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# The Pacific Wing-Oyster, *Pteria sterna*, off San Diego, California

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**ABSTRACT** *Pteria sterna* is an eastern Pacific pearl oyster of commercial value from Perú to central Baja California, México. The continuous presence of this species in San Diego for a decade is unique as it is approximately 600 km north of the expected range for the species. A minimum of three generations are present in Mission Bay at any point in time and the preferred substrate for attachment are gorgonian corals. The species is also found off shore in cooler water. The continued presence of this oyster raises the question as to the status of this population; is it a permanent range extension or simply a transient population and what has changed that allowed its continued presence?

**KEY WORDS** Pearl Oyster, *Pteria sterna*, California, Substrate, Transient Population

## INTRODUCTION

Observations regarding the Pacific Wing-Oyster, *Pteria sterna* (Gould, 1851) are presented, based on populations in Mission Bay and off-shore Point Loma (San Diego, California). The expected distribution of this species is from Ancón, Lima, Perú, north to Morro Santo Domingo in the southern most portion of Baja California, and to the head of Golfo de California at Bahía la Choya, Sonora, México (Coan &Valentich-Scott, 2012; Valentich-Scott, *et al.* 2020). Those authors indicate the species has been infrequently found as far north as Goleta, Santa Barbara County, California and recognized the difference between a transient individual/population and a sustained range extension. Life history papers are reviewed in order to place the current observations and speculation reported here in context with studies from Latin America.

*Pteria sterna* is a pearl oyster in the family Pteriidae and is of economic importance, with México supporting notable mariculture activity related to pearl production (Saucedo & Monteforte, 1997; Serna-Gallo *et al*. 2014), with similar efforts in both Perú and Ecuador (Ordinola *et al*. 2013; Lodeiros *et al*. 2018). As a result, research regarding this species has focused on aspects of mariculture, especially reproduction, diet, and growth related to the successful culture of pearls. *Pteria sterna* inhabits tropical, subtropical and temperate waters of the eastern Pacific (Serna-Gallo *et al*. 2014) and is listed as an endangered species in México, to protect depleted natural populations from harvest (Del Rio-Portilla *et. al*. 1992; Saucedo & Monteforte, 1997).

Gametogenesis in subtropical and temperate waters occurs as the water begins to cool, with spawning typically between December and March (Hernandez-Olalde *et al*. 2007; Caceres-Puig *et al*. 2009; Saucedo & Monteforte 1997). At 21-22$^{o}$C, the larvae settle out of the water column at approximately 38 days (McAnally-Salas & Valenzuela-Espinosa 1990). In some locations, various levels of reproductive activity occur throughout the year (Diaz & Buckle, 1996). Growth rate is related to food density and quality, water temperature, and age of the pearl oyster. As a result, growth rates can be quite variable between distant locations (Del

Rio-Portilla *et al*. 1992; Lodeiros *et al*. 2018, Wright-Lopez *et al*. 2009, Serna-Gallo 2014).

In southern California, *P. sterna* has been assumed to be a transient species associated with the occurrence of warm water El Niño events (Coan, *et al*. 2000; Valentich-Scott, *et al.* 2020). The population may increase during such events, but are they absent between El Niño events or simply less common? In 2010, a live specimen of *Pteria sterna* was observed by the author in Ventura Cove (Mission Bay) that measured 137 mm in height (Figure 1). Once regular observations began, the species was routinely present in the proper habitat, but never abundant. As of March 2021, their continued presence in Mission Bay for a decade has been observed.

*Pteria sterna* are most obvious when attached to various species of gorgonians. The red gorgonian *Lophogorgia chilensis* (Verrill, 1868) (Figure 2) and *Muricea californica* Aurivillius 1931 serves as the prominent substrate for the majority of *P. sterna* in the channel side of the rocky Mission Bay jetty, followed by *Muricea furticosa* Verrill 1869. The maximum depth in Mission Bay is approximately 10 m. Off-shore at 18-26 m, *Lophogorgia chilensis* hosts the majority of *P. sterna* observed at Three Fingers Reef. The thin shells of *P. sterna* are covered with fouling organisms, which makes them look like a clump of algal debris on the gorgonian (Figure 2). In the Golfo de California, between Santa Rosalia and Bahía Loreto, Wright-Lopez *et al*. (2009) reported the primary substrate for *P. sterna* as *Muricea californica*.

The gorgonian species are general indicators of good water flow, which brings particulate to the feeding polyps. The presence of *P. sterna* on gorgonians does not appear deleterious to the gorgonian unless the bivalve becomes large enough to bend the coral over. On the other hand, with the pearl oyster nestled in the gorgonian, they appear to be out of reach of predatory sea stars and are well placed to also feed on particulates in the current.

In Mission Bay, there are multiple age classes present at the same time. During October 2019, one group averaged 32.2 mm in height (n=20, STD 3.7), and based on a spring settlement, they were perhaps 6-7 months old. Saucedo & Monteforthe (1997) indicated that shells between 40-45 mm were 11 months old, and reach 70-80 mm in 15-17 months. The second group averaged 82 mm (n=15, STD 7.6) and were estimated to be approximately 16-18 months old. Individuals from 100-135 mm were scarce and typically not attached to gorgonians, making it difficult to find them in suitable numbers to estimate subsequent age classes. Collecting the largest individuals to estimate longevity was not a priority, as it would have required sacrificing the more fecund individuals and such data already exists.

Wright-Lopez *et al.* 2009 studied the *P. sterna* population from Santa Rosalia to Bahía Loreto, Baja California Sur, and used a modified von Bertalanffy model to estimate growth. By the 3$^{rd}$ year, shell size was approximately 115 mm. The model indicated that some individuals may survive more than 5 years. The largest shells averaged 130.5 mm (range 124-136 mm) with the maximum projected size of 156 mm. Growth rates decrease sharply with age; the longevity of this species was estimated by Ordinola *et al*. (2013) to be 5-7 years. Variation in longevity estimates may reflect the suitability of the habitat and the number and types of predators.

In addition to Mission Bay, *P. sterna* occurs off-shore at Point Loma where they are observed at 18-26 m, at those depths summer water temperatures seldom exceed 18.9ºC (66ºF), and

winter temperatures may be 10 -14.4ºC (50 - 58ºF). In Mission Bay, summer water temperatures may range from 23.9 - 26.6 ºC (75 - 80ºF), with winter lows from 13.8 - 16.1ºC (57 - 61ºF). Although both depth and temperature differ, the habitat of Mission Bay and Point Loma, have three things in common. Both locations support numerous gorgonian species, have excellent water flow, and usually have little to no subtidal impact from waves. As of yet, *P. sterna* off-shore in water shallower than 18 m have not been observed. Although other gorgonians are present in shallow water, large winter swells cause strong bottom surge in shallower water that may dislodge developing *P. sterna* from the gorgonians.

During November 2020 to January 2021 there were extended periods with both high swells and surf from 2 - 4 m. In January 2021, people surfing inside the Mission Bay jetty on waves from 2 – 3 m in height were photographed. The waves were breaking over the normally protected habitat of the gorgonians and *Pteria* (Figure 3). In March 2021, *P. sterna* were still present on gorgonians near the transition from the channel to the bay, but in reduced numbers. No pearl oysters were observed on gorgonians in the channel exposed to the high surf. It is not known if *P. sterna* survived the heavy surf or not, as finding detached individuals on the rocky algae covered substrate is difficult.

As a broadcast spawner, the current population of *P. sterna* in Mission Bay may be less than required for successful fertilization. Either other areas off San Diego exist with greater density or this population may be in decline. It is also possible that the local population is supported by larvae drifting northward on the Inshore Counter Current from further south in Baja California. Based on the report by McAnally-Salas & Valenzuela-Espinosa (1990), larvae settled at 38 days, therefore they may be transported great distances.

The Southern California eddy (SCE), dominates the Southern California Bight (SCB) and has interaction with other water masses, wind, and upwelling. Chenillat *et al*. (2018) published a detailed study in the SCB and found that smaller coastal eddies trap inshore water and as they detach from the shore, they tend to move north-west at an average rate of 2 km/day. The average coastal eddy within the SCB persists about three months but some last much longer. These eddies transport nutrient rich inshore water great distances off shore where they eventually dissipate (Chenillat *et al*. 2018). Larvae trapped in those eddies may not have the opportunity to return inshore to settle. The intensity and position of both the California Current from the north and the Coastal Counter Current from the south varies seasonally and annually, Bray *et al*. 1999. This variation adds complexity and variability to the transport of planktonic populations.

The continued presence of this species for a decade or perhaps longer, and apparent tolerance to temperate water suggests they may have had an historical presence that has been overlooked. The local population may be sustained by recruitment from larvae transported north via the Inshore Counter Current. How long must a species persist and reproduce in an area before it is considered to be a resident? When a species is at the extreme edge of its range, fluctuations in the population due to subtle or not so subtle changes in the marine habitat are not unexpected. The author suspects that *P. sterna* may still be a transient species in San Diego, but as sea water continues to warm perhaps other assessments over the next decades will answer the question, transient or not.

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**Figure. 1** = Mature *P. sterna*, umbo to ventral edge 137 mm, Mission Bay; **2** = Young winged pearl oyster, perhaps 6 months old on *Lophogorgia chilensis,* hinge to left, Point Loma; **3** = A perfect wave breaking over the gorgonian-*Pteria* habitat in the Mission Bay channel.