BIOLOGY

Swarming Sea Worms

Solitary Creatures, Living Buried in Rocks and Dark, Swarm at Certain Phases of Moon and Lay Their Eggs

THREADS of silvery moonbeams over tropic seas are woven intricately into the complex fabric of life on earth.

The influence of the world's cold satellite, nearly a quarter million miles away, is most remarkably exemplified in the behavior of five or six varieties of sea worms whose life histories have been studied by several investigators at the Tortugas Laboratory of the Carnegie Institution of Washington.

Sea worms are solitary creatures who live most of the time buried in rocks and darkness. At certain phases of the moon they emerge from their burrows in a strange fashion, their bodies break apart, and the rear portions swim to the surface, lay their eggs in great masses on the water, and then perish. At the proper time of the year they respond to the intensity of moonlight as though their bodies were millions of photoelectric cells.

There are few more specific reactions in living nature than that of these lowly creatures to an irresistible influence which arises in them when the moonbeams penetrate the water. The pale moon seemingly becomes the activator of mystical forces of birth and death in uncountable swarms of these sea worms in whom life is a low-burning fire, probably far below the level of consciousness.

Many biologists have studied this strange phenomenon in their attempts to establish the point of contact between the lunar cycle and life. The life histories of the worms have been followed in intimate detail. The latest results, which throw considerable new light on the behavior of the lowly animals, have recently been reported by Drs. Leonard B. Clark and Walter N. Hess, of Union and Hamilton Colleges respectively, guest investigators at Tortugas.

They worked with the Atlantic palolo worm, one of the most conspicuous of the "moon worms." It is a close relative of the Pacific palolo worm which used to be eaten by the natives of the Samoan Islands, whence it derives its name.

The Atlantic palolo worm, *Leodice fucata,* is widely distributed in the West Indies. It has been reported from the Dry Tortugas Islands, Puerto Rico, Cape Florida, Jamaica, Tobago Bay and the Bahamas. The worms live in crevices and burrows in dead coral or in limestone beach rock from the lower levels of the intertidal zone to depths of about 150 fathoms.

They can excavate their own burrows, but usually incorporate into them cavities and tunnels made by other organisms, such as burrowing mollusks. Although the rock may be honeycombed and yield as many as twenty worms per cubic foot, the burrows do not seem to communicate.

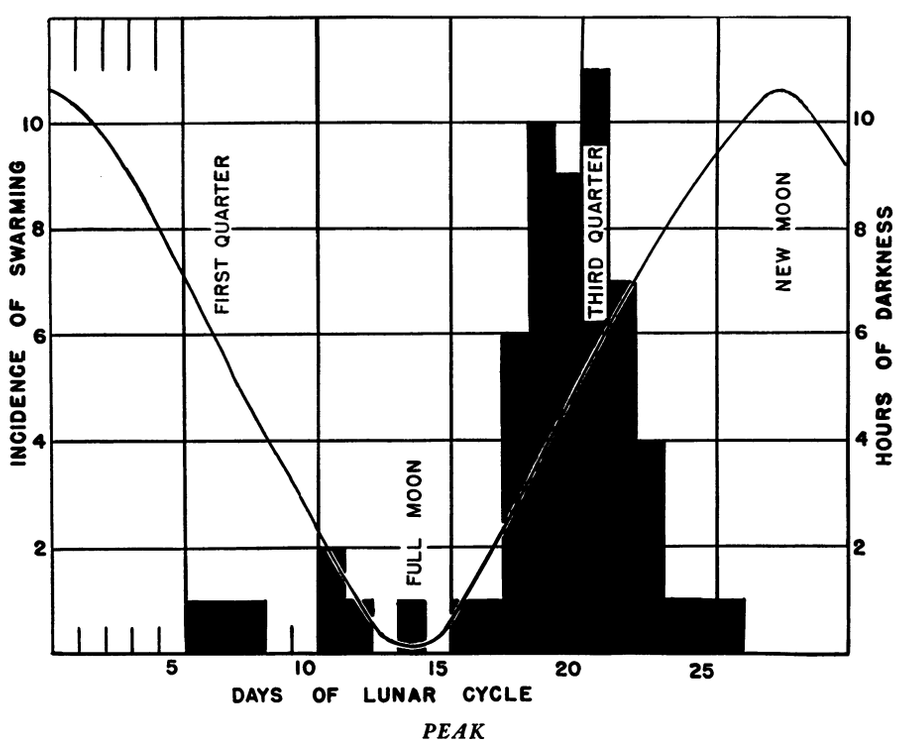
The worms remain in their burrows during the day. They have an extreme withdrawal reaction to all except very weak intensities of light. At night the front end is protruded into the water. The food consists largely of small particles of organic matter secured within a few inches of the mouth of the burrow.

During the night of swarming the worm backs out of its burrow and the rear half begins a series of convulsive twisting movements, usually counterclockwise, which eventually tear it apart from the front end. The front half crawls back into the burrow and continues to live as before. The freed rear half swims to the surface in a series of graceful, spiral movements. On a swarming night the numbers of swimming individuals increase rapidly until dawn, when the surface of the ocean is covered with them. With the rising of the sun they start releasing eggs and sperm into the water, and this may continue until the sun is about a half hour high.

The exhausted creatures may continue to swim for a short period unless eaten by fish, but they soon sink to the bottom and die, although in the laboratory it has been possible to keep them alive for as long as eight days.

After being discharged the eggs float and may appear in such immense numbers that they cover the ocean for acres. They have been observed in long windrows, several yards in width and several feet in depth. There are many thousand eggs per bucketful of water.

The eggs are fertilized immediately and proceed through their cleavage stages,



This chart shows the relation of the swarming of the Atlantic palolo worm to the lunar cycle.

so that by 10 a.m. they may be in a late stage of segmentation. By late evening or the next morning they have become well developed larvae, swimming about with a spiral motion. For three days they remain on the surface. Then they sink.

The studies of Drs. Clark and Hess show that the relation of the swarming reaction to moonlight is not quite so specific as has been assumed in the past, and that the maturity of the animal and the turbulence of the water play significant roles. The specificity remains such, however, as to constitute one of the true wonders of nature.

The swarmings, they report, may occur sporadically at almost any time during the moon's cycle except at the new moon. However, there is usually a significant increase at the first or third quarter phase of the cycle. Major swarms, during which many more worms reproduce than at all other times together, nearly always occur within five days of the third quarter moon.

The moon's phases undoubtedly are significant. Swarming about the quarter moon phases may be due to inhibition at other periods or may be due to a stimulus exerted at the quarters and not at other times. However, the actual presence of moonlight is not necessary to initiate swarming, so the events must be influenced by the moon before that time.

The influence, possibly stimulatory, exerted by the first and third lunar phases seems to differ in intensity in the two quarters. Reports are rare of swarming at the first as compared with the third quarter moon. Swarming has taken place many times at the third quarter on dates preceding the date of the earliest recorded swarm on the first quarter. In no case has swarming occurred in the first quarter less than 369 days from the swarm of the preceding year, while worms have swarmed at the third quarter moon at 353 days.

Waves Prevent Swarming

Among the other conditions which must obtain is quiet water. Wave action and water turbulence prevent swarming at the Dry Tortugas Islands if the wind has a velocity greater than eight miles an hour, unless the water is sheltered. Even after a swarm is begun wind may cause sufficient wave action to cause its cessation. Tides, to the extent that they induce or modify currents or change the depth of water, also may play some part in determining swarming.

It is almost impossible to keep these worms alive in aquaria where their strange life could be studied under controlled conditions. They are extremely sensitive to lack of circulation, to any accumulation of carbon dioxide in the water, and to any impurities. If small pieces of rock containing the creatures are put in laboratory tanks, the captives die within a very few days, even though a flow of water is maintained sufficient to give them a complete change every fifteen minutes.

It was hoped that a method could be developed by which mature worms could be removed from their burrows alive and put into aquaria. Attempts were made to drive them out by drying the rocks, putting them in warm water, and by weak electric currents. All failed completely. Few other creatures have such a remarkable power of breaking apart. They have a highly developed instinct to cling to rock, known to naturalists as "positive thigmotropism." Almost any stimulus which is strong enough to overcome this tendency also is sufficient to cause a worm to fragment.

Extremely Sensitive to Light

Also, Drs. Clark and Hess point out, the rear portion of the worm is extremely sensitive to light and usually starts twisting movements when exposed, so that it is quickly broken off and may be broken into several pieces. A measure of success was attained by breaking open the rocks with a cold chisel. It was necessary to work in dim light, as at dusk, and to expose the worm completely with one blow. If any part of the creature, especially the front end, remains in the burrow it crawls in, and even the gentlest pulling causes it to break. Very often the weight of part of the worm is sufficient to cause breaking.

With practice it was found possible to remove about five per cent of the mature worms unbroken from their burrows. They did not live free in aquaria even in a dark room. Various attempts were made to keep them in glass tubes covered with rubber, but without success. The worms entered the tubes readily and remained in them during the daytime, but left them at night and did not find their way back. At sunrise they were so stimulated that they fragmented.

The rear ends, if broken out of the rocks, behave much like those in the process of swarming, if the light is more than half a foot candle. They twist, break away, and swim at the surface. Worms broken out of rocks in the dark do not react in this way, but once the reaction has been started darkness does not inhibit it.

As the season for swarming approaches, the two biologists found, certain important changes occur in the animal. The rear half of the male becomes a deep pink in color and that of the female a greenish-gray. The two or three front segments of this half are constricted so that they are easily ruptured.

Generally the life of the secretive moon worms is far removed from any influence on human affairs, although it doubtless fills an appropriate niche in the economy of nature. Once, however, a related species of the Bahamas, the Odontosyllis, may have played a role in history in connection with Columbus' landing.

It will be remembered that at about 10 p.m., October 11, 1492, Columbus and several others, standing on the poop on the *Santa Maria,* saw a mysterious light flashing in the distance. It was described as "like the flame of a small candle, alternately raised and lowered." Navigators who have charted Columbus' course have calculated that the *Santa Maria* at that time was about 35 miles eastward and to the windward of the spot where the actual landing was made.

The light might have been, according to a recent speculation of L. R. Crawshay, British biologist, published in *Nature,* the luminescence of this worm. The swarming displays are intermittent, with short periods of excessive and declining brilliance. The whole phenomenon lasts from five to ten minutes. Seen from a distance of a few hundred yards it would have the appearance of a candle being raised and lowered. The difficulty is that the light could not have been seen thirty-five miles at sea since the worm only displays its light in shallow water, and then only at low tide.

Must Have Been Shallow

Assuming that this was the light seen by Columbus, the *Santa Maria* could not have been in the deep water thirty-five miles to the eastward of Watling Island. It must have been, on the contrary, near the narrow, rocky bank extending about three and one-half miles off the north shore of Watling Island. This is an ideal swarming place for the worms.

Hence, if Mr. Crawshay's speculation is correct, the *Santa Maria* was probably just off the northern tip of Watling Island at ten o'clock on the evening of October 11, 1492, when the mysterious light was sighted. If this were so the landing made the next morning must have been at Cat Island, not at Watling.

Thus the mute testimony of a worm may serve to fix an important point in the world's history. All this, however, is admittedly highly speculative, and most historians accept Watling Island.