

Ants (Hymenoptera: Formicidae) of Santa Cruz Island, California

James K. Wetterer¹, Philip S. Ward², Andrea L. Wetterer¹,
John T. Longino³, James C. Trager⁴ and Scott E. Miller⁵

¹Center for Environmental Research and Conservation, 1200 Amsterdam Ave.,
Columbia University, New York, New York 10027

²Department of Entomology, University of California, Davis, California 95616

³The Evergreen State College, Olympia, Washington 98505

⁴Shaw Arboretum, P.O. Box 38, Gray Summit, Missouri 63039

⁵International Centre of Insect Physiology and Ecology, Box 30772,
Nairobi, Kenya and National Museum of Natural History, Smithsonian
Institution, Washington, DC 20560

Abstract.—We conducted ant surveys on Santa Cruz Island, the largest of the California Channel Islands, in 1975/6, 1984, 1993, and 1998. Our surveys yielded a combined total of 34 different ant species: *Brachymyrmex* cf. *depilis*, *Camponotus anthrax*, *C. clarithorax*, *C. hyatti*, *C. semitestaceus*, *C. vicinus*, *C. sp.* near *vicinus*, *C. yogi*, *Cardiocondyla ectopia*, *Crematogaster californica*, *C. hespera*, *C. marioni*, *C. mormonum*, *Dorymyrmex bicolor*, *D. insanus* (s.l.), *Formica lasioides*, *F. moki*, *Hypoconerops opacior*, *Leptothorax andrei*, *L. nevadensis*, *Linepithema humile*, *Messor chamberlini*, *Monomorium ergatogyna*, *Pheidole californica*, *P. hyatti*, *Pogonomyrmex subdentatus*, *Polyergus* sp., *Prenolepis imparis*, *Pseudomyrmex apache*, *Solenopsis molesta* (s.l.), *Stenamamma diecki*, *S. snellingi*, *S. cf. diecki*, and *Tapinoma sessile*. The ant species form a substantial subset of the mainland California ant fauna. We found only two ant species that are not native to North America, *C. ectopia* and *L. humile*. *Linepithema humile*, the Argentine ant, is a destructive tramp ant that poses a serious threat to native ants.

The California Channel Islands lie in the Pacific Ocean, 20 to 100 km off the coast of southern California. As a result of isolation from the mainland, many endemic plant and animal species have evolved on these islands (Wenner and Johnson 1980; Diamond and Jones 1980; Nagano et al. 1983; Junak et al. 1995), including more than 100 species of endemic insects (Miller 1985). Two ant species, *Aphaenogaster patruelis* Forel and *Camponotus bakeri* Wheeler, are recognized as endemic to the Channel Islands (Miller 1985).

Santa Cruz Island (SCI) is the largest (245 km²) of the Channel Islands. In the past, SCI was used for ranching of cattle, sheep, and horses, as well as some agriculture and tourism (Junak et al. 1995). There were also several military installations. SCI is now entirely a nature reserve, with a resident human population of fewer than twenty people. One small, largely unmanned U.S. Navy installation remains. The western 90% of the island is owned by The Nature Conservancy, a private conservation organization, and the eastern 10% is part of

* Correspondence to James K. Wetterer. Current address: Honors College, Florida Atlantic University, 5353 Parkside Drive, Jupiter, FL 33458.

Table 1. Ant species recorded on Santa Cruz Island. Pub = previous records (see Introduction). * = unpublished record (see Results). T75/6 = Trager and Trager surveys in 1975/6. L84 = Longino survey in 1984. PW93 = Ward et al. survey in 1993. JW98 = Wetterer et al. survey in 1998. X = found in survey.

Species	Survey				
	Pub	T75/6	L84	PW93	JW98
<i>Brachymyrmex</i> cf. <i>depilis</i>					X
<i>Camponotus anthrax</i> Wheeler	X	X			
<i>Camponotus clarithorax</i> Emery		X	X	X	X
<i>Camponotus hyatti</i> Emery		X	X	X	X
<i>Camponotus semitestaceus</i> Snelling		X	X	X	X
<i>Camponotus vicinus</i> Mayr			X		
<i>Camponotus</i> sp. near <i>vicinus</i>	X	X	X	X	X
<i>Camponotus yogi</i> Wheeler			X	X	
<i>Cardiocondyla ectopia</i> Snelling					X
<i>Crematogaster californica</i> Wheeler				X	
<i>Crematogaster hespera</i> Buren			X	X	
<i>Crematogaster marioni</i> Buren		X	X	X	X
<i>Crematogaster mormonum</i> Wheeler	X	X			
<i>Dorymyrmex bicolor</i> Wheeler		X	X	X	X
<i>Dorymyrmex insanus</i> (Buckley) (s.l.)		X	X	X	X
<i>Formica lasioides</i> Emery		X			
<i>Formica moki</i> Wheeler	X	X	X	X	X
<i>Hypoponera opacior</i> (Forel)		X	X	X	X
<i>Leptothorax andrei</i> Emery		X	X	X	X
<i>Leptothorax nevadensis</i> Wheeler	*	X			
<i>Linepithema humile</i> (Mayr)					X
<i>Messor chamberlini</i> Wheeler	X			X	X
<i>Monomorium ergatogyna</i> Wheeler	X		X	X	X
<i>Pheidole californica</i> Mayr	X	X	X	X	X
<i>Pheidole hyatti</i> Emery	X	X	X	X	X
<i>Pogonomyrmex subdentatus</i> Mayr					X
<i>Polyergus</i> sp.		X		X	X
<i>Prenolepis imparis</i> (Say)	X	X	X		X
<i>Pseudomyrmex apache</i> Creighton	X	X		X	X
<i>Solenopsis molesta</i> Say (s.l.)		X	X	X	X
<i>Stenamma diecki</i> Emery			X	X	
<i>Stenamma snellingi</i> Bolton				X	
<i>Stenamma</i> cf. <i>diecki</i>				X	
<i>Tapinoma sessile</i> (Say)		X	X	X	X
# of species	10	21	20	24	23
# not recorded in earlier surveys		13	4	3	4

Channel Islands National Park. The island is far from pristine, with large populations of exotic plants (e.g., fennel, *Foeniculum vulgare* Miller) and animals (e.g., feral pigs, *Sus scrofa* L.) (Junak et al. 1995).

The California Channel Islands remain poorly studied by biologists. There have been no published comprehensive ant surveys of any of the California Channel Islands, and we found few published records of ants from SCI. Earlier published records noted only 10 different ant species on SCI (Table 1). Wheeler (1915) described *Messor chamberlini* Wheeler from SCI and also recorded *Pheidole californica* Mayr. Fall and Davis (1934) collected *Pheidole hyatti* Emery on SCI,

incidental to their study of the island's beetles. Mallis (1941) added *Prenolepis imparis* (Say), *Camponotus* sp. near *vicinus* (as *Camponotus sansabeanus vicinus* var. *maritimus*), and *Formica moki* Wheeler (as *Formica rufibarbis* var. *occidua*) to the list. More recent ant records from SCI include additional *Formica moki* (Francoeur 1973; Francoeur and Snelling 1979), as well as *Crematogaster mormonum* Wheeler (Rentz and Weissman 1981), *Pseudomyrmex apache* Creighton (Ward 1985), *Monomorium ergatogyna* Wheeler (Dubois 1986), and *Camponotus anthrax* Wheeler (Snelling 1988).

From the published records of only 10 ant species known from SCI, one might conclude that the diversity of ant fauna of this island is quite impoverished compared to the ant fauna of mainland California sites, where ant surveys typically collect more than 20 ant species (see Discussion). However, we present the results of four ant surveys conducted on SCI in 1975/6, 1984, 1993, and 1998, which greatly expand the known species list for SCI. This present synthesis was prompted by the discovery on SCI of the Argentine ant, *Linepithema humile*, a highly destructive tramp ant that poses a serious threat to native ants. Adrian Wenner first found *L. humile* on SCI in January 1996. A follow-up study by Andrew Calderwood and Emily Hebard in July 1997 found that *L. humile* occupied two noncontiguous areas, surrounding two dismantled Navy support facilities, that totaled less than 1% of the island (Calderwood et al. 1999).

Methods

In the fall of 1975, G. Trager surveyed ants on Santa Cruz Island using hand-collecting. In the summer of 1976, G. Trager and J. Trager further surveyed SCI ants using hand-collecting and tuna bait transects. J. Trager identified the ants from 1975/6. Vouchers are in the personal collection of G. Trager and unavailable for this study. From 24–27 August 1984 and 26–29 October 1984, J. Longino surveyed SCI ants using hand-collecting. Longino identified these ants and placed vouchers in the Natural History Museum of Los Angeles County (LACM) and the University of California (UC) Field Station on Santa Cruz Island. On 25–28 June 1993, P. Ward, B. Fisher, and M. Bennett surveyed SCI ants using hand-collecting and Winkler litter sifting. Ward identified the ants and placed vouchers in the Bohart Museum of Entomology, University of California, Davis, and duplicates at the LACM and the Museum of Comparative Zoology at Harvard University (MCZ). Finally, in March–May 1998, J. Wetterer, A. Wetterer, A. Wenner, A. Calderwood, and E. Hebard surveyed ants (with the assistance of numerous volunteers, primarily undergraduate students studying at Biosphere 2 Center), using hand-collecting, bait transects (with tuna and Pecan Sandies cookies as bait), and litter samples in Berlese funnels. S. Cover at the MCZ and P. S. Ward identified these ants. We have placed voucher specimens in the MCZ.

Results

Each of the four surveys of Santa Cruz Island yielded 20 to 24 ant species (Table 1). Altogether, a total of 34 different ant species were recorded by our surveys, including all 10 previously recorded species (Table 1). All 34 species are known from mainland California. Only 13 ant species were found in all four surveys, and only four of these had been previously recorded from SCI. Each of the surveys yielded at least three ant species not recorded in any earlier survey

(Table 1). None of the surveys collected either of the two endemic Channel Island ant species.

There are a number of taxonomic problems concerning the ants of SCI. Two ants, *Dorymyrmex insanus* (Buckley) (s.l.) and *Solenopsis molesta* Say (s.l.), belong to species-groups whose species boundaries have not been adequately defined (S. Cover, personal communication). Several researchers first identified the *Polyergus* specimens from SCI as *Polyergus breviceps* Emery. However, Trager (personal observation) determined the specimens to be an undescribed species with physical proportions quite distinct from *P. breviceps*. This undescribed species is unique to southern California and parasitizes only *F. moki*. We were unable to identify with certainty two ant species, listed as *Brachymyrmex* cf. *depilis* and *Stenamma* cf. *diecki*.

Cover and Longino identified *Camponotus* sp. near *vicinus* as the ant Wheeler (1910) described as *Camponotus maculatus vicinus* var. *maritimus* Wheeler, but this ant was referred to *Camponotus vicinus* Mayr by Creighton (1950). Both *Camponotus vicinus* and *Camponotus* sp. near *vicinus* occurred on SCI where they are distinct and appear to represent separate species. *Camponotus* sp. near *vicinus* was very common on SCI, whereas true *C. vicinus* was rare. In 1984, Longino found only one nest of true *C. vicinus*, under dead wood in the pine stand on the east end of SCI. In contrast, Longino (personal observation) found that *Camponotus* sp. near *vicinus* was rare in the chaparral around Santa Barbara on the adjacent mainland California, where true *vicinus* was common. Longino examined all *C. vicinus* and *C. sp. near vicinus* specimens at the Los Angeles County Museum, and concluded that some specimens from farther south in California were apparently intermediate between the two forms. In northern California, the two species are consistently distinct and recognizable (Ward, personal observation).

Camponotus hyatti Emery is quite variable on SCI, in some cases approaching the morphology of the closely related species *Camponotus bakeri* Wheeler. *Camponotus bakeri* is currently recognized as endemic to the southern Channel Islands of Santa Catalina, San Clemente, and Santa Barbara (Snelling 1988), but the relationship and distribution of *C. hyatti* and *C. bakeri* need critical review.

Longino (personal observation) identified a single damaged and undated specimen in the collection of the UC Field Station on SCI as belonging to the *Lepthorax nevadensis* Wheeler group, corroborating the 1975/76 record of *L. nevadensis*. Two species recorded in the 1975/76 survey (*Camponotus dumetorum* Wheeler and *Camponotus sayi* Emery) are excluded because identifications of the specimens are uncertain and no vouchers are available. *Crematogaster mormonum*, also recorded in an earlier study (Rentz and Weissman 1981), warrants confirmation, as it is easy to misidentify this species.

Cardiocondyla ectopia Snelling and *Linepithema humile* (Mayr) are the only ant species we found on SCI known to be not native to North America. We collected *Cardiocondyla ectopia*, an Old World species (Snelling 1974), only around buildings of the Stanton Ranch, currently used as the island headquarters of The Nature Conservancy. Our 1998 survey confirmed the distribution of *L. humile* documented (see map in Calderwood et al. 1999) and failed to locate any additional *L. humile* populations on the island.

Discussion

The number of ant species found in our surveys of Santa Cruz Island was similar to ant surveys on mainland California. For example, Fisher (1997) surveyed eight sites in northern California and found a total of 27 different ant species. Holway (1998) surveyed a similar northern California area and found 26 ant species. Suarez et al. (1998) surveyed 47 sites in southern California and found a total of 50 different ant species.

The ant species of SCI form a substantial subset of the mainland California ant fauna (Ward 1987, Fisher 1997; Holway 1998; Suarez et al. 1998; Ward, unpublished). Many common mainland ant species, however, were not found on SCI, including *Camponotus essigi* Smith, *Liometopum occidentale* Emery, *Neivamyrmex californicus* (Mayr), *N. nigrescens* (Cresson), *Formica francoeuri* Bolton, *Leptothorax nitens* Emery, *Messor andrei* (Mayr), *Pogonomyrmex californicus* (Buckley), and *Solenopsis xyloni* McCook (Ward 1987; Fisher 1997; Human and Gordon 1997; Holway 1998; Suarez et al. 1998).

The ocean appears to have been an effective barrier to colonization of SCI by many ants common on mainland California. It is unclear how many of the ant species now on SCI predate human habitation on the island. The two exotic ant species, *Cardiocondyla ectopia* and *Linepithema humile*, almost certainly arrived on SCI through human activity. We found both species only surrounding building sites.

The arrival of *Linepithema humile* on SCI is particularly distressing. Originally from South America and commonly called the Argentine ant, this ant is now a pest in subtropical and temperate regions around the world, including Australia (Majer 1994), South Africa (Hattingh 1945), the Middle East (Tigar et al. 1997), southern Europe (Way et al. 1997), Bermuda (Hilburn et al. 1990), the southern mainland United States (Barber 1916), and Hawaii (Reimer et al. 1990; Wetterer 1998; Wetterer et al. 1998). *Linepithema humile* first arrived in California earlier this century and has steadily spread across the state (Ward 1987; Holway 1995; Human and Gordon 1997). *Linepithema humile* has become the most common pest ant in urban areas of California (Knight and Rust 1990).

In areas where *L. humile* invades, native invertebrate species are heavily impacted (Erickson 1971; Cole et al. 1992; Ward 1987; Human and Gordon 1997; Way et al. 1997; Holway 1998; Suarez et al. 1998). This is true on SCI as well. Within the two areas that *L. humile* has invaded, only two other ant species have persisted, *Monomorium ergatogyna* and *Solenopsis molesta* (Wetterer et al., unpublished data). Elsewhere on SCI, the native ant fauna appears to be fairly intact. The previous absence of destructive exotic ants on SCI has likely permitted many species of native invertebrates to persist. However, if *L. humile* spreads, these native species may be seriously threatened.

Linepithema humile is also known from two other California Channel Islands. This ant is established on Santa Catalina Island (Cockerell 1940; Rentz and Weissman 1981), the only Channel Island with a sizable human population. There is also one record of *L. humile* from San Clemente Island (Straughan 1982). Comprehensive ant surveys are needed on these and the other California Channel Islands to evaluate the distribution and impact of *L. humile* and to determine what, if anything, should be done to curtail its spread.

Acknowledgments

We thank A. Wenner, A. Calderwood, E. Hebard, J. Howarth, B. Fisher, M. Bennett, G. Trager, C. Mealey, A. Southern, M. Hill, C. Dunning, J. Burger, M. Patton, K. Bartniczak, A. Mingo, L. Geschwind, J. Rowe, J. Gallagher, D. Han, L. Patterson, M. Beman, A. Ghaneker, A. Aronowitz, and A. Anderson for field assistance; R. Klinger of The Nature Conservancy, T. Coonan of the National Park Service, and L. Laughrin of the University of California Field Station for technical assistance; S. Cover of the Museum of Comparative Zoology, Harvard University and R. Snelling of the Natural History Museum of Los Angeles County for ant identification; C. O'Connell for assistance in assembling ant databases; M. Wetterer and A. Wenner for comments on this manuscript; the National Park Service for transportation to and from Santa Cruz Island; the Santa Barbara Museum of Natural History, the Los Angeles County Museum, the Bishop Museum, The Nature Conservancy, the Center for Environmental Research and Conservation, Columbia University, Biosphere 2 Center, and Florida Atlantic University for financial support.

Literature Cited

- Barber, E.R. 1916. The Argentine ant: distribution and control in the United States. U. S. Dept. Agric. Bull., 377:1-23.
- Calderwood, A., A. Wenner, and J.K. Wetterer. Argentine ant invasion of Santa Cruz Island, California. in press in Proceedings of the 1999 California Islands Symposium.
- Cockerell, T.D.A. 1940. The insects of the Californian Islands. Proc. Sixth Pacific Sci. Congr., 4:283-295.
- 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.
- Collingwood, C. A., B. J. Tigar, and D. Agosti. 1997. Introduced ants in the United Arab Emirates. J. Arid Environ., 37:505-512.
- Creighton, W.S. 1950. The ants of North America. Bull. Mus. Comp. Zool. Harvard Univ., 104:1-585.
- Diamond, J.M. and H.L. Jones. 1980. Breeding land birds of the Channel Islands. Pp. 597-612 in The California islands: Proceedings of a multidisciplinary symposium. (D. Power, ed.), Santa Barbara Museum of Natural History.
- Dubois, M.B. 1986. A revision of the native New World species of the ant genus *Monomorium* (*minimum* group) (Hymenoptera: Formicidae). Univ. Kansas Sci. Bull., 53:65-119.
- Erickson, J.M. 1971. The displacement of native ant species by the introduced Argentine ant *Iridomyrmex humilis* Mayr. Psyche, 78:257-266.
- Fall, H.C. and A.C. Davis. 1934. The Coleoptera of Santa Cruz Island, California. Can. Entomol., 66: 143-144.
- Fisher, B.L. 1997. A comparison of ant assemblages (Hymenoptera, Formicidae) on serpentine and non-serpentine soils in northern California. Insectes Soc., 44:23-33.
- Francoeur, A. 1973. Révision taxonomique des espèces Nearctiques du groupe *fusca*, genre *Formica* (Formicidae, Hymenoptera). Mém. Soc. Entomol. Quebec, 3:1-316.
- , and R.R. Snelling. 1979. Notes for a revision of the ant genus *Formica*. 2. Reidentifications for some species from the T.W. Cook Collection and new distribution data (Hymenoptera: Formicidae). Nat. Hist. Mus. Los Angeles Co. Contrib. Sci., 309:1-7.
- Hattingh, C.C. 1945. Argentine ant versus indigenous ants. J. Entomol. Soc. South Africa, 8:25-34.
- Hilburn, D.J., P.M. Marsh, and M.E. Schauff. 1990. Hymenoptera of Bermuda. Florida Entomol., 73: 161-176.
- Holway, D.A. 1995. Distribution of the Argentine ant (*Linepithema humile*) in Northern California. Conserv. Biol., 9:1634-1637.
- . 1998. Effect of Argentine ant invasions on ground-dwelling arthropods in northern California riparian woodlands. Oecologia, 116:252-258.

- Human, K.G. and D.M. Gordon. 1997. Effects of Argentine ants on invertebrate biodiversity in Northern California. *Conserv. Biol.*, 11:1242-1248.
- Junak, S., T. Ayers, R. Scott, D. Wilken, and D. Young. 1995. A Flora of Santa Cruz Island. Santa Barbara Botanic Garden, Santa Barbara, CA.
- Knight, R.L. and M.K. Rust. 1990. The urban ants of California with distribution notes of imported species. *Southwest. Entomol.*, 15:167-178.
- Majer, J.D. 1994. Spread of Argentine ants (*Linepithema humile*), with special reference to Western Australia. Pp. 163-173 in *Exotic ants. biology, impact, and control of introduced species.* (D.F. Williams, ed.), Westview Press, xiv + 332 pp.
- Mallis, A. 1941. A list of the ants of California with notes on their habits and distribution. *Bull. So. Calif. Acad. Sci.*, 40:61-100.
- Miller, S.E. 1985. The California Channel Islands—past, present, and future: an entomological perspective. Pp. 3-27 in *Entomology of the California Channel Islands.* (A.S. Menke and D.R. Miller, eds.), Santa Barbara Museum of Natural History, 178 pp.
- Nagano, C.D., S.E. Miller, and C.L. Hogue. 1983. Castaways of California. The origin of animal life on the Channel Islands. *Terra*, 29(4):23-26.
- Reimer, N.J., J.W. Beardsley, and G. Jahn. 1990. Pest ants in the Hawaiian Islands. Pp. 40-50 in *Applied myrmecology, a world perspective.* (R.K. Vander Meer, K. Jaffe, and A. Cedeno, eds.), Westview Press, xiv + 741 pp.
- Rentz, D.C. and D.B. Weissman. 1981. Faunal affinities, systematics, and bionomics of the Orthoptera of the California Channel islands. *Univ. Calif. Pub. Entomol.*, 94:1-240.
- Snelling, R.R. 1974. Studies on California ants. 8. A new species of *Cardiocondyla* (Hymenoptera: Formicidae). *J. New York Entomol. Soc.*, 82:76-81.
- . 1988. Taxonomic notes on Nearctic species of *Camponotus*, subgenus *Myrmentoma* (Hymenoptera: Formicidae). Pp. 55-78 in *Advances in Myrmecology.* (J.C. Trager, ed.), E.J. Brill, xxvii + 551 pp.
- Straughan, D. 1982. Inventory of the natural resources of sandy beaches in Southern California. *Tech. Rep. Allan Hancock Found., Univ. So. Calif.*, 6:1-447.
- Suarez, A.V., D.T. Bolger, and T.J. Case. 1998. Effects of fragmentation and invasion on native ant communities in coastal southern California. *Ecology*, 79:2041-2056.
- Ward, P.S. 1985. The Nearctic species of the genus *Pseudomyrmex* (Hymenoptera: Formicidae). *Quaest. Entomol.*, 21:209-246.
- . 1987. The 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(2):1-16.
- Way, M.J., M.E. Cammell, M.R. Paiva, and C.A. Collingwood. 1997. Distribution and dynamics of the Argentine ant, *Linepithema (Iridomyrmex) humile* (Mayr) in relation to vegetation, soil conditions, topography and native competitor ants in Portugal. *Insectes Soc.*, 44:415-433.
- Wenner, A.M. and D.L. Johnson. 1980. Land vertebrates on the California Channel Islands: sweepstakes or bridges? Pp. 497-530 in *The California islands: Proceedings of a multidisciplinary symposium.* (D. Power, ed.), Santa Barbara Museum of Natural History.
- Wetterer, J.K. 1998. Non-indigenous ants associated with geothermal and human disturbance in Hawai'i Volcanoes National Park. *Pac. Sci.*, 52:40-50.
- , P.C. Banko, L.P. Laniawe, J.W. Slotterback, and G.J. Brenner. 1998. Non-indigenous ants at high elevations on Mauna Kea, Hawaii. *Pac. Sci.*, 52:228-236.
- Wheeler, W.M. 1910. The North American ants of the genus *Camponotus* Mayr. *Ann. New York Acad. Sci.*, 20:295-354.
- . 1915. Some additions to the North American ant-fauna. *Bull. Am. Mus. Nat. Hist.*, 34:389-421.