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Mass Mortality of the Sea Cucumber (*Holothuria princeps*) along the Florida Panhandle, December 2016

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SHORT PAPERS AND NOTES

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MASS MORTALITY OF THE SEA CUCUMBER (*HOLOTHURIA PRINCEPS*) ALONG THE FLORIDA PANHANDLE, DECEMBER 2016.—Reports of mass mortalities of echinoderms are largely anecdotal, despite their worldwide occurrence. This is unfortunate, as such events provide insight into the nature of biotic and abiotic stressors and their potential impact on population and community ecology. Moreover, rising seawater temperatures and ocean acidification (IPCC, 2013), the result of rapid anthropogenic climate change, have prioritized the establishment of baseline data on such mortality events as a means of evaluating future climate impacts. Lawrence (1996) noted that abiotic factors (temperature, salinity, oxygen, hydrodynamics) can result in mass mortalities of shallow-water echinoderms. Biotoxicity has been reported in a few cases. To date, the vast majority of echinoderm mortality events that have been reported in the literature are for species of sea urchins and, to a lesser extent, sea stars (reviewed in Lawrence, 1996; also see McClintock et al., 2013). We are unaware of any published reports documenting a mass mortality event in sea cucumbers. Infaunal aspidochirote sea cucumbers, such as some *Holothuria* species, are near the bottom surface and susceptible to hydrodynamics in shallow water. They rework the sediment and bring up deep deposits to the surface. They also are major bioturbators and affect infaunal abundance and rank assemblages (Dahlgren et al., 1999). Consequently, their mass mortality in shallow waters could have a pronounced ecological effect. Dahlgren et al. (1999) reported densities of *Holothuria princeps* of four to six individuals at 10 m^{-2} at 32 m in depth off the North Carolina coast.

Observations of sea cumber mortality events are largely anecdotal in nature. For example, in the *Memoirs of the Hourglass Expedition,* Miller and Pawson (1984) note for the sea cucumber *Thyonella gemmata,* "Occasionally, large numbers are washed ashore after storms." Moreover, Wells and Wells (1961) state "the authors found thousands of sea cucumbers (*Theelothuria princeps*) in windrows on the outer beach near Fort Walton Beach, Florida." No additional information on this event—other than that the sea cucumbers were largely dead and that there had been an unusually high tide—exists. Such qualitative information is of interest; however, these statements are of little practical use, lacking even rudimentary quantitative documentation of such events and the conditions surrounding them.

Herein we document a mass mortality of adults of the sea cucumber, *Holothuria princeps,* as indicated by approximately 30 dead individuals at the tide line of a high-energy sand beach at Panama City Beach, FL, on 30 Dec. 2016.

Methods.—The individuals were observed at low tide in two groups of 10–15 individuals, each group occupying an area measuring approximately 3 × 4 m and scattered along the upper surf line (Fig. 1A). A sampling of individuals was photographed, and representative morbid body length was estimated by taking an image of an individual placed next to a coin for size reference. Evidence of movement poststranding prior to mortality was noted. Environmental conditions at the approximate time of the event were also determined. The precise location of the beach site was recorded, and one individual (11.5-cm body length) was collected 5 d later and preserved in 70% ethanol for ossicle preparation and taxonomic verification of species at the University of West Florida.

Results and discussion.—The location of the mortality event was approximately 60 m east of the M.B. Miller County Pier on Panama City Beach (30°11′19.7″N 85°49′50.1″W). The individual collected later from Panama City Beach for its ossicles was found on 4 Jan. 2017 approximately 50 m east of the Russell Fields Pier. Skeletal ossicle preparations (large tack-like tables in the podia, a second type of smaller tables in the body wall, knobbed buttons) verified the species to be *Holothuria* (*Theelothuria*) *princeps* Slenka, 1867 (Miller and Pawson, 1984). Densities of the 10–15 individuals scattered along the high-tide line in each of the two adjacent stranding areas were approximately one individual per square meter (Fig. 1A). The aggregation of individuals on the shoreline might be the result of local current patterns or the result of the stressor(s) that caused mortality affecting a population aggregated in situ. All

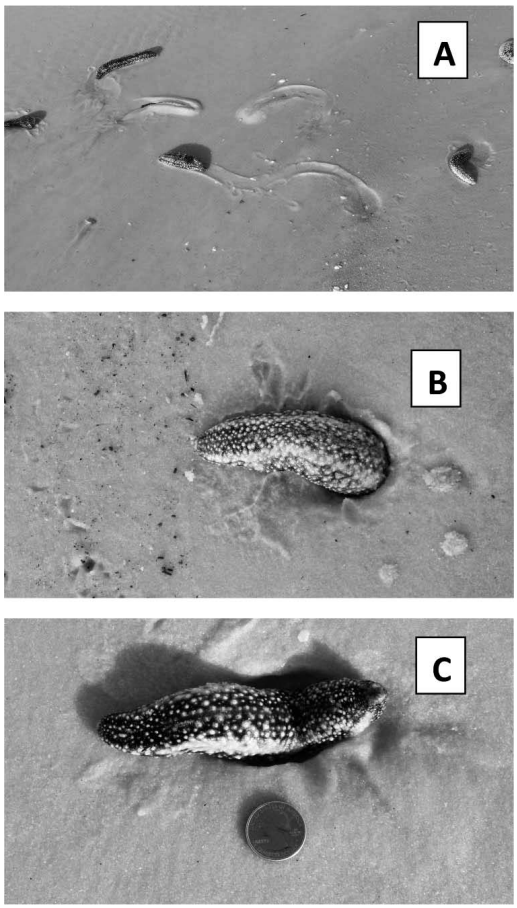

Fig. 1. A. Dead and moribund adult *Holothuria princeps* scattered at the high-tide line on Panama City Beach, FL. on 30 Dec. 2016. Note tracks associated with individual in the foreground. B. Partially burrowed individual. C. Representative adult with coin for reference (body length = 14 cm).

individuals appeared similar in body length and were at a body size indicative of small adults (14-cm length based on the one representative measured). As the species gets up to 30 cm in length (Miller and Pawson, 1984), it is possible small adults are more vulnerable to environmental change and being washed ashore. Some individuals lay adjacent to what appeared to be crawl tracks suggestive of movement after stranding (Fig. 1B). Moreover, two individuals were partially buried, with up to half their body length below the sand (Fig. 1C). When individuals were prodded, several displayed weak reflexive muscular movement, but clearly all the individuals were either dead or dying. The probability of a moribund individual being washed back to sea and surviving is extremely low.

Environmental conditions at the time that the mortality event was discovered (30 Dec. 2016) were relatively benign, with no reported storms. Wind speed ranged from 1.2 to 6.4 m/sec, and seawater temperature ranged from 16.7°C to 19.1°C (5-min interval measurements over 30 Dec. 2016, Panama City dock NOAA station PCBF1-8729210). Wave height on 30 Dec. 2016 ranged from 0.36 to 0.91 m, as recorded hourly at NOAA Buoy station LLNR 141, located 212 km SSE of Pensacola, FL. One of us, WCL, had visited the beach site the previous day without viewing any beached sea cucumbers, indicating that the mortality event had occurred < 24 hr from the time of its initial discovery.

As was the case with a similar larger sea star stranding event that occurred on the Florida Panhandle on 27 Dec. 2013 (McClintock et al., 2013), the specific cause of the sea cucumber mortality event remains unknown. Wave heights appeared insufficient at the time of the event to have scoured the sea floor. However, currents generated by longshore drift may have contributed to the displacement of the individuals. There was no evidence of tissue necrosis, as might be expected if there was a wasting disease, as has been recorded in extensive multispecies populations of sea stars along both the Pacific and Atlantic coasts (Hewson et al., 2014, and references therein). The Deepwater Horizon oil spill had occurred 6 yr previously and further to the west. Despite oil remaining in deep offshore sediments, it seems an unlikely contributing factor (Hayworth et al., 2011). That some of the sea cucumbers responded to probing, were semiburied, or had left tracks in the sand suggests that they were not dead at the time of being washed ashore. In the anecdotal documentation of a beaching of dead *H. princeps* on Fort Walton Beach, FL, on 28 Feb. 1960, several individuals close to the tide line similarly responded to probing (Wells and Wells, 1961). Sea water temperatures at the time of the beaching were below 20°C, a temperature not uncommon during winter months along the Florida Panhandle but a threshold known to immobilize some echinoderms (e.g., the sea urchin *Lytechinus variegatus*) in the northern Gulf of Mexico (J. M. Lawrence, pers. obs.). As the echinoderm mortality events recorded to date on the central West Florida Shelf (Wells and Wells, 1961; Beddingfield and McClintock, 1994; McClintock et al., 2013, present study) have all occurred during winter months (Dec.–Feb.), it is possible that low temperature is inducing a

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thermal stress that renders individuals susceptible to currents. The most parsimonious explanations are that either strong longshore current washed healthy individuals to shore or individuals were stressed in situ by an unknown factor (perhaps low winter temperature), then slowly swept shoreward and beached. While the recorded depth distribution of this species extends to 54 m, dredged collections of individuals have come from depths as shallow as 0.6–2.1 m, 1.5–3.0 m, and 3.1 m (Miller and Pawson, 1984). It is likely that populations that occur this shallow are at a greater vulnerability to being washed up on shore when stressed.

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