ARGENTINE ANTS (HYMENOPTERA: FORMICIDAE) INVADE SANTA CRUZ ISLAND, CALIFORNIA

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ABSTRACT

The ecologically destructive Argentine ant, *Linepithema humile*, was discovered on Santa Cruz Island, California, in January 1996. By inspection of ground cover and potential foraging sites, we mapped its range in July 1997, finding it restricted to two sites on the southeast section of the island, covering areas of approximately 1.5 km^2 and 0.05 km^2, respectively. Follow-up surveys employing baited traps in 1998 confirmed the limit of infestation, and documented both the exclusion of most native ant species within colonized zones and a relatively stable boundary to infestation. We estimate the age of the infestation to be five to ten years.

Keywords: *Linepithema humile*, Argentine ant, tramp ant, Santa Cruz Island.

INTRODUCTION

Tramp ants are ant species that associate with humans and are spread by human commerce. They travel the world hidden in our plant products, packaging material, building supplies, and heavy machinery such as logging and military equipment (Williams 1994). The ecological importance of most tramp ant species remains undocumented. Several, however, are known to have dramatic impacts. When these ants invade, the entire biological community is transformed, as native invertebrate species are replaced by an impoverished set of ant-tolerant and usually non-native species (Williams 1994). Here we report the spread of a highly destructive tramp ant species, the Argentine ant, *Linepithema humile*, to Santa Cruz Island of the California Channel Islands.

Linepithema humile, a native of South America, is an important pest ant in many subtropical and temperate regions, such as the southern U.S. from Florida to California (Newell and Barber 1913; Barber 1916; Ward 1987). In areas where this ant invades, native invertebrates are heavily impacted (Erickson 1971; Ward 1987; Cole et al. 1992; Gillespie and Reimer 1993; Human and Gordon 1997). Newell and Barber (1913) described how *L. humile* attacks birds: "the workers swarm over young chicks in such numbers as to cause their death...nests of many birds are frequented by the ants in the same way, and the number of young birds destroyed in this manner must be considerable."

Linepithema humile was first introduced to California earlier this century and has been steadily moving across the state, exterminating native invertebrates throughout lowland areas (Ward 1987; Human and Gordon 1997). In January 1996, Wenner first discovered *L. humile* on Santa Cruz Island of the California Channel Islands. *L. humile* was already known on two other Channel Islands, the populated islands of Santa Catalina and San Clemente (Miller, pers. comm.). Santa Cruz Island is of special concern because it is entirely a nature reserve. The western 90% of the island is owned by The Nature Conservancy and the remainder is owned by the National Park Service. At 245 km^2, Santa Cruz Island is the largest of the Northern Channel Islands and has the most diverse habitats (Miller 1985). *L. humile* is the only destructive tramp ant known to have invaded Santa Cruz Island, and it is likely that the previous absence of tramp ants has permitted many native invertebrates to persist there. Many terrestrial plants and animals are endemic to the Channel Islands, including more than 100 insect species (Miller 1985). Also found on Santa Cruz Island are more than 140 species of land birds (Power 1976; Diamond and Jones 1980), several terrestrial and marine mammals (Wenner and Johnson 1980), and 34 species of ants (Wetterer et al., In prep.).

MATERIALS AND METHODS

Three surveys were conducted. The first, conducted July 1997 by Calderwood with Emily Hebard of The Nature Conservancy, consisted of walking a number of transects through areas around known or suspected *Linepithema humile* infestations, looking for ants under ground cover such as rocks, logs, and boards, and inspecting potential foraging sites such as the branches of *Quercus agrifolia* and *Baccharis pilularis*, plants housing aphids and other homopterans attractive to some ants, including *L. humile*. Transects were

chosen based on topography and ground cover, utilizing roads, stream beds, and pig trails where dense foliage prevented overland travel. In the Sacramento Valley in northern California, this method of inspection was as effective as baiting or leaf litter sifting in detecting the presence of *L. humile* (Ward 1987). Early in the survey, we discovered that only two ant species, a species of *Solenopsis* and a species of *Monomorium*, later identified as *S. molesta* and *M. ergatogyna* (Wetterer et al., In prep.), were taken with *L. humile* at sampling points. Therefore, the absence of *L. humile* could be reasonably assumed whenever an ant other than the above three was taken at a site, at least away from the margins of the range of L. *humile*. The only inconclusive sampling points were those in which no ants, or only *S. molesta* or *M. ergatogyna*, were taken.

In the second survey, led by Wetterer in March 1998, we laid baited traps, each consisting of a small piece of tuna and some cookie crumbs (Pecan Sandies™) on an index card which was collected approximately 1 hr later. In addition to reinforcing the data gathered on the known infestations, the second survey examined other parts of the island, particularly sites most likely to harbor recent infestations such as landings, roads, and buildings which were not explored in the first survey.

The third survey, led by Wetterer in May 1998, focused on the small upper infestation, mapping its margins with a tape measure to the nearest meter at six of eight compass points in preparation for a test of an eradication technique using hydramethylnon.

RESULTS

The July 1997 survey found that *Linepithema humile* occurred on two separate areas surrounding two dismantled Navy facilities (Figure 1). The areas of the two infestations were approximated at 1.5 km^2 and 0.04 km^2 in area, respectively.

After the follow-up survey in March 1998, we found the area occupied by *L. humile* had not changed measurably. Flags placed in 1997 to mark the ant's distribution still accurately marked the boundary (Figure 1). The broadened search of the island turned up no new infestations (Figure 1, inset). The Stanton Ranch Houses (now occupied by The Nature Conservancy), the University of California Field Station, Prisoners Harbor, the road running the length of the central valley, and the perimeter of an active Navy base just east of the smaller infestation site were all examined and found free of *L. humile*.

The third survey, of May 1998, a resurvey of the smaller upper site, mapped the margins of the range of *L. humile* at six of eight compass points as radial distances from a dead peach tree near the cliff on the former site of the Navy facility: N, 130 m; NE, 93 m; E, 121 m; SE, inaccessible; S, 233 m; SW, inaccessible; W, 130 m; NW, 134 m. The treacherous scree slope to the south was explored by Wetterer and was found to harbor *L. humile*. The least polygon connecting these six points covers approximately 0.05 km^2 and serves as a conservative minimum. Rounding the corners of the curve yields an area of approximately 0.06 km^2.

In summary, the larger of the two infestations presumably radiated from the lower dismantled Navy site (Figure 1) and now occupies the entire Three-Fork Canyon watershed from sea level to approximately 230 m elevation, the deep canyon adjacent to the west to the same elevation, Cañada Pomona and the surrounding valley west to nearly Rancho del Sur (where an orchard exists today), and to the southwest, up the tributaries of Cañada Pomona to less than 100 m elevation, covering approximately 1.5 km^2. The ridge west of Ceanothus Canyon lies just east of the eastern boundary of the range of *L. humile* at this lower site. The smaller infestation occupies the area within approximately 100 to 200 m radius of the center of the upper dismantled Navy site (Figure 1) reaching the road which passes north of the site at only one point, near the access driveway, a total of 0.05 to 0.06 km^2.

DISCUSSION

Both sites of infestation of *Linepithema humile* appear to radiate from sites of Navy installations which were dismantled in 1995. The heavy equipment used in such an operation suggests a possible source for the infestation. However, the rate of spread of these infestations appears to be, at least recently, much less than the 100 m/yr reported by Erickson (1971). Extrapolating this rate of growth back to the center of the range of *L. humile* requires nearly ten years of expansion, with a low estimate of five years. Either the populations of *L. humile* underwent rapid initial expansion which has since stabilized or they are much older than the dismantling operation of 1995. If the populations have stabilized, altitude may be playing a role. The larger site is restricted to elevations under 250 m. Ward (1987) found no populations above 300 m in his northern California study area. The much smaller size of the upper site suggests that at 380 m elevation, *L. humile* may be near its altitudinal limits there, though the vigor of that infestation may be further reduced by the lack of any permanent source of water except ridgetop dew. Since no clear factor is limiting the spread of *L. humile*, the more parsimonious hypothesis is that the lower infestation is old and its spread has been slow. The hypothesis of an infestation originating in 1995 would require an initial speed of spread of >500 m/yr, greater than ever recorded.

If the small upper infestation began at the now-dismantled Navy site, it has radiated much farther southward (down a steep slope) than in any other direction. If this reflects the fact that lower elevations are more favorable to *L. humile*, there is a threat that the population may release southward and accelerate its advance. Any eradication effort must pay greatest attention to this boundary. Of course, it may also be that gravity is responsible for the rapid spread of *L. humile* southward. This possibility demands that any monitoring of an eradication attempt must include an

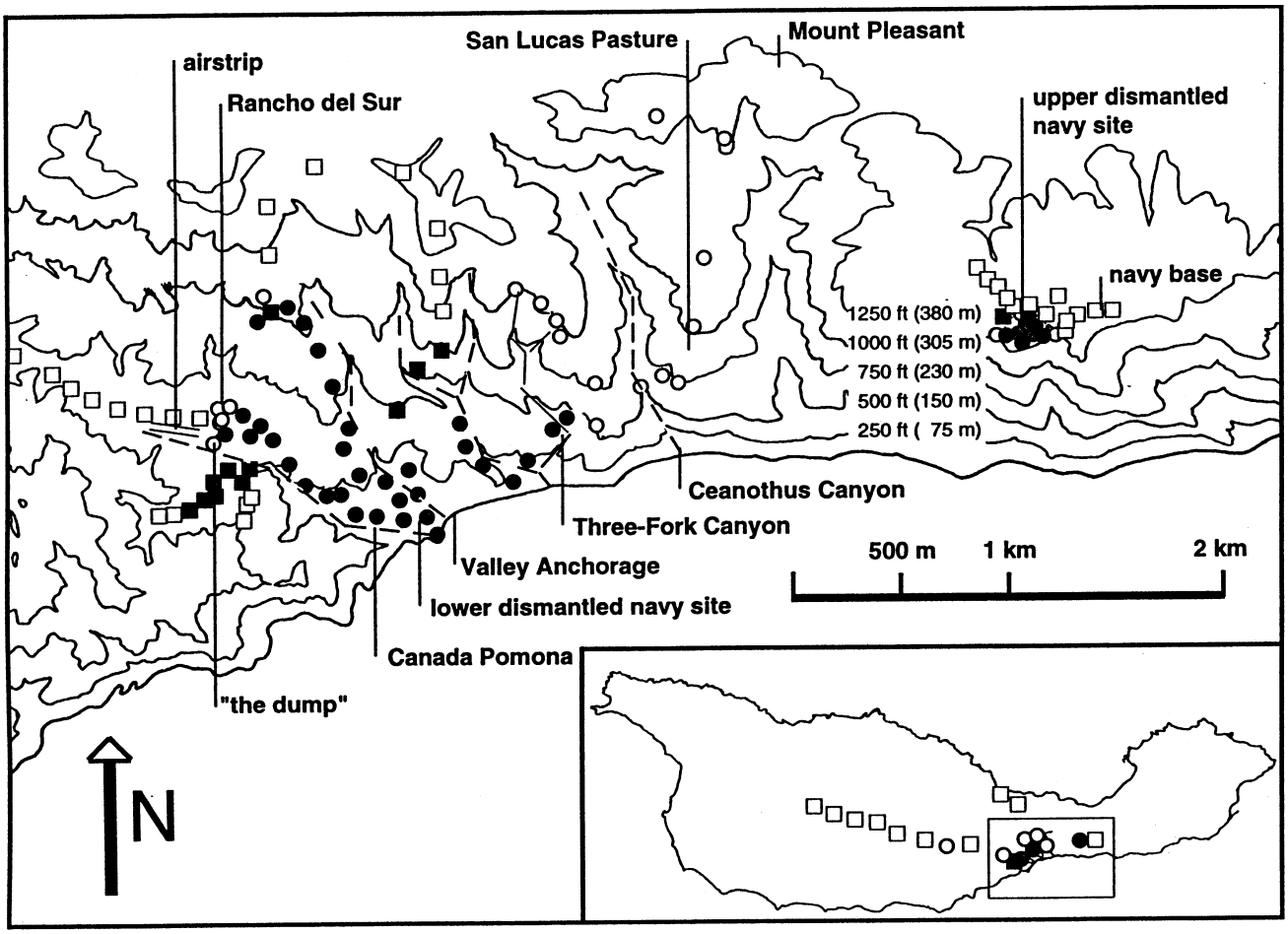

Figure 1. Distribution of the Argentine ant, *Linepithema humile*, on Santa Cruz Island, showing results of both July 1997 survey (circles) and March 1998 survey (squares). Inset: map of Santa Cruz Island indicating area of main map. Key: solid lines- topography at 250 ft (approximately 80 m) intervals, dashed lines- stream courses, grey circles or squares- sites with *L. humile*, white circles or squares- sites without *L. humile*.

examination of the slope all the way down to sea level in order to rule out a jump dispersal by way of tumbling rocks or logs infested with ants.

Linepithema humile on Santa Cruz Island has displaced most native ants within its range (Wetterer, Wetterer, and Hebard, In prep.), as was found in the Sacramento Valley (Ward 1987). Clearly, these surveys confirm the grave threat posed by *L. humile* to Santa Cruz Island biodiversity, especially to the 34 species of ants now known from the island (Wetterer et al., In prep.), and justify attempts to eradicate it.

We hope to test the use of chemical toxins for controlling *L. humile* on the island. Chemicals are commonly used for controlling tramp ants. Chemical control of ants may be particularly useful on small islands or with very localized populations as on Santa Cruz Island. Chemical methods are currently being employed to control the much larger infestation in Haleakala National Park on Maui, Hawaii (Krushelnycky and Reimer 1996). Hydramethylnon has been found to be effective against *L. humile* in citrus groves (Gaston and Baker 1984) and has full EPA approval (Krushelnycky and Reimer 1996). Hydramethylnon has been used in many situations to control other tramp ants as well. For example, application of hydramethylnon has controlled the tramp ant *Wasmannia auropunctata* on Santa Fe Island in the Galapagos (Abedrabbo 1994).

In future research, we plan to resurvey the island to monitor the effectiveness of control measures and the expected recovery of invertebrate biodiversity if *L. humile* is removed from the island. In addition, we plan to survey ants on the other California Channel Islands to determine whether any tramp ants have invaded. We plan to start with surveys of abandoned military facilities, such as the dismantled military base on Santa Rosa Island. It is important that any invasions by *L. humile* or other tramp ants are detected and stopped as soon as possible, before they spread any further.

ACKNOWLEDGMENTS

We wish to thank A. Anderson, A. Aronwitz, K. Bartniczak, M. Bemon, J. Burger, C. Dunning, J. Gallagher, A. Ghaneker, L. Geschwind, D. Han, J. Howarth, E. Hebard, M. Hill, R. Lee, C. Mealey, A. Mingo, L. Patterson, M.

Patton, S. Riseman, J. Rowe, A. Southern, and A. Wetterer for field assistance.

We thank L. Laughrin of the University of California Field Station, D. Devine and R. Klinger of The Nature Conservancy, and T. Coonan of the National Park Service for logistical support and accommodations on Santa Cruz Island. The Santa Barbara Museum of Natural History and Columbia University provided financial support.

LITERATURE CITED

Abedrabbo, S. 1994. Control of the little fire ant, *Wasmannia auropunctata*, on Santa Fe Island in the Galapagos Islands. Pages 219-227 *in* Williams, D. F. (ed.), Exotic Ants: Biology, Impact, and Control of Introduced Species. Westview Press, Boulder, CO.

Barber, E. R. 1916. The Argentine ant: distribution and control in the United States. United States Department of Agriculture Bulletin 377:1-23.

Cole, F. R., A. C. Medeiros, L. L. Loope, and W. W. Zuehlke. 1992. Effects of the Argentine ant on arthropod fauna of Hawaiian high-elevation shrubland. Ecology 73:1313-1322.

Diamond, J. M. and H. L. Jones 1980. Breeding land birds of the Channel Islands. Pages 597-612 *in* Power, D. M. (ed.), The California Islands: Proceedings of a Multidisciplinary Symposium. Santa Barbara Museum of Natural History, Santa Barbara, CA.

Erickson, J. M. 1971. The displacement of native ant species by the introduced Argentine ant *Iridomyrmex humilis* Mayr. Psyche 78:257-266.

Gaston, L. K. and T. C. Baker 1984. Toxic bait to control Argentine ant field tested. Citograph: 188.

Gillespie, R. G. and N. J. Reimer 1993. The effect of alien predatory ants (Hymenoptera: Formicidae) on Hawaiian endemic spiders (Araneae: Tetragnathidae). Pacific Science 47:21-33.

Human, K. G. and D. M. Gordon 1997. Effects of Argentine ants on invertebrate biodiversity in northern California. Conservation Biology 11:1242-1248.

Krushelnycky, P. D. and N. J. Reimer 1996. Efforts at control of the Argentine ant in Haleakala National Park, Maui, Hawai'i. Cooperative National Park Resources Study Unit, University of Hawai'i Technical Report 109:1-33.

Miller, S. E. 1985. The California Channel Islands—past, present, and future: an entomological perspective. Pages 3-27 *in* Menke, A. S. and D. R. Miller (eds.), Entomology of the California Channel Islands. Santa Barbara Museum of Natural History, Santa Barbara, CA.

Newell, W. and T. C. Barber 1913. The Argentine ant. U. S. Department of Agriculture Bulletin 221:1-98.

Power, D. M. 1976. Avifauna richness on the California Channel Islands. Condor 78:394-398.

Ward, P. S. 1987. Distribution of the introduced Argentine ant (*Iridomyrmex humilis*) in natural habitats of the lower Sacramento Valley and its effects on the indigenous ant fauna. Hilgardia 55:1-16.

Wenner, A. M. and D. L. Johnson 1980. Land vertebrates on the California Channel Islands: sweepstakes or bridges? Pages 497-530 *in* Power, D. M. (ed.), The California Islands: Proceedings of a Multidisciplinary Symposium. Santa Barbara Museum of Natural History, Santa Barbara, CA.

Williams, D. F. (ed.) 1994. Exotic Ants: Biology, Impact, and Control of Introduced Species. Westview Press, Boulder, CO.

SOURCES OF UNPUBLISHED MATERIALS

Miller, S. E. International Centre of Insect Physiology and Ecology, Box 30772, Nairobi, Kenya and National Museum of Natural History, Smithsonian Institution, Washington, DC 20560. Personal communication.

Wetterer, J. K., A. L. Wetterer, and E. Hebard. In preparation. Impact of the Argentine ant, *Linepithema humile*, on the native ants of Santa Cruz Island, California.

Wetterer, J. K., A. L. Wetterer, P. S. Ward, J. T. Longino, J. C. Trager, and S. E. Miller. In preparation. Ants (Hymenoptera: Formicidae) of Santa Cruz Island, California.