shell, which is retained through the benthic juvenile stage (Tsubokawa & Okutani, 1991). The pleurobranchaceans also develop rhinophores while still larvae (Tsubokawa & Okutani, 1991), but these have the longitudinal slit characteristic of the order (Willan, 1987). In addition, notaspidean larvae possess pigmented mantle organs on the right side of the body, a trait unknown in nudibranch larvae (Robertson, 1985; Goddard, 1984:147, in press).

The development and elaboration of the mantle of *Aegires* and pleurobranchacean notaspideans during their larval stage appears to have necessitated the increased locomotive power of an enlarged velum. These changes, in turn, have precluded the withdrawal of the velum and foot into the shell, and appear to have rendered the operculum useless. Why these species also hatch with eyespots, when the vast majority of planktotrophic opisthobranchs do not, remains a mystery.

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Further Spread of the Introduced Decollate Snail, *Rumina decollata* (Gastropoda: Pulmonata: Subulinidae), in California, USA

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This note reports the occurrence of established colonies of the non-native, terrestrial decollate snail, *Rumina decollata* (Linnaeus, 1758), in San Luis Obispo County, central California, and on San Nicolas Island, Ventura County, southern California. This species is banned from San Luis Obispo County by California law. *Rumina decollata* is a detritivore, herbivore, and facultative predator on other snails. Its presence in San Luis Obispo County may pose a threat to the Morro shoulderband snail, *Helminthoglypta walkeriana* (Hemphill, 1911), which is listed as endangered under the U.S. Endangered Species Act. Its presence on San Nicolas Island may harm the unique indigenous snail fauna of that island.

Rumina decollata (Figure 1) is native to the Mediterranean region of southern Europe and North Africa. It was first reported in the eastern United States in 1813 and in California in 1966 (Fisher, 1966; Fisher et al., 1980),

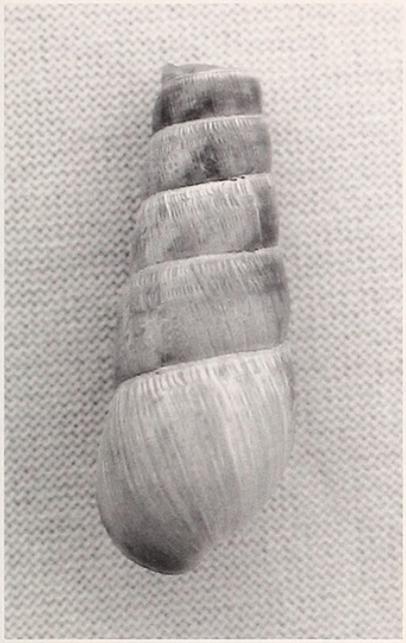

Figure 1. *Rumina decollata,* 28.4 mm specimen collected at Diablo Canyon Power Plant, San Luis Obispo County, California (LACM 152589).

though it may have occurred in California as early as 1957 or 1958 (Fisher & Orth, 1985). It has also been introduced to Bermuda, Cuba, Mexico, Central America, and Asia, and it continues to be intercepted at U.S. ports of entry (Dundee, 1970, 1974; Robinson, 1999). Its original introduction to North America presumably resulted from the transport of stowaway snails aboard ships sailing from Europe to the eastern seaboard, but its introduction to California may have been intentional, aimed at controlling the European brown garden snail, *Helix aspersa* Müller, 1774, a widespread agricultural and horticultural pest.

California state law prohibits the importation, transportation, or possession of *Rumina decollata* within all but 12 southern California counties (CDFA, 1998). Nonrestricted counties include: San Bernadino, Riverside, Imperial, Orange, San Diego, Los Angeles, Ventura, Kern, Fresno, Madera, Tulare, and Santa Barbara (Figure 2). This prohibition reflects the legal status of *R. decollata* as a "detrimental animal." Detrimental animals are defined within the California Code of Regulations as those that "pose a threat to native wildlife, the agricultural interests of the state, or to public health or safety" (CDFA, 1998:document 106.4).

The life history of *Rumina decollata* is well known. Individuals may live approximately 2.5 yr, with an average lifetime fecundity of approximately 2000 eggs/individual. *Rumina decollata* is a hermaphrodite capable of self-fertilization (Selander & Kaufman, 1973; Selander et al., 1974; Selander & Hudson, 1976), although grouped individuals appear to produce more eggs than nongrouped, i.e., self-fertilizing individuals (Fisher & Orth, 1985). Egg masses are deposited in burrows, with incubation taking 25–36 d. Following hatching, reproductive maturity is reached at approximately 12.5 mm in 75 d (Batts, 1957). During periods of adverse conditions, e.g., heat, cold, drought, *R. decollata* may become dormant, burying itself and sealing its aperture with an epiphragm to prevent desiccation (Batts, 1957; Fisher & Orth, 1985). During such periods of dormancy, it may be difficult to detect in an area. When conditions are again favorable, e.g., after the start of the winter wet season in a Mediterranean climate, adults emerge to repeat the cycle.

Occurrence in San Luis Obispo County

During daylight hours on 20 January 2000, JT collected 74 *Rumina decollata* in a 20-minute period near a small ($\sim$ 40 m^2) seaside bluff at the Diablo Canyon Power Plant facility located in San Luis Obispo County, California. The animals were found on asphalt roadways and among roadside vegetation during the first substantial rainfall of the winter wet season. Although all animals observed were collected, this was demonstrably not an exhaustive search, as approximately 250 animals were collected from the same area later in January and in mid-April 2000. Most individuals collected were presumably adults based on their large sizes ($>$ 15 mm shell height), although several smaller and possibly juvenile animals were collected. Whereas the vast majority of individuals were decollate, several of the smaller specimens ($<$ 10 mm shell height) retained their apical whorls. Since 1992, JT had consistently observed *R. decollata* at this location during and following the first substantial rainfall of the season. Whether it occurred here prior to JT's initial site visit and observation in 1992 is not known. The site is highly disturbed because of past construction activities, and is characterized by ruderal, roadside vegetation (e.g., *Hirshfeldia incana, Foeniculum vulgare*) and remnant stands of native coastal bluff scrub (e.g., *Hazardia squarosa, Atriplex* spp.) growing on fill soils. Voucher specimens from Diablo Canyon are deposited at the Santa Barbara Museum of Natural History (SBMNH 345670) and the Los Angeles County Museum of Natural History (LACM 152589).

Occurrence on San Nicolas Island

San Nicolas Island is under the control of the United States Navy. *Rumina decollata* was discovered there in February 1983 by Pearce (1993:41, Loc. 8). It was found in a small grove of planted pine and cypress trees ("Fernandez Grove") on the north side of the main naval compound. Fernandez Grove is one of the few horticulturally tended, artificially watered areas on the island; according to a sign, the trees were planted in October 1967. Around sprinklers, tall grass and *Sonchus* sp. were present. Live adult and juvenile snails were sparsely present in the soil

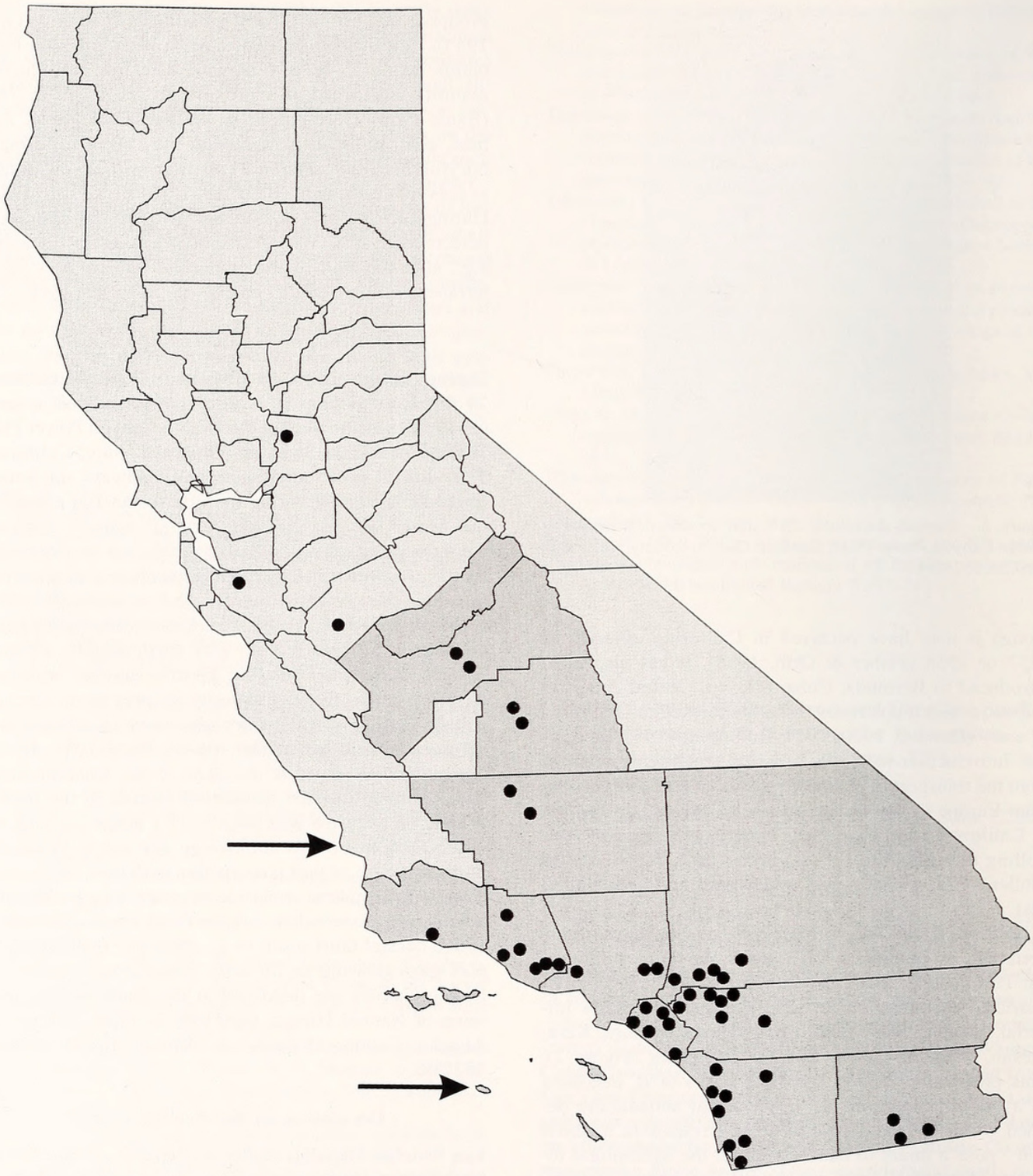

Figure 2. Known distribution of *Rumina decollata* in California. Dots indicate occurrences noted by Fisher & Orth (1985). Arrows indicate locations of feral populations at Diablo Canyon Power Plant, San Luis Obispo County (top), and San Nicolas Island, Ventura County (bottom). Twelve (12) shaded counties are those where *R. decollata* is legally permitted for release.

under the layer of pine needles carpeting the grove. At that time, considerable search elsewhere among the buildings of the compound and in the adjacent native scrub vegetation did not reveal any other occurrence of the species. It was absent from numerous other sites on the island that were inspected for land snails then and in later years (Pearce, 1993; BR, unpublished data). Observation of *R. decollata* in the pine grove was repeated by Pearce, BR, and others in 1984, 1985, 1986, and 1992.

In June 1998, BR, Alicia Cordero, and David Lindberg observed *R. decollata* to have spread into native *Coreopsis gigantea* scrub on the 100-m terrace north of the naval compound and just east of the rim of the first canyon east of Celery Canyon. This is approximately 0.4 km from the Fernandez Grove. One living specimen and about 10 empty shells were observed in a 2-hour search; some shells bore marks of small mammal predation, probably by deer mice, *Peromyscus maniculatus exterus.*

Discussion

Pest eradication without using chemicals is intuitively appealing, and biocontrol has consequently emerged as an important tool to control non-native and undesirable plants and animals. One has only to search the Internet to get an idea of the scale and breadth of this industry that has formed under the rubric of Integrated Pest Management. Several sites on the World Wide Web advertise *Rumina decollata*—available for about $25.00 US per 100 animals—as a "natural," and therefore preferable, alternative to poisoning *Helix aspersa.* Densities of approximately 1000 *R. decollata* per 0.4 ha are suggested to eradicate *H. aspersa* in 3–4 years.

Claims of eradication may be exaggerated: *Rumina decollata* preys on other snails up to approximately 15 mm shell diameter (T. W. Fisher, oral communication to BR, March 1977). Individual snails that reach a larger size are effectively immune from predation. Therefore, complete eradication of *H. aspersa* is rarely achieved; instead, its numbers are reduced to those individuals that escape predation as young but remain present and continue to reproduce. Furthermore, *R. decollata* does not prey solely on *H. aspersa*; it will eat most snail species presented to it (Fisher & Orth, 1985; T. A. Pearce, personal communication, 2000; BR, unpublished observations). *Helix aspersa* and the native snail species *Helminthoglypta umbilicata* (Pilsbry, 1898)—both abundant throughout the coastal terraces of the Diablo Canyon Power Plant site—are absent, except for a few empty shells, from the area occupied by the colony of *R. decollata.* Predation by *R. decollata* on eggs or young of these snail species is a possible explanation, but additional field observation is needed.

The rate of active dispersal by *R. decollata* depends at least partly on the frequency, type, and duration of irrigation. Fisher et al. (1980) reported a maximum dispersal rate of 20 m in 3 months in an irrigated orchard. Our observations on San Nicolas Island indicate a minimum rate in unirrigated native scrub of 0.4 km in 12 years. The Diablo Canyon colony site is also unirrigated, and it appears that the *R. decollata* population may be somewhat localized, though no distribution data were collected. Despite efforts on numerous occasions to locate *R. decollata* in vegetation approximately 1 km inland from the identified colony, JT has been unable to do so.

The expansion of *Rumina decollata* within California is likely related more to passive (anthropogenic), rather than active, dispersal mechanisms. Although warning statements prohibiting the delivery of *R. decollata* to addresses in many California counties are widely disseminated, snails are easily ordered from Internet-based businesses and advertisements in organic gardening magazines. Malacologists have long recognized that there is essentially unregulated anthropogenic dispersal of *R. decollata.*

The present distribution of *Rumina decollata* in California is unknown. Fisher & Orth (1985) mapped *R. decollata* within 14 California counties (Figure 2), and noted that "Special rulings by [the] California Fish and Game Commission permitted [a] study [of *R. decollata*] to be pursued in the counties of Butte, Del Norte, Fresno, and Sacramento, as well as 8 counties south of the Tehachapi Mountains" (Fisher & Orth, 1985: viii). Feral colonies of *R. decollata* were known prior to 1983 within all but two (Madera and Santa Barbara) of the 12 presently authorized southern California counties, and within two presently unauthorized central California counties: Santa Clara and Merced. In 1996, *R. decollata* was found feral on open ground near the San Diego River (Roth & Hertz, 1997) in a location that received no irrigation.

The mechanism of introduction of *Rumina decollata* to the power plant location is unclear. Access to the utility-owned property is largely restricted to employees, and this rural facility site is located approximately 12 km from the nearest urbanized area. It is doubtful that anyone would have intentionally introduced *R. decollata* to the site, and less likely that someone would have intentionally introduced it only on the grassy bluff to which the colony appears to be limited. Thus, unintentional transport of *R. decollata,* e.g., attached to equipment, dropboxes, lumber, or perhaps as eggs in fill soil is suspected as a mechanism of introduction to this location.

Of great concern is the fact that the Diablo Canyon colony of *Rumina decollata* is located approximately 9 km south of the remaining population of the endangered Morro shoulderband snail, *Helminthoglypta walkeriana,* near the town of Los Osos. Land development already has reduced the range of *H. walkeriana,* and introduction of *R. decollata* to this region could result in additional harm to this protected species. Despite the apparently limited potential for colony range expansion, efforts should be made to determine the distribution of *R. decollata* in

San Luis Obispo County, and eradication efforts undertaken as necessary.

The potential is great for harm by *R. decollata* to the unique, endemic land snail fauna of San Nicolas Island. Among the strictly endemic native snails, *Micrarionta opuntia* Roth 1975, never attains a shell diameter of more than about 10.3 mm; the mean adult shell diameter of *Micrarionta feralis* (Hemphill, 1901) is around 15 mm (Pearce, 1990; Roth, 1996). For these species, the "refuge" of a size greater than 15 mm diameter (which allows *Helix aspersa* to persist at low numbers in the presence of *R. decollata*) is unavailable. In addition, the total known range of *M. feralis* covers only a few hundred square meters.

The San Nicolas Island species *Xerarionta tryoni* (Newcomb, 1864) attains an adult shell diameter of 19–28 mm. Size-frequency distribution of a population observed in 1981 suggests that maximum shell size and sexual maturity are attained late in the second or early in the third year of life. A shell diameter of 15 mm is probably not attained until the second year of life (BR, unpublished observations). Time to maturity in *Helix aspersa* varies, but in a coastal southern California setting with artificially applied water, snails matured in 6–8 months (Potts, 1975). Under laboratory conditions, a shell diameter of 15 mm was attained in about 25–45 days (Potts, 1975: fig. 2). Juvenile *Xerarionta tryoni* spend more time in the vulnerable < 15-mm size class than do juvenile *Helix aspersa,* and therefore the potential impact of predation upon populations of *X. tryoni* is greater than that recorded for *H. aspersa.*

The apparent localization and slow spread of *Rumina decollata* on San Nicolas Island suggest that its eradication on that island may be possible.

Acknowledgments. Jim Carlton, Rob Cowie, Tim Pearce, and David Robinson read and commented on a draft of the manuscript, Jim Strampe helped produce the California distribution map, and Frank Focha and John Warrick (CDFA) helped interpret the pertinent regulations. We are grateful to Tim Pearce, Sally Walker, Ken Warheit, Alicia Cordero, David Lindberg, and others who helped search for *R. decollata* on San Nicolas Island.

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The Occurrence of the Shell-Less Neritacean Gastropod *Titiscania limacina* in the Galapagos Islands

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Only two species of shell-less neritacean gastropods of the family Titiscanidae have been described: *Titiscania limacina* Bergh, 1875, and *T. shinkishihataii* Taki, 1955. The former was discovered and drawn by Carl Semper during his voyage to the Philippines, and it was first named by Bergh (1875; pl. 41, fig. 10) based on Semper's figure. Later, Bergh (1890) published a complete description based on additional specimens from Mauritius. This species has been also recorded in the Eastern Pacific Ocean from the Gulf of California to Panama (Marcus & Marcus, 1967; Houston, 1990; personal observation); in the Eniwetock Atoll (Marcus & Marcus, 1967); in north-