

Insects Control

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A considerable degree of control of prickly pear cacti has been achieved on Santa Cruz Island rangeland, as a result of ecological manipulation: primarily, through the introduction of an effective natural insect enemy of the prickly pear; and secondarily, by the initiation of better range management in promoting plant competition through wild sheep eradication and restricted cattle grazing.

A NUMBER OF SPECIES of prickly pear cacti, introduced as botanical curiosities into various countries the world over have escaped from cultivation to become serious rangeland weeds. These weeds have subsequently been controlled with varying degrees of success in Australia, the Celebes, Ceylon, Hawaii, India, South Africa, and the West Indies by cactus-feeding insects imported from North, Central, or South America. Nowhere were the results of these biological control efforts more spectacular than in Australia, where from 1927 to 1930, the pad-mining caterpillars of an imported Argentine moth, *Cactoblastis cactorum* (Berg), were largely responsible for bringing about nearly complete control of *Opuntia stricta* Haworth on millions of acres of infested rangeland. California, too, can now be cited as a beneficiary of biological cactus control, for during the

past decade, cactus-feeding insects have been utilized to destroy prickly pear cacti infesting rangeland on Santa Cruz Island, a 62,000-acre island off the coast of southern California, 25 miles south of Santa Barbara, and 60 miles west of Los Angeles.

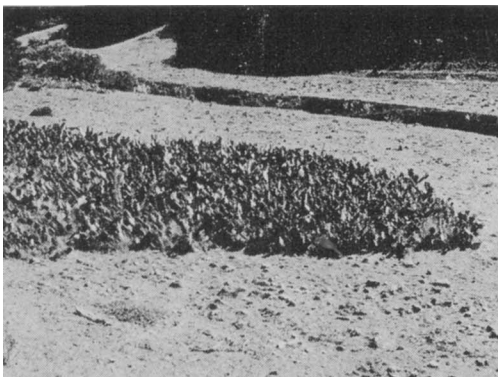
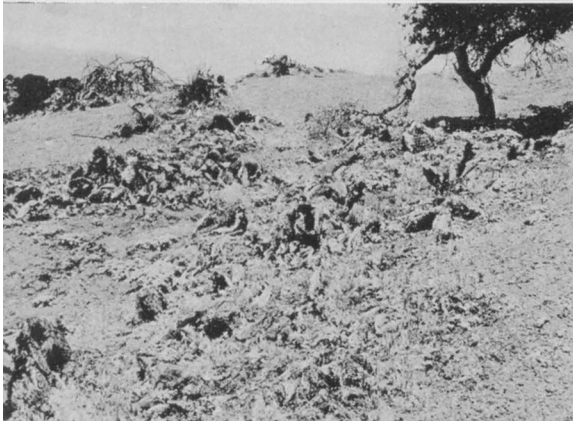
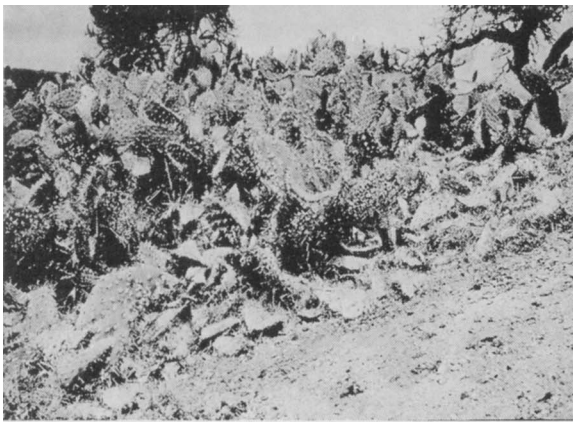
The problem

Two species of prickly pear cacti, *Opuntia littoralis* (Engelmann) Cockerell and *O. oricola* Philbrick, and their hybrids have become range weeds on Santa Cruz Island. Both species are native to the California coast, occupying south-facing slopes to elevations of 500 ft from Santa Barbara County southward into Baja California. These cacti are generally of much lower density along the coastal mainland than on the island.

In the past, Santa Cruz Island was severely overgrazed by a species of domes-

Clump of *Opuntia littoralis* X *O. oricola* attacked and killed by cochineal insects on Santa Cruz Island, photographed (top to bottom) on April 18, 1961; June 5, 1964; and September 28, 1965.

Clump of *Opuntia littoralis* X *O. oricola* attacked and killed by cochineal insects on Santa Cruz Island, photographed (left to right) on October 21, 1964; September 29, 1965; and May 14, 1966.



Prickly Pear Cactus

tic sheep now gone wild. These animals were first introduced to the island by early Spanish colonists. The sheep overran the island and essentially denuded its grasslands. The overgrazed lands were invaded by the resident cacti which, in turn, went largely ungrazed. Pads broken from clumps by passing animals and wind took root, and in the absence of competing vegetation, spread rapidly. During the early 1940's, approximately 40 per cent of the rangeland on Santa Cruz Island was rendered useless by cacti for cattle grazing, which today remains the island's chief industry.

Biological control

The Department of Biological Control at Riverside then initiated the program summarized in this report, under the direction of Professor Harry S. Smith, now deceased (see *Hilgardia* 38: 579-606 for a more detailed account).

Biological control of the cacti was thought possible if the limited number of species of cactus-feeding insects already present on Santa Cruz Island could be supplemented with species restricted in their feeding habits to prickly pear cacti, and freed of their own natural insect enemies. The first species so introduced was the cochineal insect, *Dactylopius tomentosus* (Lamarck), collected on the

southern California mainland and colonized on the island in 1940. This colonization failed, as did an attempt in 1942 to establish *D. confusus* Cockerell, originally collected in Arizona in 1941.

The coreid bug, *Chelinidea tabulata* (Burmeister), from Texas was colonized on the island in 1945. Although not recovered until 1961, it represented the first natural enemy of the cacti successfully introduced to the island. *Chelinidea tabulata* has spread very little since its establishment, has caused negligible damage to the prickly pears; and is therefore considered to be of little value as a biological control agent.

Limited numbers of the pad-mining caterpillar, *M. prodenialis*, from Arizona and Texas were colonized in 1945 and 1962, but this species was not established. Another species of cactus moth, *Olycella junctolineella* (Hulst), from Texas was colonized on the island in 1961 and 1962, but it too failed to become established.

A second species of coreid bug, *Chelinidea vittiger* Uhler, from Texas was colonized on the island in 1945. This attempt to establish *C. vittiger* failed; however, a colonization in 1961 using material introduced from the southern California mainland proved successful. As with *C. tabulata*, we currently consider *C. vittiger* to be of little value as a biological control

agent. It, too, has spread little since its establishment and apparently causes negligible damage to the cacti.

A cochineal insect (*Dactylopius* sp., species designation unresolved) was successfully introduced to Santa Cruz Island from Hawaii in 1951. It has become a valuable biological control agent. These insects are thought to be descendants of specimens first collected in Mexico by Australian researchers in 1927 and introduced into Hawaii from Australia for cactus control in 1949. Interestingly, the natural range of this Mexican species apparently extends northward to Temecula, California, which lies but 40 miles south of Riverside and 120 miles southeast of Santa Cruz Island.

Natural stands of *Opuntia littoralis* and *O. oricola* along the coast of lower southern California support far smaller local populations of the same cochineal insect that is now so abundant on Santa Cruz Island. These mainland colonies also invariably show signs of considerable damage by predaceous insects. However, freed from their two most important predators, the coccinellid beetle, *Hyperaspis taeniata significanus* Casey, and larvae of the moth, *Laetilia coccidivora* (Comstock), during their circuitous journey described above, the cochineal insects have multiplied markedly on the island.

Close-up of same clump as in photo sequence to left, photographed (left to right) on May 26, 1965; September 29, 1965; and September 30, 1967; showing control effectiveness of cochineal insects.



They have attained such high numbers that their combined feeding damage in many instances has allowed them locally to overwhelm and completely destroy their cactus hosts. The cochineal insects have now spread island-wide, largely via windborne, first-instar nymphs, but also by intentional transport of cochineal-infested pads by man and inadvertently by grazing animals.

Photos

Beginning in 1961, sequential photographs have been taken biannually during the spring and fall of selected prickly pear clumps located throughout the island. The relatively rapid and thorough destruction of cochineal-infested clumps is graphically shown in the photo sequences. Such destruction continues on the island at the present time. Apparently *Opuntia littoralis* and *O. littoralis* × *O. oricola* hybrids that more closely resemble the first-named species are more susceptible to attack by the cochineal insects. It appears that the susceptible species and hybrids have been brought under substantial control; whereas, only partial control of *O. oricola* and hybrids resembling this species has been effected.

Sheep

Sheep eradication and restricted cattle grazing as practiced by the Stanton Ranch, which occupies over 90 per cent of the island, have significantly aided these biological control efforts. During the past decade, the island was laced with many miles of fencing, and the thousands of sheep trapped within the enclosures so formed were removed from the range. These efforts so reduced overgrazing that several species of annual grasses have been able to persist on formerly barren land, as shown by the terminal photographs in the photo sequences. Conservation of this grass cover has substantially curbed the further spread of the cacti.

During the late winter and the spring growth periods, these grasses also compete directly with the cacti for water, space, and nutrients. *Dactylopius* sp. injury has also undoubtedly reduced the competitive advantage of the cacti in favor of these grasses.

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INTEGRATING FOREST-ORIENTED RECREATION WITH TIMBER GROWING

--a case study of economic factors

FLOW-CHART OF FACTORS INFLUENCING DECISION TO INTEGRATE RECREATION WITH TIMBER PRODUCTION

