BREEDING HABITS OF OCTOPUS

Octopus rugosus Bosc is the common octopus of the Florida Gulf Coast and seems to be particularly abundant on the sandy flats near the city of Fort Myers. On February 18, 1928, the writer, while exploring the shallow water along the sandy shore known as Crescent Beach, picked up a shell of the so-called pearl oyster which, upon being opened, was found to contain a small female octopus of this species, together with a batch of eggs. The position of the octopus in the shell was one in which the tentacles were thrown back over the body with suckers from each individual tentacle fastened to each valve of the shell and holding the shell tightly closed. The eggs were deposited—a clump to each half of the shell—fifty-seven eggs in one cluster and seventy in the other—each egg being attached to the shell by a gelatinous thread which proved to be a continuation of the egg capsule. The eggs were cylindrical in shape, five to six mm long, about two mm in diameter, with the attachment thread two mm in length. At this time all the eggs were cloudy at the distal end with a limited clear region at the proximal end and some of them bore also near the proximal end a black dot, which it was later determined marked the position of an eye.

On March 6, a second shell, this time a cockle shell, was found with an adult octopus and eggs inside. The eggs in this case each had two black spots near the proximal end, which spots, it was noted, were the pigmented eyes of the young octopus. On March 20 a heavy storm strewed the beach with débris, and following the storm some twenty shells with octopus eggs were collected, and in fifteen of the specimens the adult octopus was found either in or near the shell. The size of the eggs at this date had increased to a length of 9 to 10 mm and a diameter of 2.5 mm and all at this time showed young octopi within. A quantity of eggs was placed in sea water for observation, with the result that within a day's time young octopi had emerged from many of them. The process of emergence of the young octopi began when the young animals, which were at first located at the proximal end of the eggs or in the clear area already mentioned, with the body close against the attached end and with the tentacles extending out over the cloudy yolk, began to swallow the yolk. This process of engulfing the yolk continued for some hours, it being essential, apparently, that the yolk be partially swallowed before the young animal could escape from the egg capsule. When about half of the yolk had been engulfed, and after much twisting and squirming, the young octopi reversed ends by sliding past or exchanging places with the still partially unswallowed yolk substance. So far the young animal appeared to be almost transparent, very little pigment outside of that in the eyes being visible.

Within an hour or so after the reversal of ends, during which time the body of the octopus was pressed against the distal end of the egg capsule, a round cap (sometimes irregular) popped off of the distal end of the egg case, leaving a circular aperture just large enough to allow the young octopus to squeeze through to freedom. The body of the octopus usually slipped through this opening easily, but there was often some difficulty in pulling the tentacles with the unswallowed yolk through the exit. When this was at last accomplished, the evacuated, thin, translucent, collapsed egg capsule remained attached to the shell by the stalk. Once free the young octopus settled down to finish the swallowing of the yolk and at the same time began rapidly to show color. After about an hour the yolk had disappeared within, and the young octopus, now a perfect miniature of the adult, with much of the adult's ability to swim or crawl about and to change color, began an active, independent life. Under the binocular scope, rows of pigment cells looking like rows of colored blocks within the transparent protoplasm were now visible, these pigment cells appearing to lie at different levels. The rows were not mixed, however, *i.e.,* all the blocks in a given row were brown, yellow, green, etc., as the case might be.

It appears, then, that the breeding habits of the Florida octopus, *Octopus rugosus,* agree with those reported for other species in that the eggs are laid and development takes place during the winter months. For the region of Fort Myers, Florida, the eggs are probably laid early in February and after a developmental period of from five to eight weeks, during which time the eggs are brooded and aerated by the adult, the young emerge as perfect miniature octopi, there being no metamorphosis subsequent to hatching.

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LOVELAND LOESS: POST-ILLINOIAN, PRE-IOWAN IN AGE

THE following statement was made by the writer in 1924 in an abstract of a paper published in the *Bulletin* of the Geological Society of America, Volume 35, page 73:

The name "Loveland formation" was given by Shimek to a deposit in western Iowa which is a "heavy, compact, reddish (especially on exposure to the air) or sometimes yellowish silt which when dry is hard with a tendency to break into blocks like a joint clay and when wet becomes very tough and sticky and hence is sometimes called a gumbo." The type section of this formation is at Loveland, Harrison County. By early workers this formation was thought to be related to the wide-

spread buff loess of the region, but Shimek believed that it was a fluvio-glacial deposit "formed during the melting of the Kansan ice." In many places it is calcareous and contains calcium carbonate concretions, many of which are from three to six inches in diameter; a few were seen with greatest diameter more than twelve inches. The Loveland does not show the laminations of water-laid clay, but in places sands and silts of distinct aqueous origin are interstratified with the Loveland clay and in a few places volcanic ash is interbedded with the formation. Moreover, it has the vertical cleavage of loess and stands with similar vertical faces. Although in places fossil shells are present in the Loveland, they are extremely rare in comparison with the numbers of shells which are in the buff loess. The writer believes that the Loveland is not a fluvio-glacial deposit, but a loess distinctly older than the widespread buff loess which overlies the Loveland and which is thought to be chiefly of Peorian age; the Loveland is younger than the Kansas glacial epoch, since it lies upon the maturely eroded surfaces of Kansan till.

This statement was based upon investigations in a comparatively limited region near the type section, which is on the east slope of the Missouri River valley. The views to be presented in this brief paper are the result of detailed studies of the Loveland formation in widely distributed exposures in Iowa. The characteristics, distribution, origin and age of the deposits of Loveland time in Iowa have been determined and will be described fully in a paper now in preparation.

In western and northwestern Iowa, at least, the Loveland deposits consist not alone of loess, but also of widespread silts, sands and gravels. While the Loveland silts, sands and gravels were being deposited in valleys, the Loveland loess was accumulating on adjacent slopes and uplands.

With the writer's knowledge of the characteristics and relationships of the Loveland loess and associated silts, sands and gravels in western Iowa as a background, he examined similar deposits in that part of northwestern Iowa which lies west of the Des Moines lobe of the Wisconsin terminal moraine, where within the last few years Frank Leverett, J. E. Carman and the writer have found evidence of a post-Kansan, pre-Peorian drift which is apparently of the same age as the Iowan drift of northeastern Iowa. Within this Iowan drift area of northwestern Iowa the Loveland loess, silts, sands and gravels are post-Kansan gumbotil erosion, pre-Iowan in age. The Loveland deposits are younger than the valleys cut in the Kansan drift and are overlain in some places by calcareous Iowan till and in other places by unleached gravels of Iowan age.

The Loveland deposits were traced next into central and southern Iowa, then into the Iowan drift area of northeastern Iowa and finally into the Illinoian drift area of southeastern Iowa. In the Iowan and Illinoian areas only the loess phase of the Loveland deposits has been found thus far. In the Iowan drift area of northeastern Iowa this loess is post-Kansan gumbotil erosion, pre-Iowan in age. Here the Loveland loess is underlain by Kansas gumbotil or Kansan till and overlain by calcareous Iowan till. In the Illinoian area of southeastern Iowa the Loveland loess is post-Illinoian gumbotil, pre-Peorian loess in age.

This same relationship of a loess younger than the Illinoian gumbotil and older than Peorian loess was described by Leighton in a paper published in the *Journal of Geology* in 1926 on the Farm Creek section, east of Peoria, Illinois. He interpreted the older loess to be late Sangamon in age. Leverett in a personal communication expressed the opinion in 1926 that old reddish loess which he had seen in several localities "should perhaps be put in the early Sangamon." The evidence indicates that the reddish or brownish loess older than the widespread Peorian loess to which reference has been made from time to time for many years by different geologists in western and southwestern Iowa, eastern Nebraska, northwestern Missouri and western Illinois, is Loveland loess.

The Loveland loess has now been established by stratigraphic methods as being much younger than the Illinoian glacial drift and older than the Iowan glacial drift. The significance of the determination of the definite age of the Loveland loess must be emphasized. It would seem to settle conclusively the relative ages of the Illinoian glacial stage and the Iowan glacial stage. The Loveland loess was deposited after the development over wide areas, chiefly by chemical weathering, of a gumbotil more than three feet thick on the Illinoian till. Furthermore, there was sufficient time after the Loveland loess was laid down for this loess to be leached to a depth of several feet before the coming of the Iowan ice sheet.

The knowledge of the Loveland loess adds new evidence to that which has been presented for many years by several geologists in support of the view that the Iowan glacial stage is much younger than the Illinoian glacial stage. There is at present no adequate basis for correlating the Iowan drift with the Illinoian drift as was suggested recently by Leverett in "The Pleistocene Glacial Stages: Were there More than Four?", a paper which was read before the American Philosophical Society of Philadelphia.

Five glacial stages and four interglacial stages must continue to be included in the classification of the Pleistocene of the Mississippi Valley.

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