MILLIPEDES IN AND AROUND STRUCTURES IN FLORIDA[1]

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ABSTRACT

The 2 millipedes which most commonly become nuisances around structures in Florida are the greenhouse millipede, *Oxidus gracilis* Koch, and the tropical millipede, *Orthomorpha coarctata* (Saussure). Several others are bothersome more sporadically. The greenhouse millipede is more widespread, but is generally less of a problem because it appears to breed only in wild and overgrown areas where there is much decaying leaf litter from which it occasionally disperses to nearby structures. The tropical millipede apparently breeds in the thick lawngrass thatches common in south Florida.

The biology of the tropical millipede was found to be much like that of the better known greenhouse millipede. Egg to adult time for *Orthomorpha coarctata* was 119 to 187 days, with apparently 2 generations a year. Development continued slowly through the winter, but mating and egg laying appeared to begin in March. These millipedes were active through the night, but peak activity was reached in mid-morning and with the least activity during afternoon and early evening hours.

Oxidus gracilis fed on decaying organic matter, and could not be forced to eat grass or bean plants. In cross-mating tests, *gracilis* males attempted to mate with *coarctata* females, but no eggs were produced from these pairings.

In laboratory-scale control tests, the carbamates methomyl, carbaryl, and propoxur provided complete and quick kill of greenhouse millipedes.

Millipedes have for many years been reported as occasional nuisance pests in turfgrass and around business and home structures in Florida. This study, which was supported by the National Pest Control Association, was conducted to establish a better understanding of the millipede species present, their biology, and their control.

SPECIES ASSOCIATED WITH STRUCTURES

The millipedes were hand-collected on a series of trips. It was not possible to get reliably quantitative or qualitative samples with the mechanical techniques tried.

Most of the species do not appear to breed in lawngrasses, but occur in lawns and structures only when the millipedes sporadically build up large numbers in nearby breeding areas and disperse short distances (a few hundred feet).

For example, *Dicellarius okefenokensis* (Chamberlin) developed a huge population in a pile of decaying leaves under a porch of a home. When a heavy rain washed the millipedes out from under the porch, the homeowner was alarmed, but most of the millipedes soon desiccated and died. Similar instances of large numbers of other millipedes emerging from storm sewers have been described to us.

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We observed a population of the large, cylindrical *Narceus americanus* (Beauvois) invading a Pinellas County business establishment which was an island surrounded by a wide moat of asphalt parking lot. On 3 sides of the lot were overgrown, wet fields from which the millipedes were dispersing. They were mashed on the lot and some got into the building where they caused great consternation.

Pleuroloma cala (Chamberlin) was also encountered in the vicinity of structures, but was never abundant enough to be of concern.

The greenhouse millipede, *Oxidus gracilis* Koch, and the tropical millipede, *Orthomorpha coarctata* (Saussure), are almost indistinguishable. They are widespread in Florida, and more frequently become nuisances to a degree that control procedures are employed.

The greenhouse millipede is widely distributed and the best known of the 5 species mentioned. It is now found throughout the tropics and field populations occur throughout southern and western regions of the U.S. In this study, populations appeared to develop only in wild areas where there was much leaf litter and particularly in unused mucklands. Where such areas immediately adjoined residences, dispersing greenhouse millipedes were a severe nuisance around the nearest structures.

The tropical millipede was found only in the southern half of Florida. It occurs in the Tampa Bay region, but is more commonly a problem in southeast Florida. It evidently can breed in thickly thatched St. Augustine grass, feeding mostly on the great amount of decaying organic matter in these mats of turf.

Biology and Behavior

Orthomorpha coarctata

No significant writings on the biology and behavior of the tropical millipede were found, and accordingly, studies were made both of field populations and of cultures established in a rearing room in Gainesville. *Development*–The eggs are laid in the soil in holes 2 to 4 cm deep and 5 to 7 mm diam. Eleven batches from both field and laboratory contained 25 to 300 eggs.

Nine observed matings in the laboratory indicated that each female deposits only 1 batch, and it is left untended to develop. The eggs were translucent white to creamy yellow, smooth spheres, about 0.35 to 0.41 mm diam, and coated with a glutinous fluid which tended to make them clump together loosely. At temperatures averaging 78°F during the day and 72°F at night, the incubation period was 5 to 10 days.

Stadium I lasted 20 to 24 hr, with the larva–which is about 0.5 mm long–remaining almost motionless throughout as its 3 paired leg buds slowly expanded to almost full length.

Growth is reformative, with each molt giving more segments and legs. With the first molt the increase in segment number is from 7 to 9, with 1 pair of true legs on segments 2, 3, 4, and 6; 5 has 2 pairs of legs. Instar II is whitish, approximately 1.58 mm long, and active, moving into surrounding soil or on the soil surface. Stadium II lasted 18 to 20 days.

Instar III has 12 post-cephalic segments and bears 11 pairs of legs, with 2 pairs on each of segments 5, 6, 7, and 8. Segments 2, 3, and 4 always bear only

1 pair. Stadium III lasted 10 to 20 days. Toward the end of the stadium the larva may begin preparing a molting chamber 5 to 30 mm down in the soil. As development continues the chamber is enlarged.

Instar IV has 15 segments and for the first time the sexes are distinguishable. Females are slightly longer than males. Female IV instars have 17 pairs of legs; the male has 16 pairs, with the last pair replaced by small gonopod buds. The stadium lasted 14 to 25 days.

At the end of stadium VII the millipede metamorphoses into an adult. Egg to adult time ranged from 119 to 187 days. These data are not exact since the times are a composite from 15 individuals not all of which survived to adulthood.

Mating—Mating appeared to occur at any time of day. The male approached the female, usually from the rear, and crawled upon her back even when she was in motion. She sometimes carried the male about for hours. He moved up so his head was even with hers, and began rapidly stroking her head and first few segments with his first several pairs of legs. If she halted and twisted the front part of her body, the male then twisted so that his ventral surface was against hers and transferred a drop of spermatic fluid, held by the gonopods, to the vulvae of the female. After the transferral of the sperm, which took from 1 to 5 sec, the 2 millipedes separated. Males were observed to mate with more than 1 female, but females were never noted mating more than once.

Movement—Movement of these millipedes had to be studied by direct observation in open areas adjoining infested lawns. Pitfall traps were not reliable, nor were counts from ft^2 sections of turf dug up and inspected, nor the use of flotation or pyrethrum drench techniques used for lawn insects like chinch bugs and sod webworms. Counts and observations were made frequently, day and night, for a 7 day period in October 1971 around 2 homes in Hollywood, Florida. Measured sections of sidewalks were examined to try to get some quantitative data, and all areas of the premises were checked. Two-thousand marked millipedes were released during the week of study as a further aid to determining movement. Color codes were used to distinguish different days of release. A small spot of oil-based paint was applied to the dorsal surface of one of the middle body segments. It was established earlier that this was nontoxic and did not affect behavior. Nearly 4,000 sightings of millipedes are the basis of the following comments.

Using sightings on the measured sections of sidewalk as a criterion, the greatest millipede activity was from about 8 AM to 11 AM. The afternoon hours until about sunset saw very little activity. Through the night, from 10 PM to 7 AM, there was a steady, moderate level of activity—approximately one-third that of the morning peak level. Ambient temperatures ranged from a low of 76°F at 7 AM to 94°F at 1 PM. Temperatures in the turf were more stable, ranging from 76 to 86° at equivalent times. The relative humidity in the turf thatch remained stable; ambient humidity began dropping just as the increased morning activity started.

Areas where millipede movement was commonly observed were patios, outside walls, and foundations of buildings, and particularly where small ditches were edged out along sidewalks and foundations. On walls, the millipedes congregated at inside corners.

Few of the 2,000 marked individuals released on the sidewalks were seen again. Forty-four were resighted on the same sidewalks; only 2 of these were seen the same day they were released. Two-thirds of the re-sightings were on the third day after release, with others being noted up to 6 days.

Two marked individuals provided some idea of distance traveled. One was found on the back patio 11 hr after release, a straight line distance of 20 ft through turf. The other was found in a trap 50 hr after release, the shortest distance to the trap being 150 ft.

Seasonal cycle—Limited development apparently occurs during winter months in south Florida since active adults and V, VI, and VII instar larvae were found in small numbers in Ft. Lauderdale-Hollywood lawns in December and February. No egg laying was found in the field or laboratory cultures at that time, however. Mating was observed in March. If the information given earlier on development time is correct, eggs layed in March would result in mature individuals in June through August. Eggs laid during these latter months would result in a second generation of adults September through January.

This suggested seasonal cycle agrees with field observations. Increasing numbers of millipedes are found during the summer months, with pest level numbers occurring from late September to early December.

Oxidus gracilis

Feeding hosts—The life history and ecology of the greenhouse millipede have been studied by others (Causey 1943, Murakami 1962, Gromysz-Kalkowska and Stojalowska 1968, Giljarov 1957, Lang 1962) and were not emphasized in the present study. We were interested, however, in whether this millipede caused direct damage to lawngrass. McDaniel (1931) reported *O. gracilis* as a serious problem in forcing houses owing to feeding on tender roots and shoots of plants. Other authors have stated *O. gracilis* never feeds on living plant tissue or is of little economic importance (Causey 1943, Henneberry and Taylor 1961). Cook (1911) noted that the mouth parts are not adapted for biting and chewing, but consist of combs and scrapers for collecting soft, decaying materials. He mentioned that the only living plants eaten regularly are fleshy fungi such as *Amanita, Russula,* and *Lactarius.* He also said secondary damage might be caused by the millipedes' continued scraping of exposed surfaces of wounds and cuttings.

In the present study, *O. gracilis* was confined on individual, small lima bean plants and on St. Augustinegrass cuttings grown in inorganic medium. Five adult millipedes were placed in each cage which was an 1,800 ml beaker. Ninety-two percent of the millipedes died during the 35 days of the test. The plants were examined microscopically and no evidence of damage to living plant tissue—above or below the soil surface—was found. Feeding had occurred on the decaying leaf of a bean plant that died.

All of our work indicated that *O. gracilis* millipedes fed only on decaying organic matter. Our laboratory cultures were maintained on forest floor litter and decaying leaves.

Crossing tests—The general appearance of *Oxidus gracilis* is much like that of *Orthomorpha coarctata*, and as Murakami (1962) stated, the generic name of *O. gracilis* is questionable on many points. Both belong to the family Paradoxosomatidae (Strongylosomidae or Strongylosomatidae in some earlier works). *O. gracilis* was at one time placed in the genus *Orthomorpha*, and later taken from it and the new generic name *Oxidus* proposed, with *O.*

gracilis as the type (Cook 1911). Considering that the position of *coarctata* was never mentioned in the reassignment, the confusion attending past and present classifications of the class Diplopoda, the lack of usable keys, and lack of comprehensive works, *gracilis* and *coarctata* may well belong to the same genus.

In the present study, cross-mating between *gracilis* and *coarctata* was attempted to determine if the 2 are distinct species. The following procedure was repeated 10 times. Each of five VII instar female *coarctata* were isolated in individual petri dishes, as were 3 female and 8 male VII instar *gracilis.* They were supplied with food and water. They molted into adults within a few days of each other, at which time a male *gracilis* was paired with 1 female of each species–giving 5 pairs of *gracilis-coarctata,* and 3 pairs of *gracilis-gracilis* as controls.

The males attempted to mate with both species. After 4 weeks all *gracilis-gracilis* pairs had produced viable eggs. After 3 1/2 months, when the test was terminated, none of the *gracilis-coarctata* pairs had produced eggs.
Control–Millipede control has been difficult, as many toxicants widely used in turf insect control are of little use against millipedes. Enough *Oxidus gracilis* could be collected to conduct laboratory-scale tests to give a fairly precise measure of which toxicants millipedes are susceptible to.

Three replicates of each treatment were made. Acetone solutions of the toxicants were placed in the bottom of 9 cm glass petri dishes, in the amount of 1.9 ml per dish. Concentrations used were 0.333, 0.167, 0.084, 0.042, and 0.021%. The checks were treated with plain acetone. After the acetone evaporated, leaving a film of toxicant on the glass, 7 males and 8 females were placed in each treated dish. After 15 min of exposure to the toxicants, the millipedes were transferred to clean holding dishes.

Mortality readings were taken during the 15 min of exposure, 30 min after exposure began, 24 hr after, and 48 hr after. The criterion of death was a completely moribund condition in which there was no response to prodding. It was necessary to hold the millipedes in a high humidity cabinet to prevent desiccation. They were held in petri dishes floored with moistened filter paper, but they were not fed during the test.

The 10 pesticides tested in this way were methomyl, carbaryl, propoxur, lindane, chlordane, malathion, carbophenothion diazinon, chlorpyrifos, and Gardona (2-chlor-1-(2, 4, 5-trichlorophenyl) vinyl dimethyl phosphate). *Bacillus thuringiensis* (BT) was tested at rates equivalent to 1.5 and 4 lb/acre. The BT was suspended in water and deposited on moist humus and detritus placed in the petri dishes. The millipedes were held continuously in the dishes with BT, and mortality counts taken for 10 days.

Gardona, chlordane, BT and the checks had no mortality. Lindane caused no mortality at 0.167% and less than 40% mortality at 0.333%. Malathion, carbophenothion, diazinon, and chlorpyrifos gave partial control, in the range of 50 to 70%.

The 3 carbamates, methomyl, carbaryl, and propoxur, were most effective. The 2 highest concentrations gave 100% kill after 4 to 5 hr in all cases. Analysis of variance indicated no significant differences among these 3, and with all 3 providing highly significant kill compared to the check.

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