According to the view here presented, the following are some of the actions and reactions taking place in thunder-storms: —

1°. There exists above the earth's surface strong currents of air moving inward toward the central line or area of the thunder-storm. This is attested by balloon observations and by observations of clouds.

2°. There arises from the sudden expansion of air entering the vortex of thunder-storms from beneath a reaction which produces a compression of the air near the earth's surface, and a rise of the barometer.

3°. This compression causes the air near the earth's surface to tend outward in all directions from the centre of a thunder-storm; but the outflow in moving storms is only felt, or attains its greatest strength, on the front of the storm, where the direction of the outflow is combined with the progressive motion of the storm. In tornadoes the vortex usually reaches to the earth's surface, and there is no place for a vertical reaction; but where the vortex is some distance above the earth's surface, there is the same evidence of a straight outblowing wind moving in the direction of the tornado, as there is in a thunder-storm.

4°. This rapidly outflowing current, by its dynamic action on the barometer or its environment, frequently or generally causes a depression of the barometer in the front of thunder-storms, where the outflow is most violent. H. HELM CLAYTON.

Blue Hill meteor. observ., April 10.

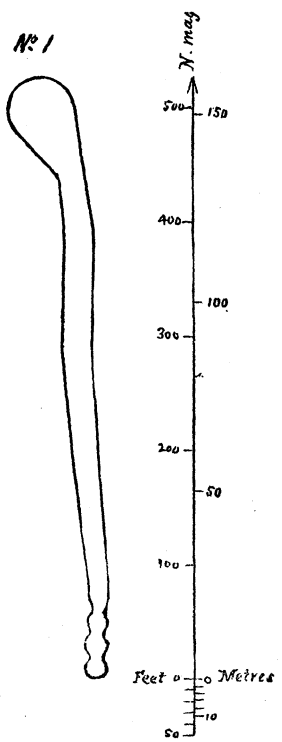
Snake and snake-like mounds in Minnesota.

From time immemorial a certain mythical or superstitious interest has attached itself to the serpent — the wisest of the beasts of the field — amongst most nations, whether civilized or barbarous, and his pictured or sculptured delineations have been the occasion for much writing on the part of antiquarians. In North America the creature has been depicted by the ancient inhabitants in various ways; as, for instance, by carvings on rocks, by outline arrangements of stones or bowlders placed on the ground, and, more sparingly, by mounds of earth. The latter belong to the class of earth-works known as 'effigies,' of which the 'Great Serpent' of Adams county, O., stands an unequalled representative. Indeed, with the exception of this one, no mounds representing snakes have hitherto been delineated and published, except one or two somewhat dubious specimens in Wisconsin.

In the course of my surveys in Minnesota, I have met with at least two such effigy-mounds, which, with some others looking suspiciously like tadpoles, I have drawn in plan for the engraver. They are numbered and described as follows: —

No. 1 is situated on the west side of St. Croix Lake, on the town-site of Afton, Washington county. The land here slopes toward the lake, and the Rattlesnake lies just above high-water mark. The head is 5½ feet high, 88 feet long, and 56 feet wide at the broadest point, which is also the highest, from which it gradually descends to the body. Where the head joins the body the embankment is 22 feet wide and nearly 2½ feet high. The body is but slightly curved. In the next 160 feet the width increases to 26 feet, but the height drops to 2 feet. From this point it gradually diminishes to 18 feet in width and 1 foot in height. Connected with the extremity or tail, there are three small mounds whose bases interlock, thus forming the rattles. The last of these mounds is 20 feet long and 18 feet wide, and the two between it and the tail are each 18 feet in diameter, and all three are of the same height as the end of the tail. The total length of this effigy is 534 feet. On June 25, 1883, when this survey was made, in addition to the snake, there were four round mounds and one embankment in the group. Formerly there were other mounds, but they had been demolished.

No. 2 is on the east side of Spring Creek, some three miles westward from Red Wing. It has a perceptible head, which is 8 feet wide and 1 foot high; the neck is nearly 7 feet wide and 10 inches in height. From the latter point the body gradually increases its width until the middle is reached, where it is 14 feet wide and 2 feet high: thence it decreases to the



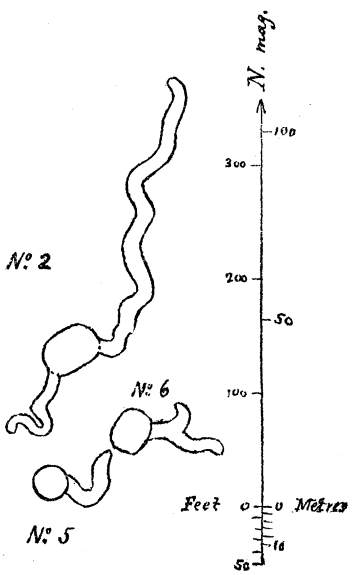
end of the tail, which is 8 feet wide and 1 foot high. Its total length following the curves is 430 feet. The mound which covers the body near the head is 52 feet in length, 36 feet wide, and 5 feet in height. From general appearances it would seem that it was built after the snake was constructed; for the slope of the mound where it strikes the body of the snake is somewhat irregular, and indicates that its builders were at a loss to know how to join them symmetrically. These irregularities are not caused by the dirt washing down from the top of the mound, for otherwise it is perfectly symmetrical and the base well defined.

No. 3 is in another group of mounds about 250 yards down the same creek from the preceding one. The head is circular in form, being 40 feet in diameter and 3½ feet high. The body at the junction with

the head is 20 feet wide and 1½ feet high, but gradually decreases to a point 97 feet distant, where it is but 14 feet wide and 1 foot high. Thence to the end of the tail it retains the latter width and height. Its total length, following the curves, is 290 feet.

No. 4 is in the same group, and lies south-west of the tail of No. 3, 35 feet. The head is circular, being 36 feet in diameter and 4 feet high. The body at the junction with the head is 16 feet wide and 1½ feet high. From this point it gradually decreases in width to the end of the tail, which is 12 feet wide and 1 foot high. The extreme length of this effigy is 300 feet. The heads of Nos. 3 and 4 are away from the creek. In addition to Nos. 3 and 4, there are nine small round mounds in the group.

No. 5 is in the same group with No. 2, and its head is 40 feet south-east from the head of the latter, and rests on the edge of the plateau. The head is

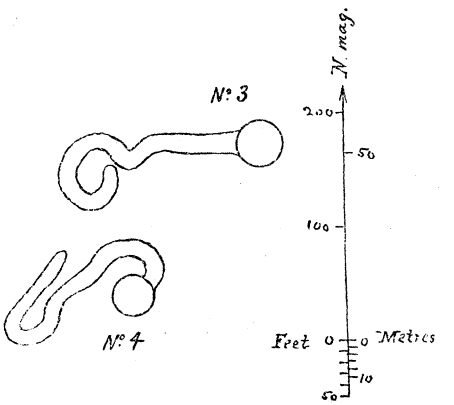


30 feet in diameter and 4 feet high. The body at the junction with the head is 20 feet wide and 1 foot high, and does not vary until within 20 feet of the end of the tail. From this width it gradually diminishes to 6 feet. Its total length, following the curves, is 105 feet.

No. 6 is close to No. 5, its head being only 10 feet from the end of the tail of the latter. The head differs from the others in being oblong, and is 40 feet long, 30 feet wide, and 3 feet high. About one-third of the way from the head the body forks, forming two tails of unequal length. Near the head the body is 16 feet wide and 1½ feet high, and at the end of each of the tails 8 feet wide and 1 foot high. Its greatest length, from the extremity of the head to the tip of the longest tail, is 105 feet.

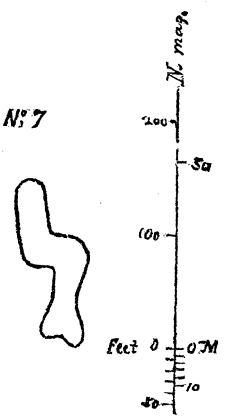
The heads of Nos. 2, 5, and 6 are towards the creek, and, in addition to them, there are sixteen mounds and embankments. Both of these Spring Creek groups are on a plateau some 40 feet above the water, and were covered with brush and young timber when the survey was made (Sept. 5, 1885), but Nos. 3 and 4 are now cultivated.

No. 7 is near the south end of Lake Koronis, west of the outlet, in Meeker county. Although this mound is serpentine in form, and apparently has an open mouth, it is hard to determine exactly what it is intended to represent. The head at its widest point is 36 feet broad and 2½ feet high. The body varies from 20 feet in width at its junction with the head, to 34 feet near the middle and 25 feet near the end of the tail, and is 2 feet high. Its greatest



length, following the curve, is 167 feet. In addition to this stumpy snake, there are thirty-two other mounds and embankments in the group. Directly opposite, on the east side of the outlet, there is another small group of mounds, the largest of which is nearly circular in form, and is 19 feet high. These groups were surveyed Nov. 8, 1886.

The reader fond of comparison can, if he pleases contrast these Minnesota serpents with the Great Serpent of Ohio, by making use of the following di-



mensions of the latter, as measured Feb. 18, 1886: total length from tips of jaws (if closed), following the windings of the body, to the end of the convoluted tail, is 1,020 feet; length of head, about 120 feet; width of head, 80 feet. The body and tail vary in width from about 30 feet at the neck, to 8 feet at the tip of the tail, and in present height from 3½ feet to 1 foot.

T. H. LEWIS.

St. Paul, Minn., April 6.