# SEA STAR DISEASE AND POPULATION DECLINES AT THE CHANNEL ISLANDS

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## ABSTRACT

In the summer of 1997, we quantified the incidence of wasting disease among multiple species of sea stars throughout the Channel Islands and adjacent mainland areas. The disease has been observed since 1978 during warmer water periods. Following the 1982-1983 El Niño, the disease and severe sea star population declines were observed, however, quantitative surveys of disease were not conducted. In our 1997 surveys, *Asterina miniata* and *Pisaster giganteus* were the species most severely affected; however, the disease was also observed in *Astropecten armatus*, *Dermasterias imbricata*, *Henricia leviuscula*, *Mediaster aequalis*, *Orthasterias koehleri*, *Pisaster brevispinus*, *Pisaster ochraceus*, and *Pycnopodia helianthoides*. Three species were not observed with the disease (*Henricia* sp., *Astropecten verrilli*, and *Luidia foliolata*); however, these species were rare. Population declines that might have resulted from disease are apparent in monitoring data from the Channel Islands Research Program and the Channel Islands National Park. Surveys at Catalina Island indicate that population declines occurred in summer and were not the result of winter El Niño-associated events such as storms or increased rainfall. In 1997, wasting disease was observed in other echinoderms (Echinoids, Ophiuroids, and Holothuroids) as well.

**Keywords**: *Asterina miniata*, *Pisaster giganteus*, *Astropecten armatus*, *Dermasterias imbricata*, *Henricia leviuscula*, *Mediaster aequalis*, *Orthasterias koehleri*, *Pisaster brevispinus*, *Pisaster ochraceus*, *Pycnopodia helianthoides*, *Henricia* sp., *Astropecten verrilli*, *Luidia foliolata*, Santa Catalina Island, Santa Barbara Island, Anacapa Island, Santa Cruz Island, Santa Rosa Island, San Miguel Island.

## INTRODUCTION

Mass mortalities of echinoids as a result of disease have been widely reported from all over the world (Johnson 1971; Pearse et al. 1977; Miller and Colodey 1983; Lessios et al. 1984; Maes and Jangoux 1984; Scheibling and Stephenson 1984; Maes and Jangoux 1985; Lessios 1988; Stien et al. 1995; Scheibling and Hennigar 1997); however, mass mortalities due to disease have not been widely reported in other echinoderms. Are sea urchins different from other echinoderms in their susceptibility to disease and mass mortality, or rather, is disease more widely noticed in this class because sea urchins are more abundant, widely distributed, and economically important? One severe case of sea star wasting disease was noted in *Heliaster kubiniji*, in the Gulf of California in 1978 (Dungan et al. 1982). The species was virtually eliminated by the disease, and to date, recovery has not occurred at some sites in the Gulf of California where it used to be abundant (D. Thomson, pers. comm.). Wasting disease has been observed in sea stars in southern California periodically during warm-water years since it was first recognized in 1978 and was especially prevalent during the 1982-1984 El Niño (Engle, pers. obs.; Channel Islands National Park Annual Reports). In 1997 we observed a high incidence of sea star wasting disease and an occurrence of disease in other echinoderms in southern California. We were able to quantify the incidence of sea star wasting disease and to examine subsequent population trends recorded by long-term monitoring by the Channel Islands National Park and the Channel Islands Research Program. The purpose of this paper is to document the incidence of wasting disease in sea stars and other echinoderms in 1997 and to document the subsequent population decline in two species of sea stars in 1998.

## MATERIALS AND METHODS

Sea star density data were collected by the Channel Islands National Park's long-term Kelp Forest Monitoring Program (with the exception of Catalina Island). The program was established in 1982 and is described along with protocols in Davis (1988) and Davis et al. (in prep.). The program monitors 16 sites representing the north and south sides of Santa Barbara, Anacapa, Santa Cruz, Santa Rosa, and San Miguel islands. Each site consists of a 100 meter permanent transect that is sampled non-invasively and revisited on an annual basis. *Pisaster giganteus* and *Asterina*

*miniata* densities were surveyed using quadrat counts randomly placed along each transect. The number and size of quadrats has changed several times since the implementation of this monitoring program in 1982, however all density data in this paper are presented per meter square. From 1985 to 1995 twenty 2-$m^2$ quadrats were sampled per site. In 1996 the protocol was changed to twelve 2-$m^2$ quadrats per site.

Sea star density data for Catalina Island were collected at two sites by the Channel Islands Research Program. *Pisaster giganteus* were surveyed on April 25, 1997, and September 25, 1997, using three 3 x 60 m band transects at Intake Pipes (at 6 m, 12 m, and 18 m depths) and three 6 x 60 m band transects at Bird Rock Wall (at 0 to 6 m, 7 to 12 m, 13 to 18 m depths).

Sea star wasting disease data were collected in September and October 1997, and August and September 1998, by the Channel Islands Research Program and Ginny Eckert. Timed searches for healthy and diseased sea star were conducted at multiple sites throughout the Channel Islands and adjacent mainland areas. Sea stars were scored as being healthy or sick/dead. Surveys were conducted at the peak of the disease in 1997; however, our data are most likely underestimates of the incidence of disease, because the disease continued for a longer time period that our survey effort. It is likely that individuals could have died from wasting disease before sampling or contracted the disease after sampling. However, for certain sea star species, it is also possible that healthy individuals were cryptic and therefore not counted by our survey. The Channel Islands National Park long-term Kelp Forest Monitoring Program has recorded presence/absence of disease at their permanent sites since 1992.

## RESULTS

The first indication of sea star wasting disease is a 'deflated' appearance, due to loss of turgor. White lesions are then noted on the aboral surface, initially appearing at the junctions of the arms with the central disk. Lesions enlarge until the entire animal fragments and body parts dissolve. Ossicles (skeletal fragments) can be found in the shape of an individual sea star in locations with little water motion. A severely diseased *A. miniata* is shown in Figure 1, along with a healthy one for comparison.

During our 1997 disease surveys, the incidence of wasting disease at a site ranged from 0.8% to 59.6% with a trend of increased incidence in more southerly and easterly sites (Table 1). Two sites seemed particularly affected, with greater than 50% of all sea stars observed with wasting disease (Ford Point, Santa Rosa Island and Frenchy's Cove, Anacapa Island). The average incidence of sick/dead animals in 1997 was 24.2%, whereas in 1998 the average incidence of sick/dead animals was 2.0% (Table 1). The values in 1998 possibly represent a baseline for 'normal' rates of injury/mortality since individuals were scored as sick/dead even if cause could not be determined. Wasting disease has been observed as far south as Punta Banda, Baja California (20 km south of Ensenada) (Eckert, pers. obs.) and as far north as Point Estero, California (Eckert, pers. obs.).

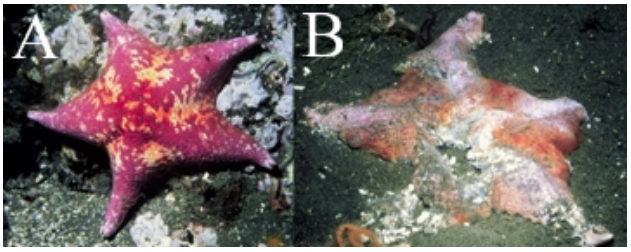


**Figure 1. A. Healthy *Asterina miniata*. Photo © P. Haaker, used with permission. B. *Asterina miniata* with wasting disease. Photo © R. Herrmann, used with permission.**

**Table 1. Percent of individuals of all sea star species found with wasting disease in 1997 and 1998. Sites are ordered from southeast to northwest. ANA = Anacapa Island, SCI = Santa Cruz Island, SRI = Santa Rosa Island, SMI = San Miguel Island. All other sites are on the mainland.**

| Site | % Sick 1997 | n | Site | % Sick 1998 | n |
|---|---|---|---|---|---|
| Frenchy's, ANA | 54.7 | 106 | Frenchy's, ANA | 8.0 | 97 |
| Stearns Wharf | 35.3 | 68 | | | |
| Goleta Pier | 27.1 | 70 | Goleta Pier | 0.0 | 103 |
| Potato Rk., SCI | 24.1 | 133 | Potato Rk., SCI | 0.0 | 42 |
| Platt's, SCI | 28.2 | 163 | Coche Pt., SCI | 8.0 | 26 |
| Ab Rks., SRI | 16.7 | 430 | Diablo Rk., SCI | 0.0 | 272 |
| Ford Pt., SRI | 56.7 | 134 | 63ft Rock, SCI | 4.0 | 129 |
| Johnson's, SRI | 23.9 | 205 | Forney, SCI | 2.0 | 129 |
| Gaviota Pier | 20.3 | 158 | Gaviota Pier | 0.0 | 0 |
| Bee Rk., SRI | 2.0 | 345 | Rodes Reef, SRI | 1.0 | 164 |
| | | | Talcott Shoals, SRI | 0.0 | 269 |
| | | | Prince Island, SMI | 0.4 | 504 |
| Crook Pt., SMI | 0.8 | 389 | Harris Cove, SMI | 0.0 | 367 |
| Nifty Rk., SMI | 0.9 | 446 | Nifty Rk., SMI | 0.0 | 406 |
| **average** | 24.2 | | **average** | 2.0 | |

Wasting disease was found in ten sea star species, and not found in three sea star species, although these species were rare (Table 2). Three species of sea urchin (*Stronglyocentrotus purpuratus*, *Strongylocentrotus franciscanus*, and *Lytechinus pictus*), two species of brittlestar (*Ophioplocus esmarki*, *Ophiopteris papilosa*), and one species of sea cucumber (*Parastichopus parvimensis*) were found with disease. It is not known whether all of these echinoderms have been infected with the same etiologic agent. The incidence of disease was highest in sea stars and sea urchins and less common in brittlestars and sea cucumbers.

Population density data were available for two of the most common sea stars, *A. miniata* and *P. giganteus*. These two species were also the most abundant in disease surveys (Table 2). Populations of both species at Channel Islands National Park Kelp Forest Monitoring sites were relatively constant from 1995 through 1997, then in 1998 populations declined 75% for *A. miniata* and 56% for *P. giganteus* (Figure 2A). Population declines occurred one year after a large incidence of disease (Figure 2B). This lag results from a sampling interval of one year. Sampling at Catalina Island for *P. giganteus* indicates that the decline occurred between April and September, 1997 (Figure 3).

**Table 2. Incidence of wasting disease in sea stars at all sites in 1997.**

| Species | % sick/dead | n |
|---|---|---|
| *Asterina miniata* | 13.9 | 1260 |
| *Pisaster giganteus* | 10.7 | 923 |
| *Astropecten armatus* | 44.8 | 210 |
| *Pisaster ochraceus* | 23.7 | 190 |
| *Pisaster brevispinus* | 25 | 52 |
| *Pycnopodia helianthoides* | 10 | 50 |
| *Orthasterias koehleri* | 2.2 | 45 |
| *Dermasterias imbricata* | 16.7 | 24 |
| *Astropecten verrilli* | 0 | 6 |
| *Henricia* spp. | 0 | 5 |
| *Luidia foliata* | 0 | 5 |
| *Mediaster aequalis* | 25 | 4 |
| *Henricia leviuscula* | 33.3 | 3 |

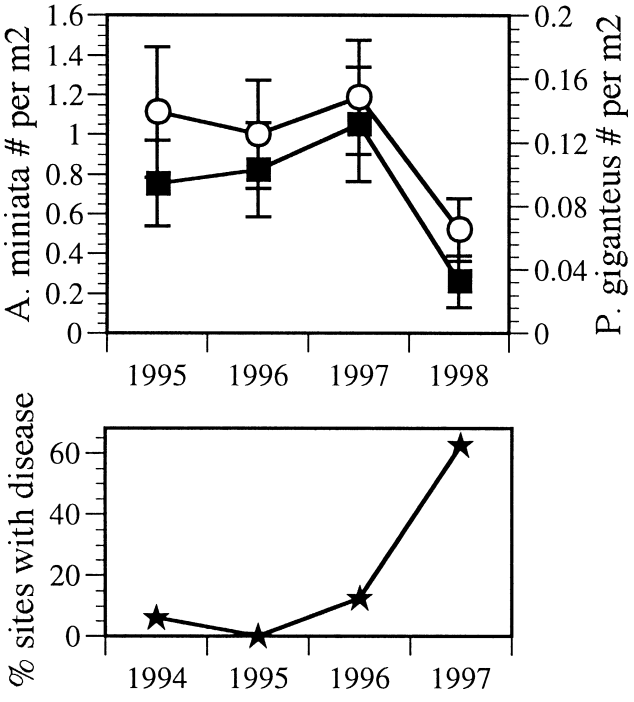


**Figure 2. A. (top panel) Density of *Pisaster giganteus* and *Asterina miniata* at all CINP Kelp Forest Monitoring sites. Note decline in 1998. B. (lower panel) Percent of CINP Kelp Forest Monitoring sites observed with sea star wasting disease. Note high incidence of disease observed in year before density decline.**

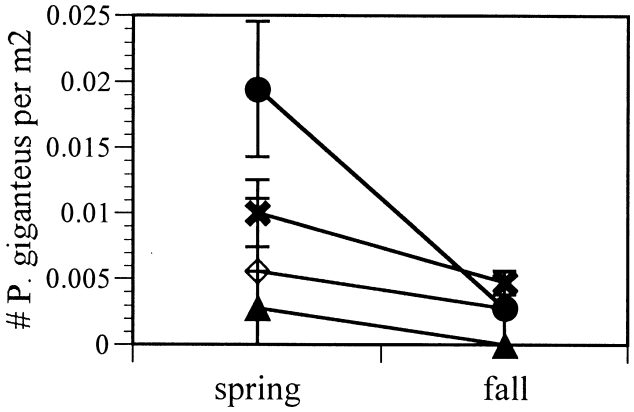


**Figure 3. Decline of *Pisaster giganteus* at four sites on Catalina Island from Spring to Fall 1997.**

## DISCUSSION

The observation of sea star wasting disease in 1997 was significant, occurring in ten species of sea stars and at all sites sampled by the Channel Islands Research Program. Incidence of the disease appears to decline in northwest portions of the Channel Islands. Populations of two species of sea star, *A. miniata* and *P. giganteus*, have declined subsequent to the observation of high incidence of wasting disease. The major question which lies unanswered is what causes sea star wasting disease.

Sea temperature data from the Scripps Pier since 1920 indicate that a long-term warming trend has occurred in southern California from 1976 to 1998. Initial appearance of sea star wasting disease occurred two years after the start of the warming trend and has been noted periodically since then (Channel Islands National Park Annual Reports; Engle, unpublished data). There apparently is a relationship between increased seawater temperature and incidence of the disease in the Channel Islands (Eckert, in prep). Sea star wasting disease has not been limited to southern California. In fact, Menge (1979) describes a similar kind of wasting disease in 1972 in the sea star *Asterias vulgaris* in Maine. It is interesting that the 1978 observation of sea star wasting disease in the Gulf of California (Dungan et al. 1982) coincided with observations of the disease in southern California (Engle, unpublished data). The etiologic agent responsible for the disease has been preliminarily identified as a *Vibrio* bacteria (Schroeter et al., unpublished manuscript; Crowell, pers. comm.). One preliminary conclusion is that extended warming periods compromise the immune system (Crowell, pers. comm.). Sea stars can recover from the disease if put into cold water, and death has been noted within seven days of onset of the disease (Engle, unpublished data).

Sea star wasting disease has great implications for southern California kelp forest communities. Population declines subsequent to the high incidence of the disease indicate that the disease can decimate populations of these ecologically important species. Many of the affected sea stars are voracious predators that function as 'keystone species'

(Paine 1966, 1974; Menge et al. 1994) or are less voracious but nonetheless play an important role in the kelp forest community (Schroeter et al. 1983; Leonard 1994). The decline of these species resulting from sea star wasting disease will surely have impacts on kelp forest communities.

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