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THE EFFECTS OF THE WINTER OF 1917-1918 ON THE OCCURRENCE OF *SAGARTIA LUCIÆ* VERRILL<sup>1</sup>

IN June, 1902, I published in the *AMERICAN NATURALIST* some notes on the dispersal of *Sagartia luciæ* that tended to show that this sea-anemone had spread from the neighborhood of New Haven, Conn., along the New England coast as far north as Salem, Mass. This migration was accomplished in approximately a decade, from 1892 to 1901. Since 1902 repeated efforts have been made to discover evidences of this species farther to the north than Salem but without avail. Apparently the species had reached its northernmost limits.

*Sagartia luciæ* was first noticed in Woods Hole, Mass., in 1898. From that year until the present it has been an extremely abundant species on the stones, mussels and eel grass in the waters of this region. On Pine Island, a narrow ridge of rocky gravel overtopped with coarse vegetation and lying in the swift tidal currents of the Hole, the narrow beaches between tides have been covered with thousands of this species of sea-anemone. When this locality was visited in June, 1918, not a single specimen of *Sagartia luciæ* could be found, though the particular area examined had been covered with many individuals the year before. Nor was this condition due to the relatively early date at which the search was made. Repeated attempts during low tides in July and August never yielded at Pine Island more than two or three specimens at a time, and it was quite clear that *Sagartia luciæ*, once so prevalent in that locality, had suddenly become all but extinct there. The same was true of other situations in and about Woods Hole. In fact, a general search showed that in not a single location where this sea-anemone had been abundant in 1917 could there be found more than a paltry number of specimens in 1918.

The occasion of this sudden and great diminution in the numbers of *Sagartia luciæ* is to be attributed, I believe, to the rigor of the winter of 1917-1918. The cold and ice of this winter were almost unprecedented. Mr. Vinal Edwards, the veteran collector of the laboratory of the United States Bureau of Fisheries at Woods Hole, has kept a continuous record of the weather conditions of this region for a long period and this record shows, as might be expected, that the winter conditions in 1917-1918 were more severe than for many years past. In no win-

<sup>1</sup> Contributions from the Zoological Laboratory of the Museum of Comparative Zoology at Harvard College.

ter during the last ten years has the sea water been at 0° C. or lower for so long a period as last winter. Beginning with the season of 1908–1909 and proceeding to that of 1917–1918, the number of days for each of the ten winters in which the temperature of the seawater was 0° C., or lower, was 3, 40, 44, 63, 3, 55, 0, 65, 36 and 80. Thus 1917–1918 with its 80 days of extremely cold water strikingly outruns any one of the preceding nine years.

This winter was conspicuous for the formation of large amounts of anchor frost in the shallow waters about Woods Hole. This frost or ice can be seen forming on the bottom of shallow bodies of salt water when the temperature of that water is at 0° C., or lower. It is apparently due to the freezing of fresh water that, seeping through the land, rises from the sea bottom and solidifies at once on coming in contact with seawater below its own freezing point. This fresh-water ice is especially destructive to marine animals on the bottom and its great prevalence during the winter of 1917–1918 is probably responsible for the scarcity of sea-urchins and other like forms the following summer. It probably had little or no effect on *Sagartia*, for this sea-anemone lives chiefly between tides and, therefore, above the level at which anchor frost is found, but as a winter phenomenon this ice is a good index of severity and it is severity in the nature of low temperature that is responsible, I believe, for the almost complete elimination of *Sagartia*.

That this sea-anemone was not destroyed by the merely mechanical effect of ice and waves is seen from the fact that the same stretches on Pine Island that were populated with *Sagartia luciae* were, and still are, covered with many specimens of *Metridium marginatum*. This northern species seems not to have suffered in the least from the severity of the past winter and I, therefore, conclude, since *Metridium* was as much exposed to mechanical injury as *Sagartia* and still survived in ordinary numbers, that *Sagartia* succumbed to low temperature rather than to any other factor in its environment. This is in accord with the general belief, originally expressed by Verrill, that *Sagartia luciae* is a southern species introduced by some accident into northern waters. Granting this conclusion, it is easy to understand why this species has not migrated farther northward into colder waters and why in severe winters it is almost exterminated in localities such as Woods Hole.

G. H. PARKER