SELENISA SUEROIDES (LEPIDOPTERA: NOCTUIDAE): A PEST OF SUBCANOPY IRRIGATRION SYSTEMS IN CITRUS IN SOUTHWEST FLORIDA

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ABSTRACT

Mature larvae of *Selenisa sueroides* (Guenée) damaged micro-sprinkler irrigation systems in three citrus groves located in Hendry Co., Florida during October and November 1987. After completing development on fabaceous food plants, American jointvetch, *Aeschynomene americana* L., or phasey bean *Macroptilium lathyroides* (L.) Urban, larvae left the host plants, climbed nearby irrigation sprinklers, and chewed holes in the flexible polyvinylchloride tubing. Larvae then entered the tubing and pupated. Damage to sprinklers and connecting tubing resulted in additional grove costs that averaged $797 per site (range, $50 to $1,500). The level of damage within each grove was related to the abundance and distribution of host-plants, larval population levels, sprinkler type, and grove cultural practices.

RESUMEN

Gusanos maduros de *Selenisa sueroies* (Guenée) dañaron sistemas de riego de bajo volumen (micro-regador) en tres huertas cítricas localizadas en el Condado de Hendry, Florida en Octubre y Noviembre de 1987. Después de terminar de desarrollar en plantas hospederas, American jointvetch, *Aeschynomene americana* L., y en phasey bean, *Macroptilium lathyroides* (L.) Urban, los gusanos se fueron de las plantas hospederas, subieron a los tubos del sistema de riego que estaban cerca, y excavaron hoyos en los tubos flexibles de polyvinylcoruro. Enseguida los gusanos entraron a los tubos y se hicieron crisálidas. El daño a los sistemas de riego, incluyendo los tubos y los micro-regadores, resultaron en costos adicionales en cada huerta entre $50 y $1,500 con un promedio de $797 en cada sitio. El nivel del daño de cada huerta fue relacionado a la multitud y distribución de las plantas hospederas, la concentración de los gusanos, la clase del sistema del riego, y las actividades principales en la huerta.

Larvae of the noctuid moth, *Selenisa sueroides* (Guenée), have been reported as occasional serious defoliators of various fabaceous plants in Florida (Sealy 1954, Weems 1954, Wolfenbarger 1954, Genung & Allen 1962, Genung & Green 1965, Bullock & Kretschmer 1982). Skinner (1918) first noted that mature larvae may additionally damage the host, in this case an unidentified fabaceous plant, by boring into the stem to pupate. Similar damage caused by larvae boring into stems of *Sesbania* sp. soybean,

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and *Aeschynomene* spp. was documented by Genung & Allen (1962), Genung & Green (1965), and Kretschmer & Bullock (1979), respectively.

Production managers of three citrus groves in Hendry Co., Florida, contacted the Southwest Florida Research and Education Center (SWFREC) in Immokalee during October and November 1987 concerning damage to subcanopy irrigation systems. Samples of damaged sprinklers and connecting tubing from each grove exhibited circular holes and external scarring. Reports from the managers, who first discovered the damage during routine grove maintenance, implicated a caterpillar as the causal organism. Recovery of mature lepidopteran larvae, prepupae, and pupae from damaged microsprinklers and tubing confirmed the field reports. Identification of adults reared from field-collected pupae established that larvae of *S. sueroides* used the irrigation components as pupation sites.

Here we report costs to replace and repair destroyed sprinklers damage caused by *S. sueroides*, cultural practices that contributed to the relative severity of the damage within each grove, and possible control measures.

Material and Methods

Estimates of the total grove areas affected, number of sprinklers replaced, and replacement costs, i.e., materials and labor, were obtained from grove records. Information detailing prior land use, citrus plantings, irrigation systems, and cultural practices was obtained through interviews with the respective manager and by examination of grove records.

Cooperative Producers, Inc. (CPI). Located 3.5 km north of State Road (S.R.) 82, this grove consisted of 1,457 ha previously used to grow vegetables but now planted in either grapefruit, *Citrus paradisi* Macf., or sweet orange, *Citrus sinensis* (L.) Osb. var. 'Valencia'. Trees (358 per ha) were double-bedded (2 tree rows/ bed), with a tree spacing of 3.7 m by 7.6 m. Furrows, 7 m wide by 1.2 m deep, separated the elevated beds. Because of high water tables in southwest Florida, citrus trees are usually planted in parallel rows (beds) of mounded soil. These raised beds ensure adequate drainage around the root systems of young citrus plantings (Ziegler & Wolf 1975, Childers et al. 1987). The grove area that sustained damage was planted in grapefruit during November 1986. Since then, bahiagrass, *Paspalum notatum* Flügge, and bermudagrass, *Cynodon dactylon* (L.), covered the beds except for a 1.8 m wide strip that was banded within each tree now with a herbicide, while both grasses and broadleaf weed species established in the furrows. The beds were mechanically mowed twice during 1987; vegetation in the furrows, however, remained uncut until November. The irrigation system consisted of a 5.1-cm diam tube of flexible polyvinylchloride (PVC) that paralleled each tree row. The main line fed water via a 61 cm long by 7-mm diam section of flexible PVC tubing to a Bosmith® "SP" Series, Fan-Jet® sprinkler staked beside each tree. A large-capacity, Reese Clip-on® Citrus Insulator jacketed each tree trunk. Observations characterizing larval behavior of *S. sueroides* were made during October 1987 at the CPI grove.

Turner Corporation. Located north of, but adjacent to S.R. 82, this grove consisted of 1,052 ha planted in either 'Valencia' or 'Hamlin' oranges. Prior land use included vegetable production or cattle pasture. Like the CPI grove, rows were double-bedded and separated by a furrow; between row spacing, however, was 7.3 m. Trees (373 per ha) were planted during August 1987 and ground cover consisted of bahiagrass and broadleaf weeds. The beds were mowed twice in 1987, once in September and again in November. Furrow vegetation remained uncut until November. A Regulated Micro-Sprayer adjacent to each tree provided irrigation, while a Tree Saver® Citrus Tree Protector surrounded each trunk.

Johnson Grove. This 186-ha grove is located 10.1 km north of CPI and Turner and about 4.8 km east of S.R. 29. Previously the land served as cattle pasture. 'Valencia' or 'Hamlin' oranges were planted during February 1987. Tree spacing, bedding, and ground cover were as described for the CPI grove. Beds and furrows had been mowed five times since the February planting. Each tree was irrigated by a Bowsmith® "SK" Series, Fan-Jet® sprinkler, and each trunk was jacketed with a Sprout Saver® II Trunk Wrap.

Confirmation that *S. sueroides* damaged the irrigation system at the Turner grove was made from preserved larval and pupal specimens recovered by the grove manager from damaged sprinklers. In the Johnson grove, pupal exuviae of *S. sueroides* removed from desiccated weed stems adjacent to damaged sprinklers, together with micro-sprinkler damage like that observed in the CPI and Turner groves, provided evidence that damage resulted from larvae of this noctuid.

Estimates of *S. sueroides* larval population levels in the most severely damaged grove areas were obtained by counting the number of entrance holes present in the Reese Citrus Insulators (CPI) or the Citrus Tree Protectors (Turner). The design of the trunk wraps used at the Johnson grove prevented larvae from using these as pupation sites. Thirty randomly selected insulators were sampled at CPI and 28 tree protectors were sampled at the Turner grove. Values reported in the text represent the mean ± 1 SEM determined from these counts.

Voucher specimens of mature larvae, pupae, and adults were deposited in the United States National Museum, Smithsonian Institution, Washington, D.C., and the Florida State Collection of Anthropods (FSCA), Gainesville, Fla.

Results and Discussion

Of the three irrigation systems damaged by *S. sueroides* larvae, the CPI system sustained the highest number of destroyed sprinklers yet total replacement costs were $660.00 less than those incurred at the Turner grove (Table 1). Reasons for this, and the considerably lower number of damaged micro-sprinklers and resultant repair costs at the Johnson grove, can be attributed to several factors: 1) the abundance and distribution of host-plants within each grove, 2) type of micro-sprinkler, 3) larval population levels of *S. sueroides*, 4) presence of alternative pupation sites, and 5) grove cultural practices.

In the grove area (approx. 2.83 ha) having extensive sprinkler damage at CPI, larvae of *S. sueroides* actively fed on two fabaceous plants, phasey bean (*Macroptilium lathyroides* (L.) Urban) and American jointvetch (*Aeschynomene americana* L.) Indi-

TABLE 1. Estimates of infested areas (range) and cost of repairs to three citrus irrigation systems damaged by *S. sueroides* larvae in Hendry Co., Florida, 1987.

Grove	Infested area (ha)	No. sprinklers replaced	Cost: Materials	Cost: Labor
Turner	20.2-40.5[a]	300	$234.00	$1,266.00
CPI	32.4-40.5	1,200[b]	240.00	300.00
Johnson	12.1-16.2	100	20.00	30.00

[a]Total for three separate grove areas.
[b]Includes PVC tubing from sprinkler base to main water line.

vidual *M. lathyroides* were irregularly distributed between tree rows and within the herbicide-treated strips. All plants exhibited feeding damage, with most being severely or completely defoliated. Dense stands of *A. americana* that extended throughout the entire row length clogged the furrows and formed a nearly continuous vegetative border along the herbicide-treated strips. The border plants were a minimum of 1.4 m from the micro-sprinklers, ca. 1.2 m tall, and from 25-100% defoliated. Damage to the irrigation system outside this area was sporadic and coincided with the distribution and considerable reduction in the number of host plants growing within the furrows or between rows.

Determination of the exact host-plant composition and distribution within the Turner grove was not possible because both beds and furrows had been mowed prior to discovery of the damage to the irrigation system on 10 November. However, remains of *A. americana* not destroyed by the mowing were found bordering furrows in the areas that also had damaged sprinklers. In addition, the edges of drainage ditches running at right angles 4.6 m from the ends of the citrus beds still supported dense stands of *A. americana* that were from 75-100% defoliated.

The only fabaceous host found within the Johnson grove was *M. lathyroides*. Plants were distributed in a pattern similar to that observed in the CPI grove. All plants were at least partially defoliated while the majority were completely defoliated. The distribution of *M. lathyroides* largely coincided with grove areas having damaged micro-sprinklers. A few plants grew directly over the sprinklers, while the remaining *M. lathyroides* were located a maximum distance of 1.5 m from the irrigation components.

Thirty-six other plant species have been identified as hosts of *S. sueroides* (Table 2.). Several of these alternative hosts reportedly have been severely defoliated by *S. sueroides* larvae and include *Aeschynomene* spp. (Genung & Allen 1962, Genung & Green 1965, Kretschmer & Bullock 1979, Bullock & Kretschmer 1982), *Cassia* spp. (Sealy 1954, Weems 1954), *Poinciana* sp. (Sealy 1954), and *Sesbania* sp. (Sealy 1954, Wolfenbarger 1954, Genung & Green 1962).

After completing development on the host-plant, larvae crawled to the ground and migrated to the nearby irrigation system. Caterpillars then climbed up the micro-sprinklers and destroyed them by chewing an entrance hole, approximately 4.5-5.0 mm diam. in the PVC tubing. Larvae entered the tubing head first, reversed direction, sealed the hole with translucent silk, and pupated (Fig. 1). The use of the PVC tubing as a pupation site probably reflects a requirement of *S. sueroides* larvae for a suitable stem in which to pupate. Evidence for this comes from reports that describe larval behavior in relation to other plant hosts.

Skinner (1918) reported that *S. sueroides* larvae fed on foliage and later pupated within the bored-out stems of an unidentified variety of sensitive plant. Similarly, larvae of this noctuid consumed leaves and bored into stems of another jointvetch species, *Aeschynomene indica* L. (Genung & Allen 1962), and soybean, *Glycine max* (L.) (Genung & Green 1965). Kretschmer & Bullock (1979) recorded larval boring damage to 10 of 21 *Aeschynomene* species, including 9 of 98 *A. americana* accessions that were evaluated for potential use as cattle forage. In another study, however, *S. sueroides* larvae that attacked test plots of *A. american* left the host and pupated elsewhere (Bullock & Kretschmer 1982). The authors attributed this behavior to a larval requirement for a minimum diameter stem to serve as a pupal chamber, a condition usually not met by *A. americana* but satisfied by the more robust-stemmed *A. indica*.

The amount of damage inflicted by *S. sueroides* to each irrigation system depended on the type of micro-sprinkler used within the grove. The two-piece sprinklers at CPI suffered damage to both the 15.8-cm high PVC risers and the connecting tubing. Based on the degree of scarring that resulted from unsuccessful attempts by larvae to penetrate either component, the risers were subjected to higher levels of attack but sus-

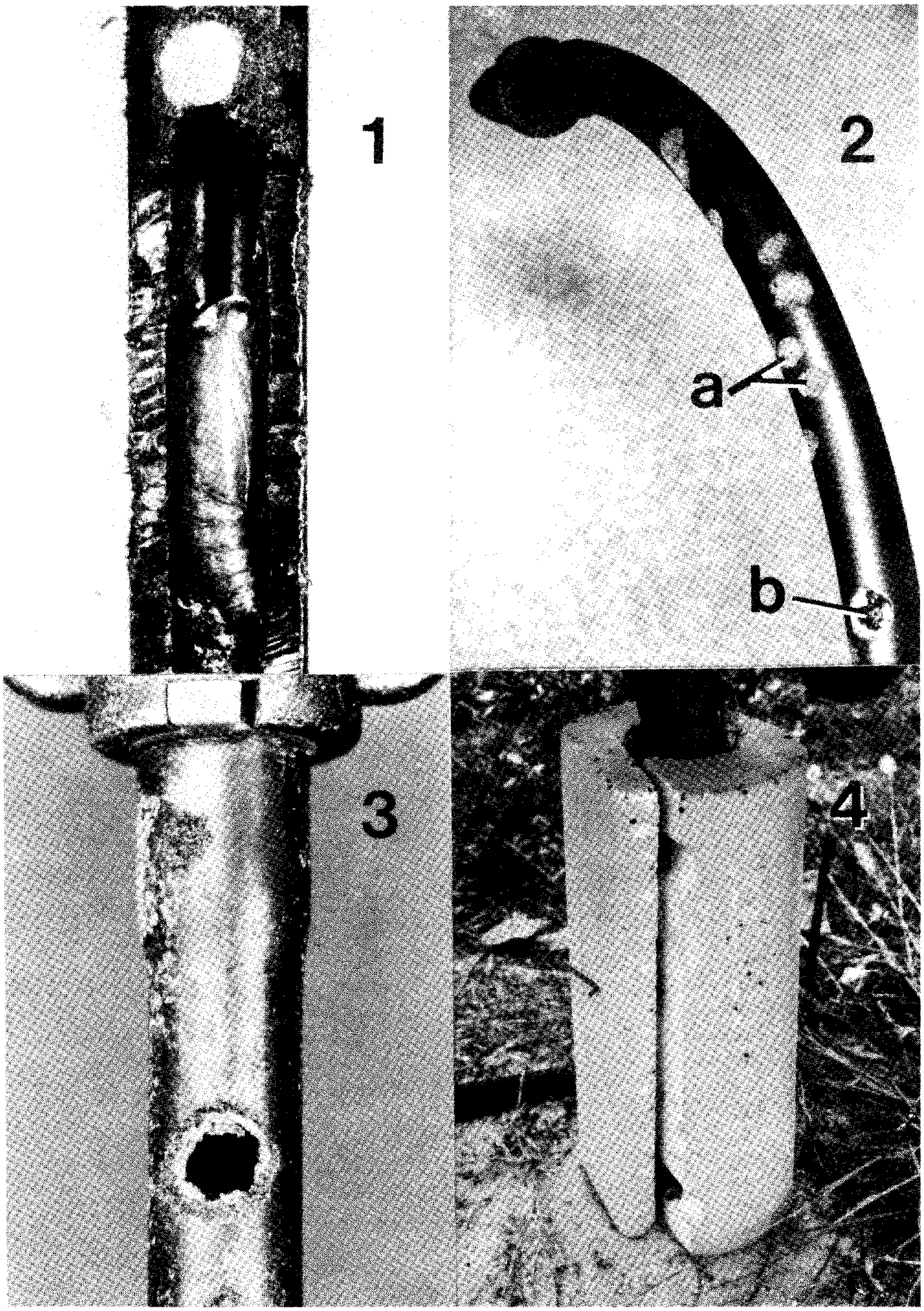
TABLE 2. FABACEOUS PLANT HOSTS OF *S. SUEROIDES*.

Species	References
Acacia sp.	Habeck (pers. comm.)
Aeschynomene americana L.	Kretschmer & Bullock (1979)
	Bullock & Kretschmer (1982)
	Present Study
Aeschynomene indicia L.	Genung & Allen (1962)
	Genung & Green (1965)
	Kretschmer & Bullock (1979)
Aeschynomene spp.[a]	Kretschmer & Bullock (1979)
Arachis sp.	Habeck (pers. comm.)
Cassia nictitans L.	Tietz (1972)
Cassia obtusifolia L.	Sealy (1954)
Cassia sp.	Weems (1954)
	Kimball (1965)
Crotolaria sp.	Habeck (pers. comm.)
Desmanthes virgatus (L.) Willd.	Genung & Allen (1962)
Desmodium sp.	Habeck (pers. comm.)
Glottidium sp.	Habeck (pers. comm.)
Glycine max (L.)	Genung & Green (1965)
Macroptilium lathyroides (L.) Urban	Present Study
Pithecellobium dulce (Roxb.) Benth.	Kimball (1965)
Poinciana sp.	Sealy (1954)
Sensitive plant[b]	Skinner (1918)
Sesbania punicea (Cav.) Benth.	Kimball (1965)
Sesbania sp.	Sealy (1954)
	Wolfenbarger (1954)
	Genung & Allen (1962)
Wild locust[c]	Kimball (1965)

[a]Nineteen additional species.
[b]May refer to *Acacia* sp., *Aeschynomene* sp., *Mimosa* sp., or *Sesbania* sp. (Kretschmer & Bullock 1979).
[c]May refer to either *Robinia* sp. or *Gleditsia* sp.

tained fewer successful penetrations. Risers were scarred for nearly the entire length, with some areas sustaining high levels of scarring that identifying individual points of attack was impossible. In contrast, the connecting tubing exhibited distinct chewed areas that easily identified the location of attempted entrance holes (Fig. 2). However, whereas the risers had only one hole/unit, the connecting tubes were penetrated from 1 to 3 times. This finding may reflect the difference in hardness of the PVC plastic that comprised each piece. In either case, a single hole in the component necessitated replacement.

The one-piece sprinklers at the Turner and Johnson groves actually reduced costs, because replacement of the damaged micro-sprinkler tubing depended upon where an *S. sueroides* larva chewed through the line. In general, larvae climbed the tubing and chewed a hole within 2.5 cm of the top (Fig. 3). In these instances, the sprinkler head was removed and then replaced after the tubing was cut back to just below the entrance hole. Complete replacement of the damaged sprinkler tubing took place only when an entrance hole occurred below this top 2.5-cm section. Despite the immediate savings in replacement costs provided by this technique, the long-term effects of altering spray coverage by shortening the PVC risers remain unknown. This probably would only be a problem in young citrus when changing the spray pattern might affect subsequent tree growth and yield.



Figs. 1-4. 1- Pupa of *S. sueroides* within PVC riser, CPI grove; 2- Terminal end of PVC connecting tubing exhibiting (a) scarred areas denoting failed attempts by larvae to chew through the tubing and (b) an *S. sueroides* entrance hole, CPI grove; 3- *S. sueroides* entrance hole located 1.6 cm below sprinkler head, Johnson grove; 4- Reece Citrus Insulator riddled with *S. sueroides* borings, CPI grove.

At the CPI and Johnson groves *S. sueroides* larvae also pupated in desiccated weed stems present within the herbicide-treated strips. The dried stems at CPI resulted from herbicide treatments applied to plants that established and matured prior to treatment. Those at the Johnbson grove were the remains of plants, principally dogfennel (*Eupatorium* sp.), not killed by herbicide application but cut by hand at ground level and discarded within the strips.

Alternatively, both the Reese Citrus Insulators (CPI) and the Tree Saver® trunk wraps (Turner) also served as pupation sites (Fig. 4). Within the 2.83-ha area having the heaviest sprinkler damage at CPI, we obtained an average of 38.1 ± 2.2 entrance holes/insulator. Based on tree density per hectare and not counting larvae still present on host plants, those migrating to the irrigation system, pupae within the sprinklers, connecting tubing, and dead stems, we conservatively estimated that a minimum of 13,640 *S. sueroides* larvae per hectare survived to the pupal stage. In contrast, the number of entrance holes in the trunk wraps at Turner averaged 2.3 ± 1.8 for an estimated survival rate of 855 larvae per ha. The substantial difference in population levels of *S. sueroides* within each grove can be attributed to the relative abundance and distribution of the larval host plants.

Grove cultural practices, primarily the mowing regime, probably contributed more than any other factor to determine the degree of damage sustained by each irrigation system. In the Turner and the CPI groves where furrow vegetation remained unmowed until November, large populations of *S. sueroides* larvae developed on abundant food supplies. Mature larvae, unable to use the host-plant stems as pupation sites, were forced to seek alternative sites, with the PVC irrigation tubing and sprinklers serving as suitable substitutes. Even in the Johnson grove where a limited number of host plants apparently kept larval populations from reaching outbreak levels, larvae pupated within the PVC tubing.

Based on our findings and field observations, keeping the furrow vegetation mowed would have substantially reduced damage and replacement costs at both the CPI and Turner groves. However, at the Johnson grove where vegetation in the furrows and citrus beds was mowed regularly, the problem was not completely eliminated. The few scattered host plants that grew within rows still supported sufficient numbers of *S. sueroides* larvae to cause minor damage.

To our knowledge, this is the first documented case *S. sueroides* larvae damaging subcanopy irrigation systems in citrus. Field observations showed that mature larvae traveled up to 4.6 m from host plants to locate suitable pupation sites and that host plant abundance, distribution, and species composition within a particular grove determined the amount of damage inflicted by this noctuid.

To prevent *S. sueroides* from establishing within a grove, we recommend that beginning in September vegetation should be regularly monitored for the presence of *A. americana*, *M. lathyroides*, and other potential fabaceous hosts. Host plants found growing within herbicide-treated strips should be removed, while furrow, citrus bed, and drainage ditch vegetation should be kept mowed at least through November.

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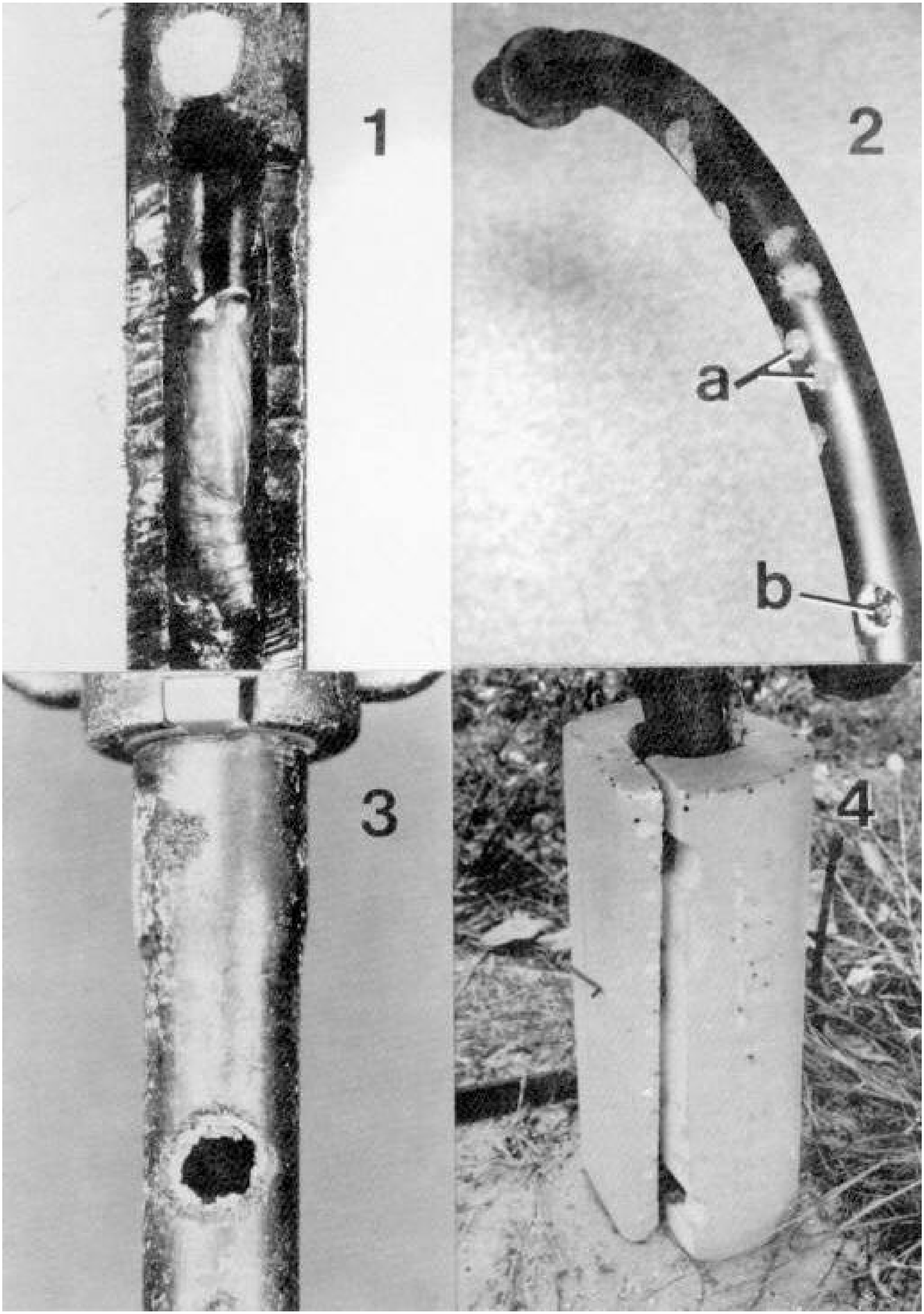
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