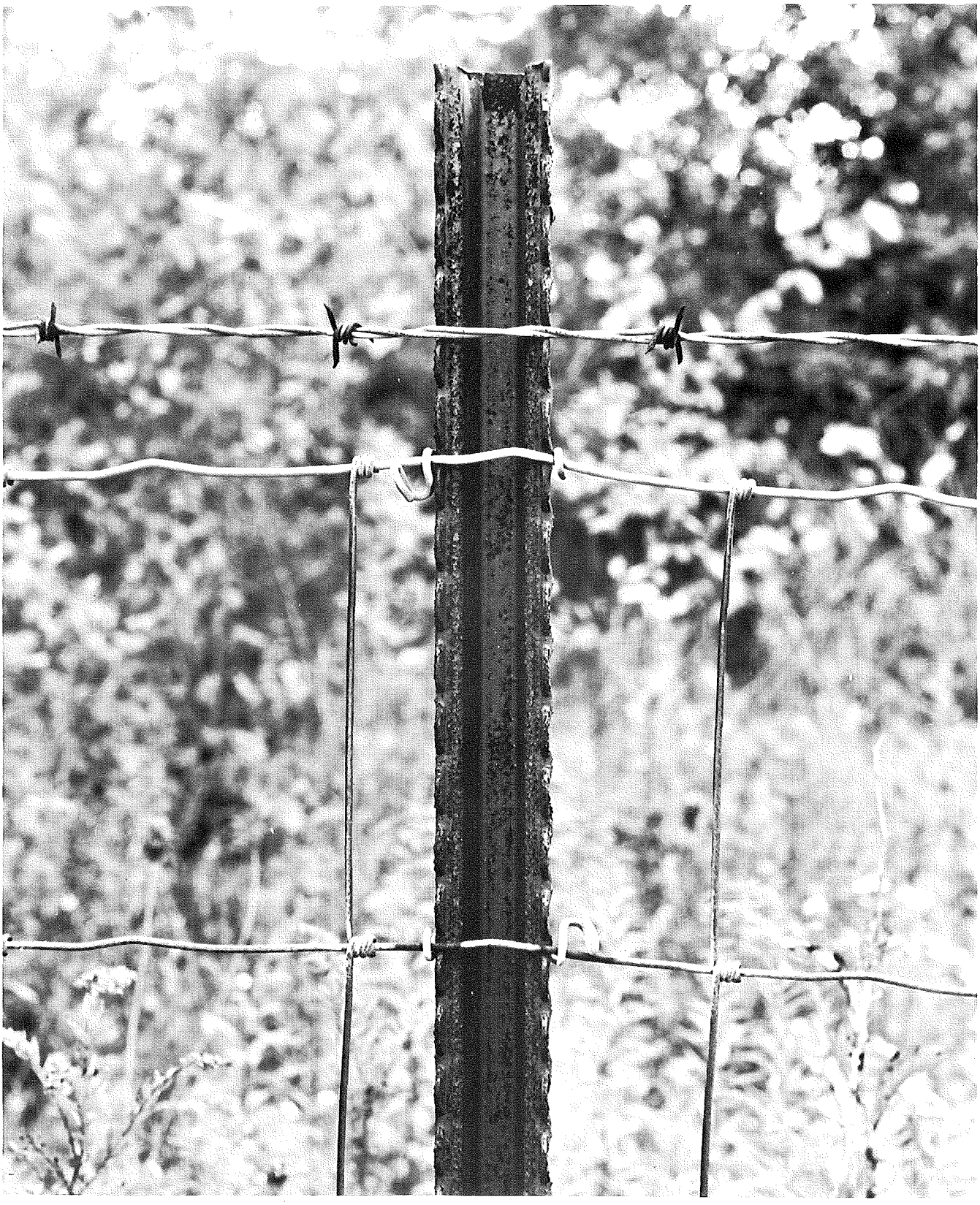

Figure 5. Age: 4 years. East side of I 75 at Station 1099+90, south of M 57. Severe corrosion. Note apparent galvanic corrosion of horizontal wire near bottom of figure at clip area where wire is in contact with post.

Figure 6. Age: 5 years. West side of I 75 at Station 1357+00 south of Vreeland Road between Detroit and Monroe. Two views of severe corrosion of intermediate braced post with several instances of galvanic corrosion of fencing wire.

Figure 7. Age: 5 years. West side of I 75 at Vreeland Road between Detroit and Monroe. Excessive, severe corrosion, typical of posts in this area. Post is still structurally sound, but wobbly.

Figure 8. Age: 13 years. South side of I 94, 1/2 mile east of Cooper Street exit, Jackson area. Large section corroded through at ground level, with fence lying on ground. One post (see Figure 9) taken to laboratory for study. Wire fencing badly corroded.

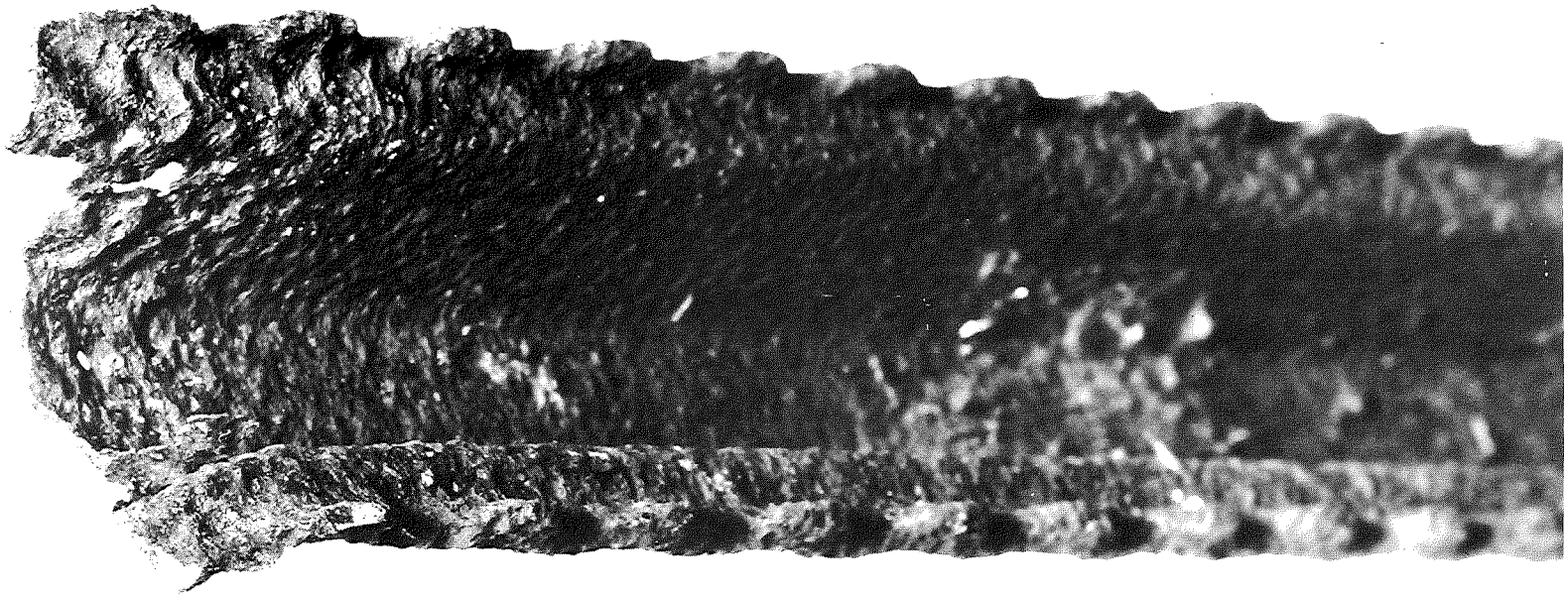

Figure 9. Age: 13 years. Post from fence section shown in Figure 8 taken to laboratory for study. Shows end of part above ground corroded through at ground level, with very severe corrosion above.

Figure 10. Age: 24 years. South-east corner of East Grand River Road (formerly US 16) and Bauer Road between Brighton and Howell. Corner pipe post corroded through about 2-1/2 ft above ground level, upper portion held up by brace posts.

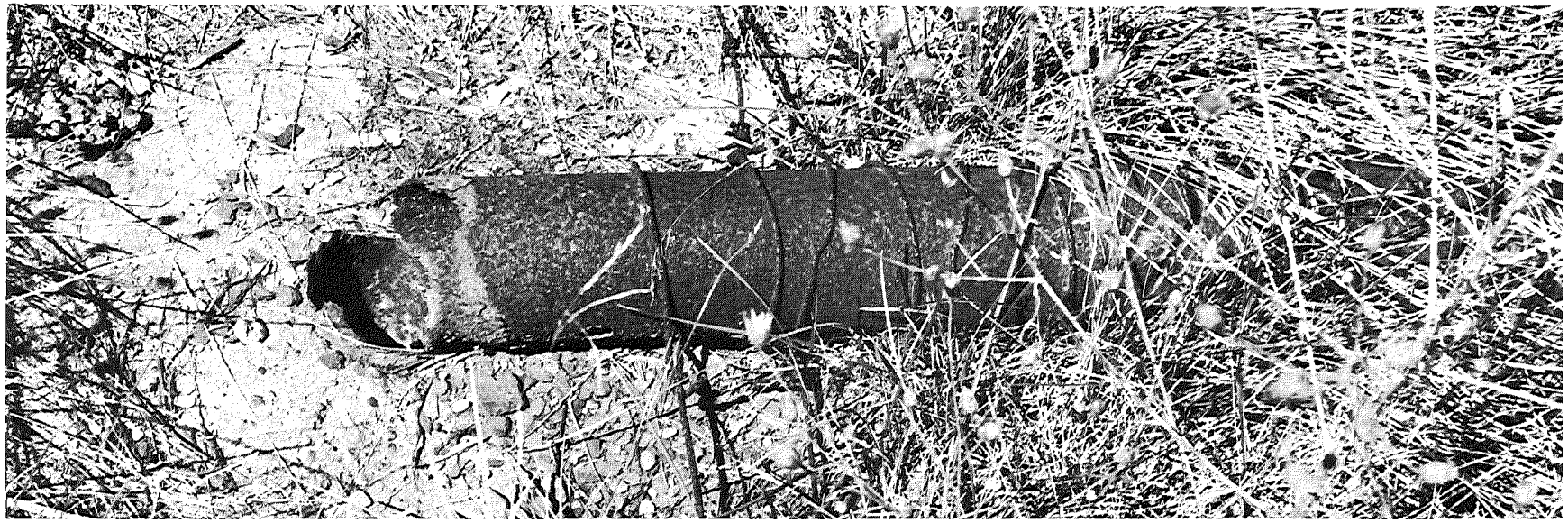

Figure 11. Age: 24 years. West side of US 16, north edge of Brighton. Pipe post corroded through at ground level, fence lying on ground.

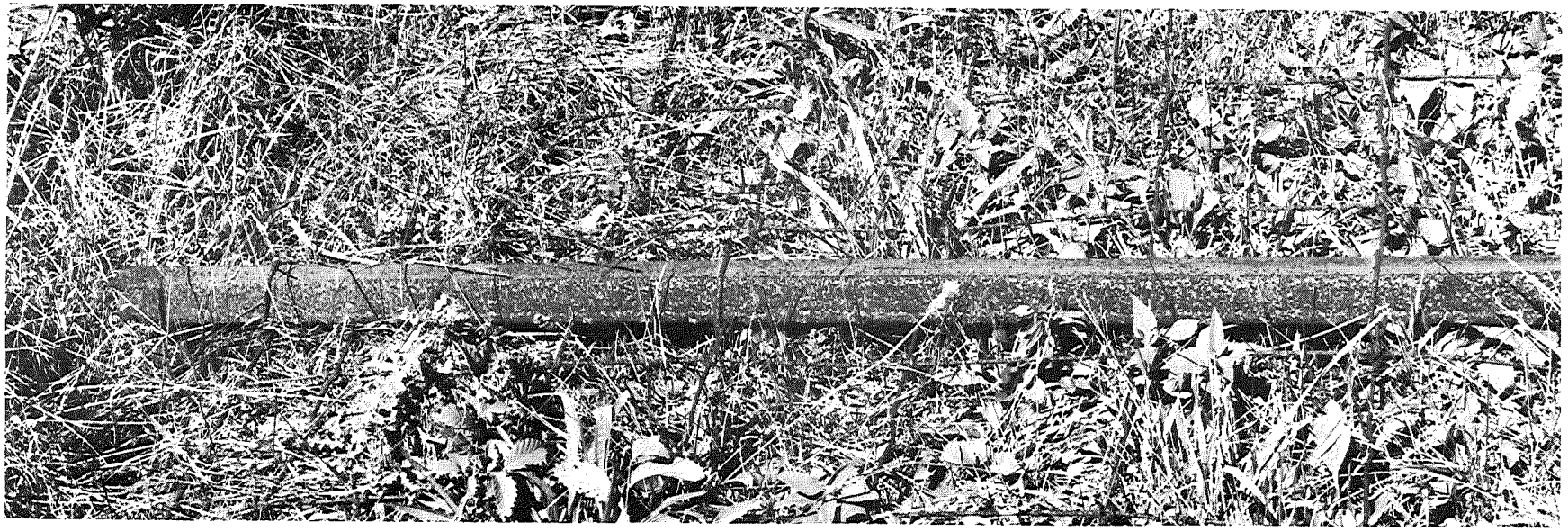

Figure 12. Age: 24 years. West side of US 23 just south of M 59 at Camp Tamarack. Fence post corroded through at ground level, fence lying on ground.

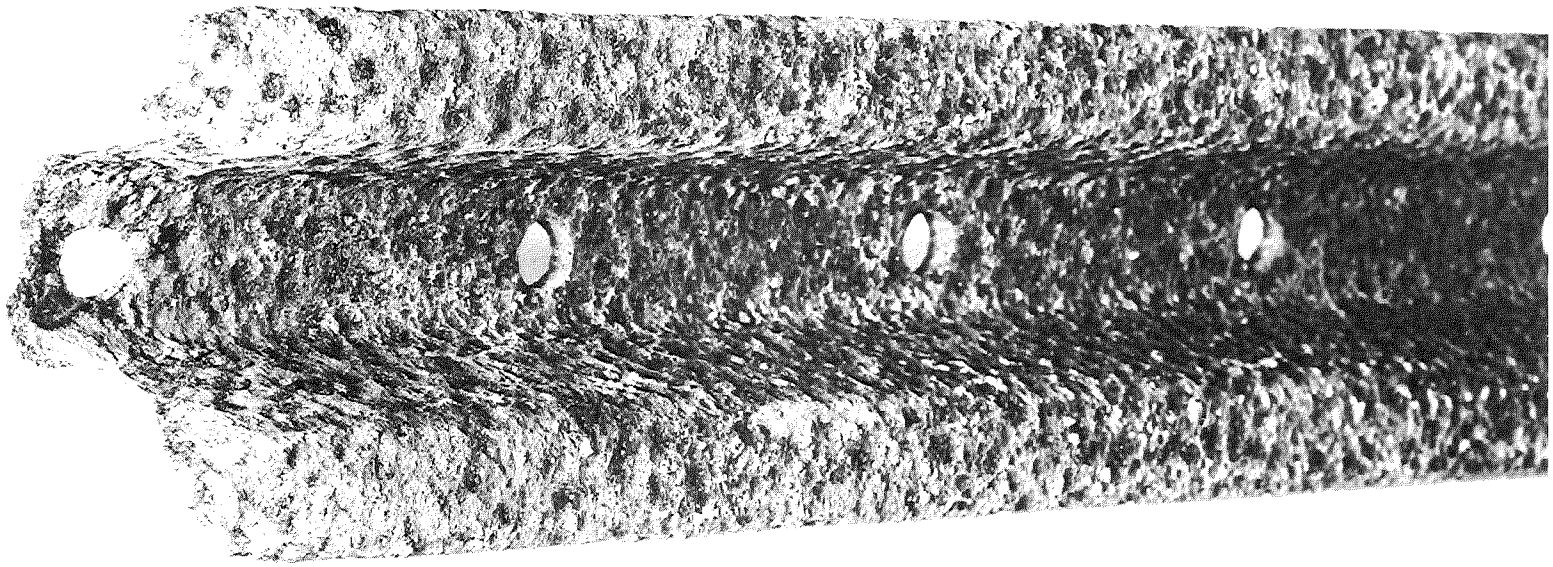

Figure 13. Age: 37 years. Southeast corner of Grand River and Stowe Road on US 16 east of Webberville. Post corroded through and lying loose on ground taken to laboratory for examination. Advanced corrosion above ground.

GROUP 2: GROUND LEVEL AND BELOW

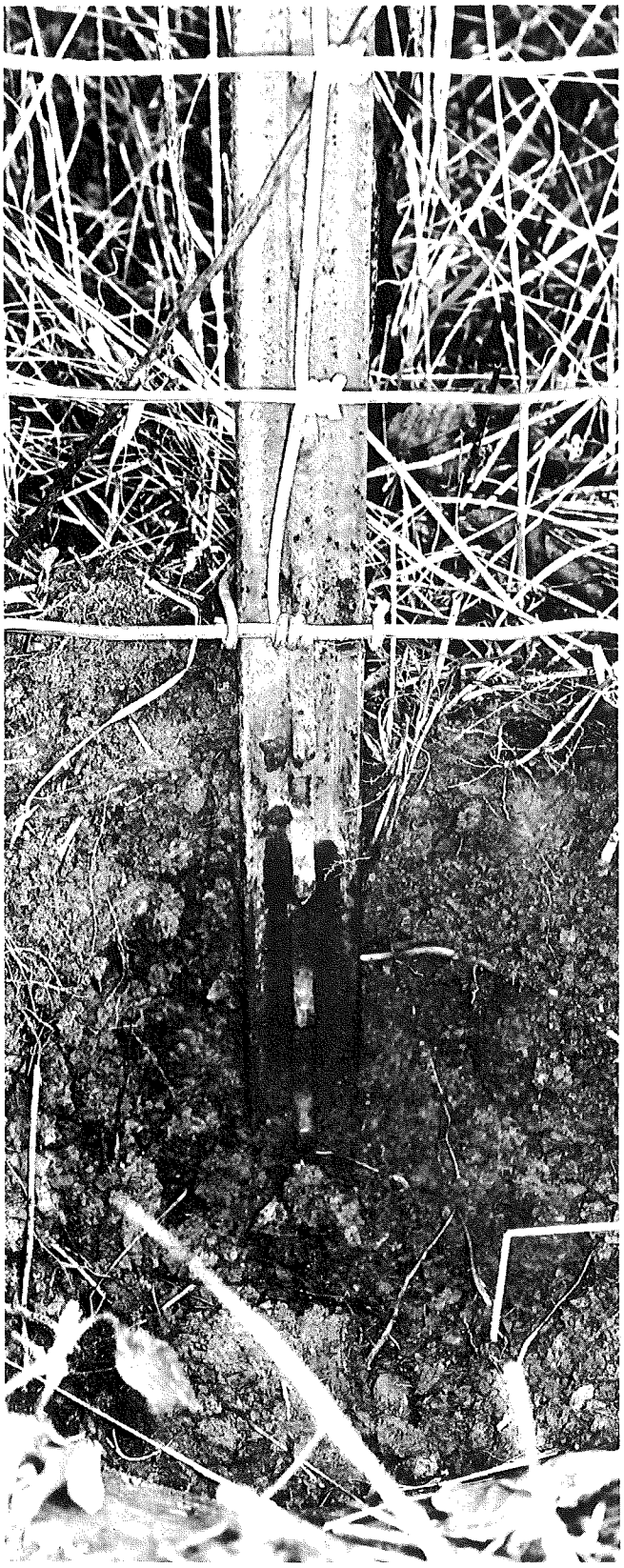

Figure 14. Age: 4 years. East side of I 75 just north of Flint. Clay soil. Original green paint still very good below ground level. Severe attack at ground line.

Figure 15. Age: 4 years. East side of I 75 south of M 57. Dark, rich soil. Green paint still satisfactory below ground but corrosion is severe at ground level.

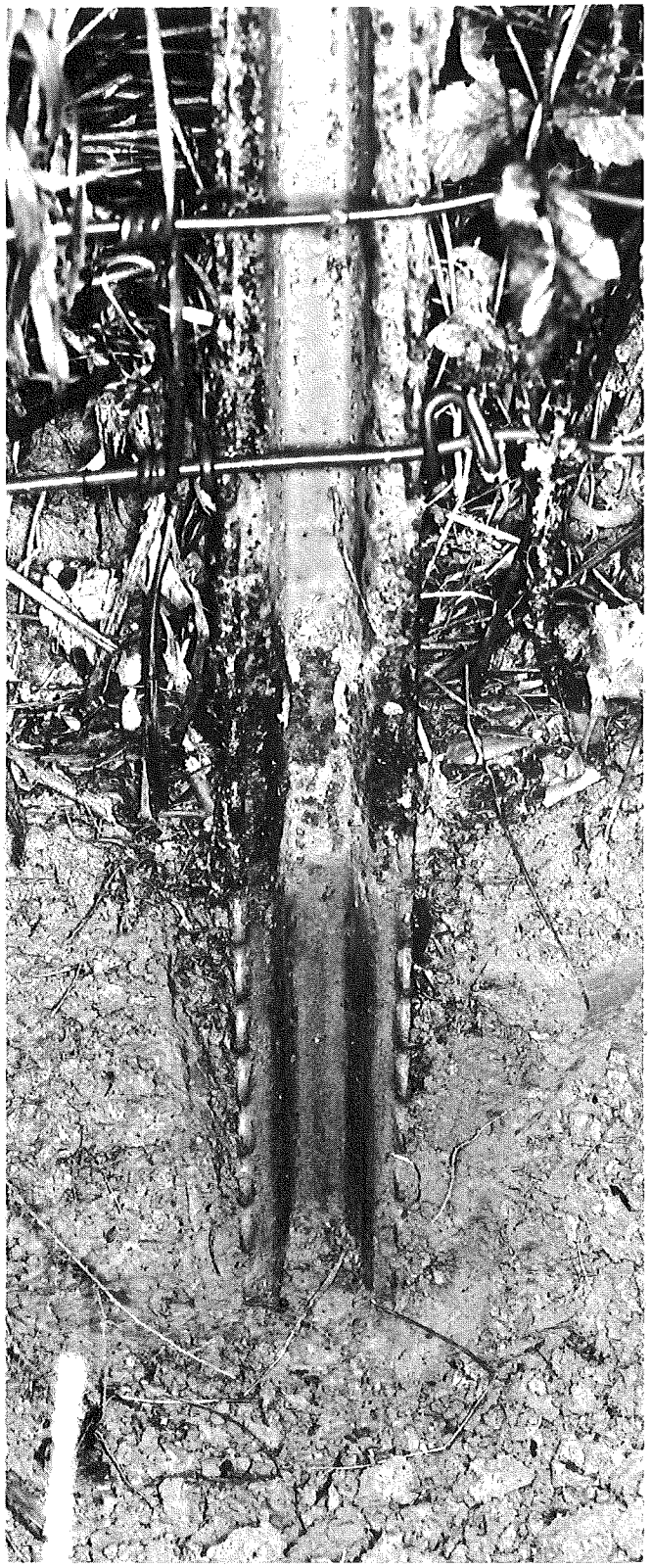

Figure 16. Age: 5 years. West side of I 75 at 1357+00. Clay loam soil. Green paint excellent below ground level with no apparent corrosion. Severe corrosion at ground line, less severe above ground.

Figure 17. Age: 5 years. West side of I 75 at Vreeland Road overpass. Clay loam soil. Green paint excellent below ground level with practically no apparent corrosion. Severe corrosion at ground line, less severe above ground.

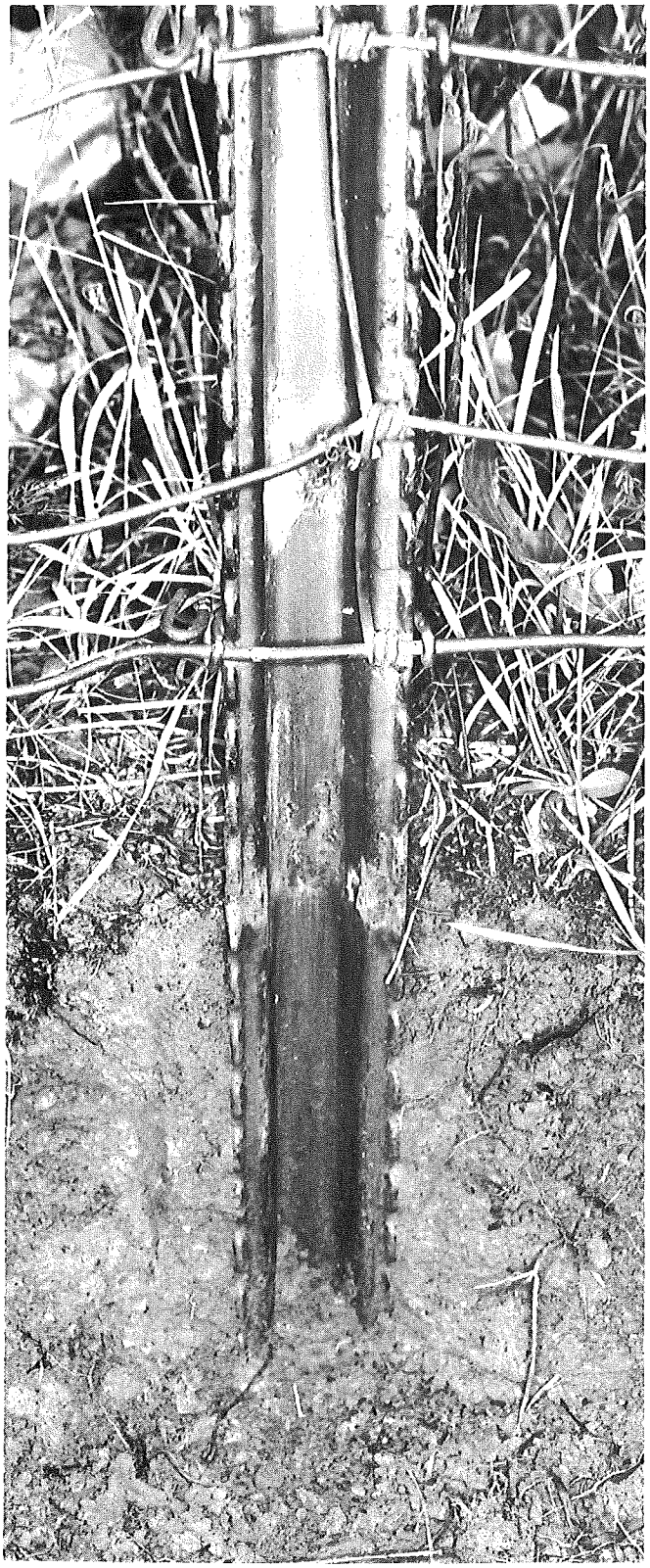

Figure 18. Age: 5 years. West side of I 75 at Mount Morris exit. Sandy loam soil. Green paint excellent below ground level with little apparent corrosion. Severe corrosion at ground line, less severe above ground. White area is caterpillar's nest.

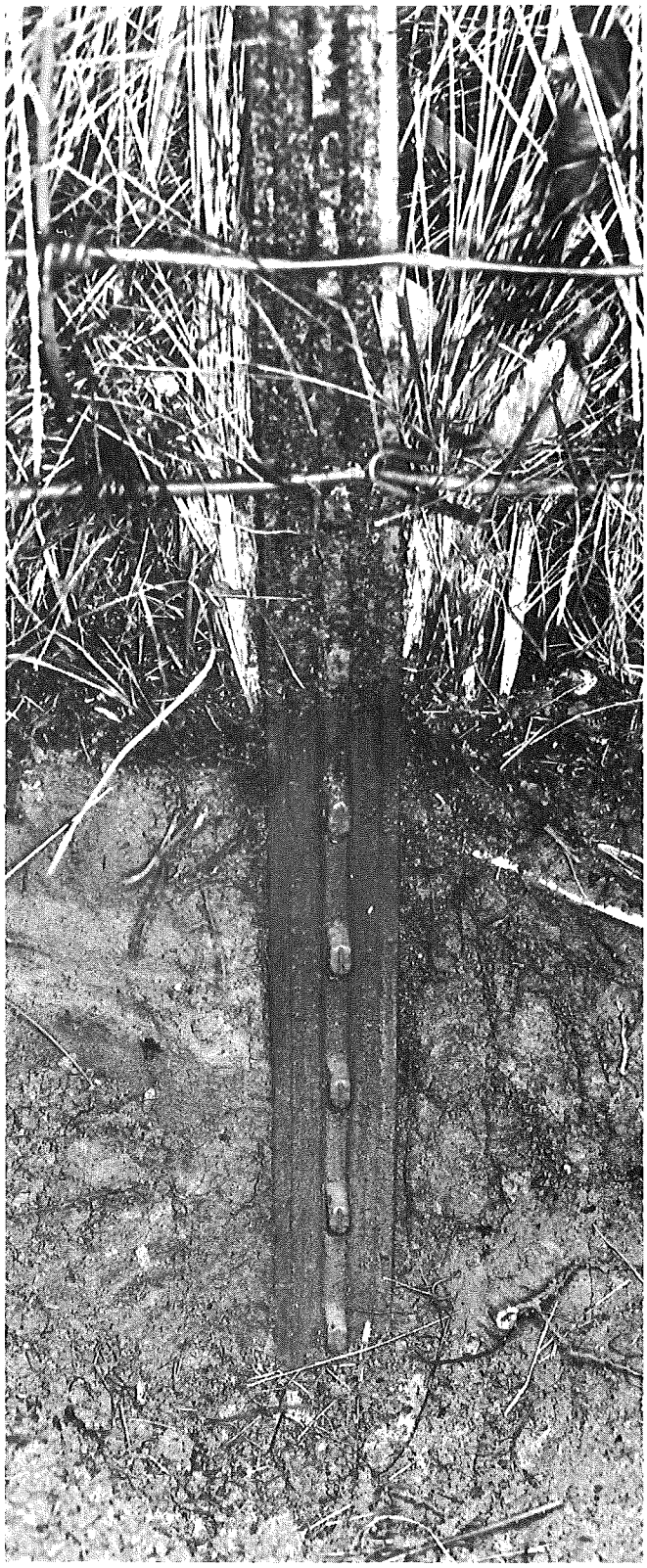

Figure 19. Age: 5 years. West side of I 75 at 1305+00. Sandy loam soil. Green paint in good condition below ground level with little apparent corrosion. Severe corrosion starting at ground line and extending above ground.

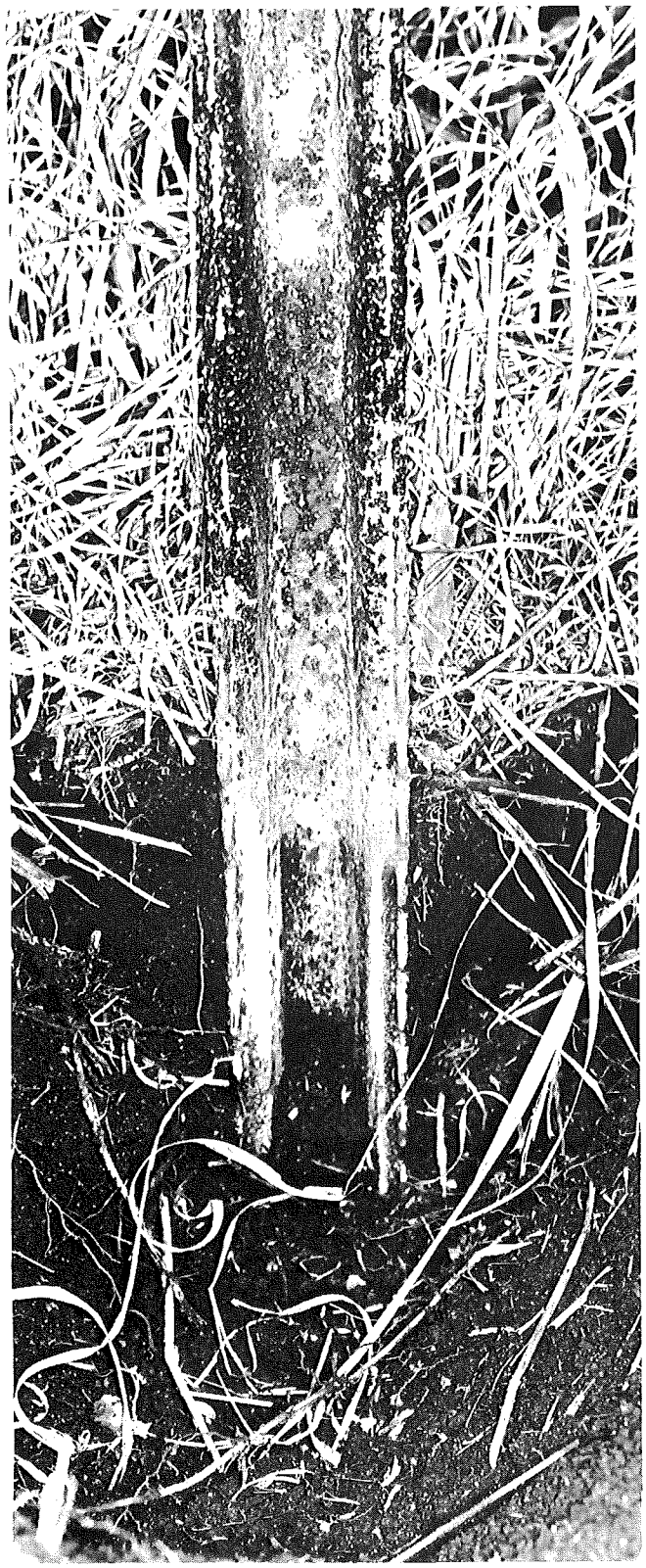

Figure 20. Age: 8 years. North side of I 94 just west of US 127. Black dirt. Yellow paint still in good condition below ground level, with little corrosion. Intense corrosion at ground line with severe corrosion above ground.

Figure 21. Age: 28 years. North side of US 16 about 4 miles east of Hogback Road and 1 mile west of M 59 intersection. Clay soil with some loam. Corroded completely through at ground line with severe corrosion above ground. Yellow paint still present below ground level. Three or four spots where paint has come off show shiny black metallic surface. Some corrosion under ground.

Figure 22. Age: 38 years. North side of US 16 just east of I 96 entrance west of Lansing. Sandy loam soil. Surface corrosion below ground level, otherwise sound. Corroded completely through at ground line, extensive corrosion above ground.

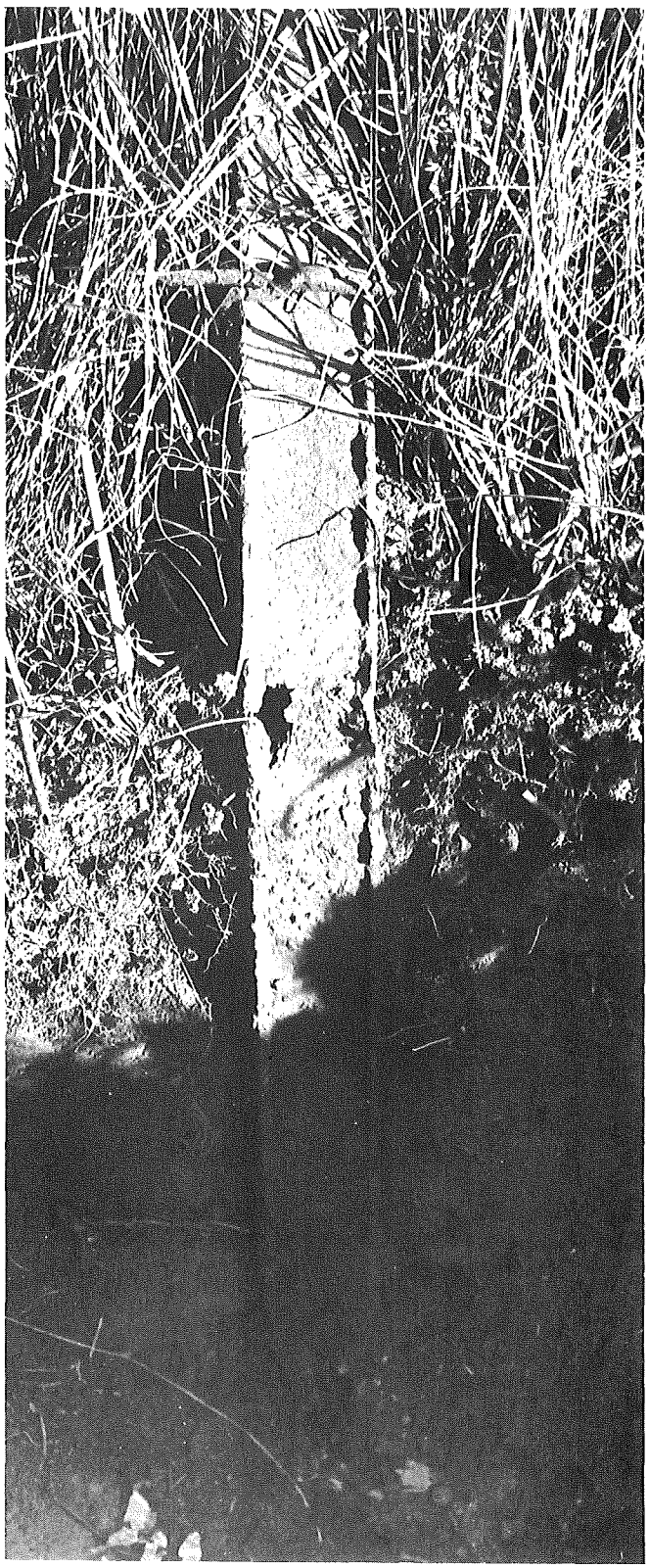

Figure 23. Age: 38 years. Another post in same location as that shown on left. More metal appears to be present below ground than above.

Figure 24. Age: 39 years. North side of US 16 just east of Fowlerville. Clay and loam soil, stony. Corroded entirely through at ground level. Apparently protective rust has formed below grade. Corrosion severe above ground.

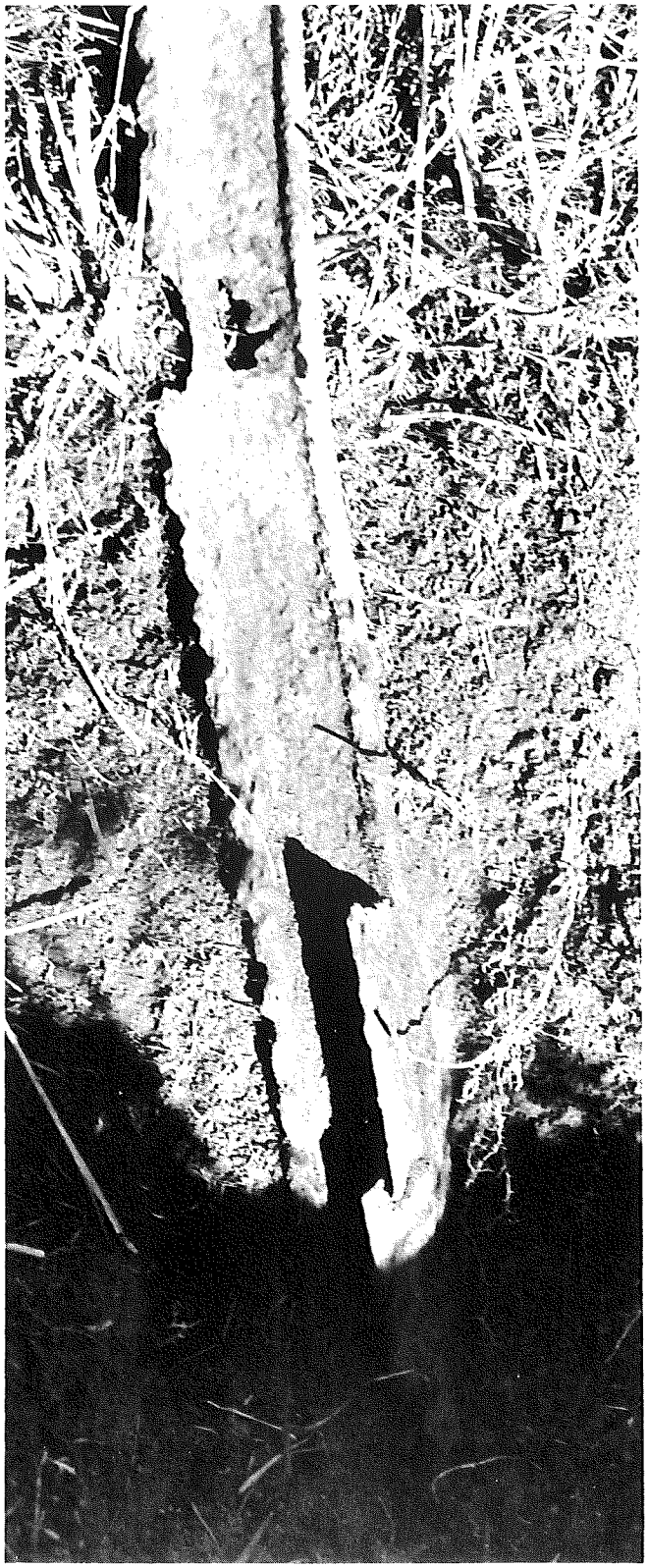

Figure 25. Age: 41 years. South side of US 16 just west of M 59 intersection. Sandy loam soil. Sound below grade with surface rusting. Almost completely severed at ground line by corrosion.