ART. XV.—*On the Sandstone Fossils of Connecticut River.*

By James Deane, M. D.

Prior to the year 1835, the indications of organic life, co-existing with the sandstone deposition of Connecticut River, were exclusively confined to a few genera of heterocercal fishes. This rock was formerly supposed to be so destitute of animal remains, that when in this year I opened a new chapter of its organic history, my discoveries were treated with incredulity and neglect. But, after the investigations of twenty years that have resulted, it is known to be exceedingly rich in the imperishable materials of geological history. Very few indeed have any conception of the marvellous perfection of these fossil inscriptions, or of the multitudes of once living creatures whose existence they commemorate. During the vast sandstone deposition, it is presumed that animals whose instincts and organizations attracted them to littoral margins, were as numerous as their living representatives. The immense groups of birds embraced countless individuals who have inscribed upon the shores whereon they congregated their unmistakeable and instructive history. Most of the finest impressions have never been described, and the rich discoveries of late years, render a thorough revision of these fossils indispensable to a clear comprehension of the sublime truths they teach.

Other inferior creatures existed in astonishing profusion during the sandstone period, and like the birds, have left the imprints of their feet vivid as upon the day they were made. The presumption is that they embraced as a class, animals no higher in the scale of organization than vertebrated reptiles. They were quadrupedal, and were grouped into several orders; Saurians, Batrachians and Chelonians. Of the saurian and batrachian orders I am acquainted with twenty species at least, and shall present herewith a notice of ten of that number. In one essential feature all these impressions concur, and that is, in the difference in magnitude between the anterior and posterior feet, the latter being about four times greater than the former. This distinctive character, and the diminutive size of the animals they indicate, appear to distinguish them into species, having their affinities in existing salamandrian or tailed Batrachians.

The indications of Tortoises prove them to have been very numerous, but it is nearly impossible to detect specific differences. Their movements over soft mud resulted in ploughing up a trace or furrow by the solid armor of their bodies. In some instances the swinging movements of their feet are well preserved, and in rare cases the pedal imprints are also visible.

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Descending in the scale of organization, this rock has retained the foot-print of insects and crustacea with surprizing fidelity. Nothing in the strange history of the sandstone fossils, is more astonishing than the unrivalled perfection of the vestiges of these frail creatures.

In this brief memoir I shall endeavor to portray some of these interesting hieroglyphics of extinct existences. Fig. *c*, pl. 18, is an unimpeachable footprint of a bird, no other animal could impress it. Its analogies are unmistakeable. It is a left foot, the inner toe has two, the middle three, and outer four phalanges, exclusive of the nail, which is in exact correspondence with the feet of existing trydactylous birds. The triple-headed, or distal extremity of the tarso-metatarsal bone, is also unequivocally impressed. Naturalists may, if they prefer it, explain the origin of these impressions upon the hypothetical existence of such monsters as biped reptiles, but by the unerring laws of comparison, I have never hesitated for a moment to ascribe these footprints to birds. In this opinion I am sustained by a distinguished comparative anatomist, who, in relation to fig. *c*, remarks, "that some naturalists would call it reptilian, because, according to their idea of cosgomony, birds did not exist in the new red sandstone period, and there are some very distinguished naturalists who maintain this doctrine, but I call it the footprint of a bird, cosmogony or no cosmogony."

Fig. *a* is quadrupedal, and is Batrachian. Each foot has four toes radiating forward, and the anterior foot is considerably more advanced than is usual. This is a very beautiful specimen of these delicate footprints.

Fig. *d* has four toes, two diverging outward and two inward. They are thick and somewhat massive, and blunt at their extremity. Both the anterior and posterior feet are analogous as to form.

Fig. *e* is an elegant and interesting example of the quadrupedal impressions, and the most diminutive ever seen. It is very perfect, yet it is difficult to comprehend the place to which the animal who made them should be assigned. All the other quadrupeds move by alternate steps, but in this example both right and left feet fall simultaneously. There is no impression of a fore foot, but this is a common defect in delicate quadrupedal impressions, the impression of the fore foot not always being retained. It may be that the imprint of the anterior foot is obliterated by that of the posterior foot. The dragging of the foot from one step to another is distinctly preserved. There were probably four toes. The surface upon which the creature moved is smooth as if polished, and no other would retain the imprints with such extraordinary fidelity.

Fig. *b* is probably Saurian. It is exceedingly perfect. It is a hind foot with five heavy toes, if the appendage upon the left be considered as a toe. It has a Chirotherian aspect, but as it is a solitary example, and is separated from the fore foot, its true relations cannot be exactly determined. The fine preservation of its massive heel and toes renders it a very beautiful example of foot prints.

Fig. *a*, diagram A, pl. 20, is an undescribed species of quadrupedal imprints. The foot-prints are defective, being impressed when the mud was too soft to retain forms, but this condition was favorable to receive the trail of the animal's tail, which is exquisitely preserved. This is a rare feature.

Fig. *b*, diagram A, pl. 20, is likewise new and undescribed, and is remarkable for the disparity of the anterior and posterior feet. The fore feet are very perfect, four thick but pointed toes radiate outward and somewhat backward. The posterior feet are comprised of four long, slender toes, lying nearly parallel, and the feet are divergent. Right and left feet widely separated.

The foregoing species of quadrupedal imprints have never been figured or described. Those which follow are copied from drawings made by myself and published in the Journal of the American Academy of Arts and Sciences a few years since. They are inserted here for comparison, although a simple outline of a foot can convey no adequate idea of its organization.

Fig. *a*, diagram B, pl. 20, is remarkable for its peculiar symmetry. Four thick, tapering toes radiate forward, and in the hind foot the impression of the heel is prolonged backward to a considerable distance, and is broad and flattened. The fore foot is planted a little in advance and a little outward of the hind foot.

Fig. *b*, diagram B, pl. 20. The hind foot consists of three thick, pointed toes, widely spread, and a short toe pointing inward. The heel is projected backward, and terminates in a rounded extremity. The anterior foot is not conformable to the posterior. Four toes, two pointing forward and outward, and two outward and backward. In birds the foot points inward without exception; in quadrupedal impressions it diverges outward in every instance I have ever seen except this. The hind foot inclines slightly inward. Both examples upon diagram B are exquisitely beautiful and perfect.

Fig. *a*, diagram C, pl. 20, is a series of very delicate foot-prints. Toes four, long and slender, and drag from one step to another. Impression of anterior feet not retained.

Fig. *b*, diagram C, pl. 20, is probably Saurian. Toes have a chirotherian look, thick and massive. Feet divergent. The fore foot planted near the hind, sometimes partially obliterated by it. Stride very great. Fig. *d*, diagram C, is probably analogous, and both, with the exception of the appendage upon the side opposite the thumb, have a striking resemblance to fig. *b*, pl. 18.

The remaining fig. *c*, diagram C, pl. 20, is probably Batrachian; toes four, feet divergent, impressions of anterior feet not retained.

The impressions upon pl. 19 are of recent discovery, and the obscurity of their origin is in proportion to their beauty and extraordinary preservation. Nothing of the kind has hitherto been described or even discovered.

Fig. *a* of this plate is remarkable for the geometrical symmetry and perfection of the dotted impressions, which are arranged in divisions, each a reproduction of the other.

I think in the present state of science it is impossible to explain the origin of this elegant fossil. If the accuminated bodies that constitute the various lines of impressions be not due to the deciduous fronds of plants, they must be taken for the dermoid protuberances of some animal. There is not the slightest evidence of a compressed stem of a coniferous or other plant, which should certainly be the case in so perfect a specimen; and moreover, upon the superior or superincumbent stratum, the imprint is reversed; it is a cast, and this, it appears to me, is conclusive evidence against a vegetable origin. I have drawn this beautiful fossil with excessive care, for it is the most difficult puzzle I have ever encountered, and I must leave it to others more competent than myself to determine its origin. The reader who will take the trouble to analyze the various line of impressions, will find a corresponding number in each repetition. Thus in the unbroken row running obliquely upward from left to right, there are invariably fourteen of the protuberant points, and in each other line, when repeated, is consistent, both as to number and arrangement of the geometrical lines of elevations.

The remaining figures upon this plate are probably foot-prints of a class of creatures not higher in the scale of organization than the articulated division of animals, and a few observations perhaps may assist in deciding upon their origin. I rely more upon the fidelity of the drawing than upon any descriptions to convey exact ideas.

Fig. *l*, pl. 19, is the simplest form of these linear imprints. It is a single set of straight, slender, parallel feet, planted in regular succession.

Fig. *f*. The set is also single, feet slightly divergent, and terminate in an enlargement or depression, caused apparently by the momentum by which the creature moved.

Fig. *c*. The two rows upon the left are identical with those of fig. *f*, but there is also an additional row of impressions upon the right, the terminations of which are not excavated.

In fig. *b* the impressions are identical with fig. *c*, except that the order is reversed.

In fig. *h* two sets of feet are exquisitely preserved. The irregular or odd number of feet may perhaps be explained upon the hypotheis that the creature was moving upon the bottom of the water, and by floating used a part only of its organs of locomotion. This conjecture is sustained by the fact that the rows of impressions sometimes appear and disappear abruptly upon the surface, and are both preceded and succeeded by delicate prolonged lines, caused by dragging of the feet.

Fig. *g* displays two rows of linear feet, and are very fine indeed. The entire length of the original impressions is fifteen inches.

Fig. *k* shows a row of parallel linear feet, and corresponding rows of lateral bulbous impressions.

Fig. *d* also shows the central or parallel rows, and two corresponding lateral rows of curved feet.

Fig. *e* exhibits the trail of the body, with lateral feet.

These extraordinary fossils occur upon surfaces as smooth as polished marble; no other would receive, much less retain such delicate impressions with such fidelity. To explain their obscure meaning I have sought the assistance of several gentlemen distinguished for their scientific attainments, and it gives me pleasure to subjoin their opinions to these meagre descriptions of my own.

Prof. Leidy considers the impressions *k*, *d*, *i*, *f*, *c*, and *b*, to be the tracks of insects and crustacea; *g* and *e* those of worms; and *a*, from its remarkable uniformity, to be rather a vegetable than an animal impression.

Prof. Gray is of opinion that fig. *a* represents leaf scars of some plant like a tree fern.

Prof. Wyman is of opinion that fig. *a* is a vegetable impression, and that the other impressions upon this plate are due to articulate animals, insects or Crustaceans.

Prof. W. B. Rogers is of a similar opinion as regards fig. *a*, yet he remarks that this is but conjecture, and that we are without any guide as to what might be esteemed a probable interpretation of this mysterious inscription.

Prof. Dana can refer fig. *a* to nothing but a plant, the prominence being the traces of leaves, probably coniferous; still it is not like any known coniferous plant, ancient or modern. Upon the remaining figures of pl. 19 he offers the following valuable remarks: "The delicate linear tracks must be made by an articulate animal. They can hardly have been made by annelids (excepting *e* and *g* of which there is doubt), and may have been made by Crustaceans or insects, perhaps water insects. I should incline to say Crustaceans. Among the tribe of this class they may have been either Entomostracans, Isopods, Macrourans, or small species of Anomourans. Isopods have too small legs and pointed claws to make so large a track as *h*, and they would not make the two distinct series of this figure, or a track with three impressions as in *c*. The legs spread from the longitudinal axis, and do not point forward as in *l*. Still it is possible that *d* and *k* might have been made by an Isopod, the bent form of the track in this case being due to the fact that three joints of the leg, pressed on the mud in the progress of the animal. There is a small tribe of Crustaceans near the Isopods, which I have called *Anisopods*, in which the two anterior feet often have large claws, and are projected forward in front of the head, and such an animal might make marks with these claws like *l*, but I should think they would be likely to be less regularly, or even continuous lines."

"The Entomostracans may have been tracking the mud; but so small species of that group have usually very thin or slender feet, commonly more or less foliaceous for swimming."

"I should therefore be inclined to refer the triple and quadruple track to small Anomourans. The two more central tracks, where there are four, being made by the

anterior claws; and the one where there are three to the claw of one side, for it is very common for one claw to be larger than the other, and sometimes the difference of size is exceedingly great."

"I cannot say that *g* and *e* are Crustaceans, as some large Isopods have legs that would make as strong impressions. But in Isopods the three anterior of the seven pairs of legs are directed obliquely forward, and the four posterior pairs obliquely backward, so that there would hardly be with such animals the exact uniformity of direction these tracks present."

In bringing this paper to a conclusion, I must here express my acknowledgements to the gentlemen who have so politely responded to my request for information. I am also under peculiar obligations to Roswell Field, Esq., who is the discoverer of all the original specimens of the two plates and those of the diagram A, and who kindly loaned the specimen. The estate of Mr. Field is situated at Turner's Falls, and by his sagacity and activity he has been very successful in developing the history of these sandstone fossils. He has made many very splendid discoveries. The fossils that constitute the originals of the plates and diagrams are exclusively from Turner's Falls.

Greenfield, March, 1856.

Drawn on Stone by J. Deane, M.D. T. Sinclair, Lith. Phila.

SANDSTONE FOSSILS

CONN. RIVER.

Lithotone by J Deane M.D

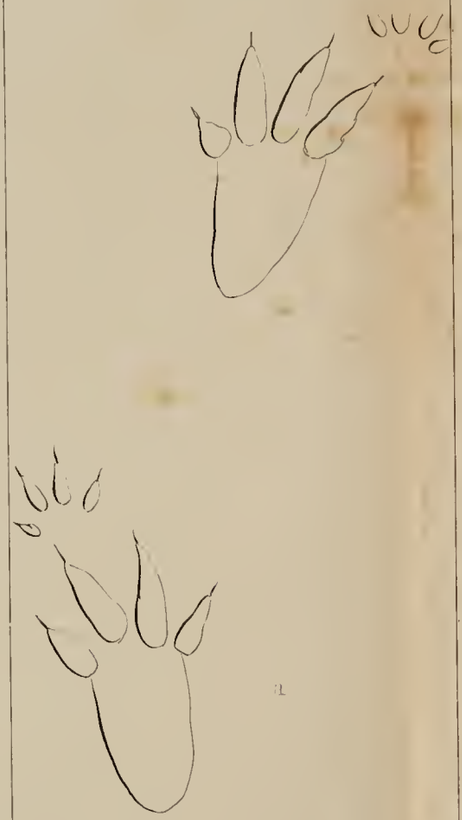
T. Sinclair & Son Phil.

SANDSTONE FOSSILS

CONN. RIVER.

a

b



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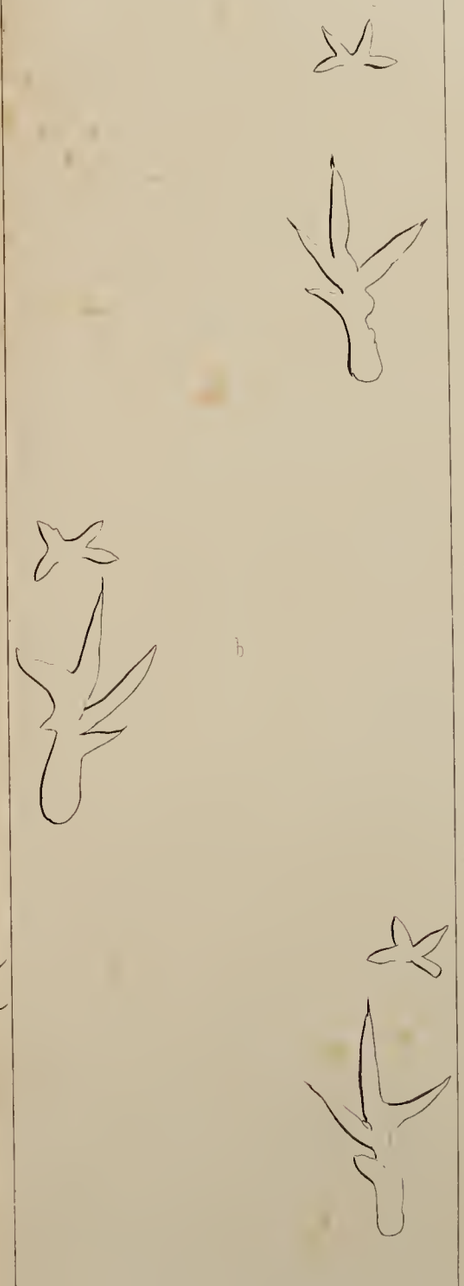

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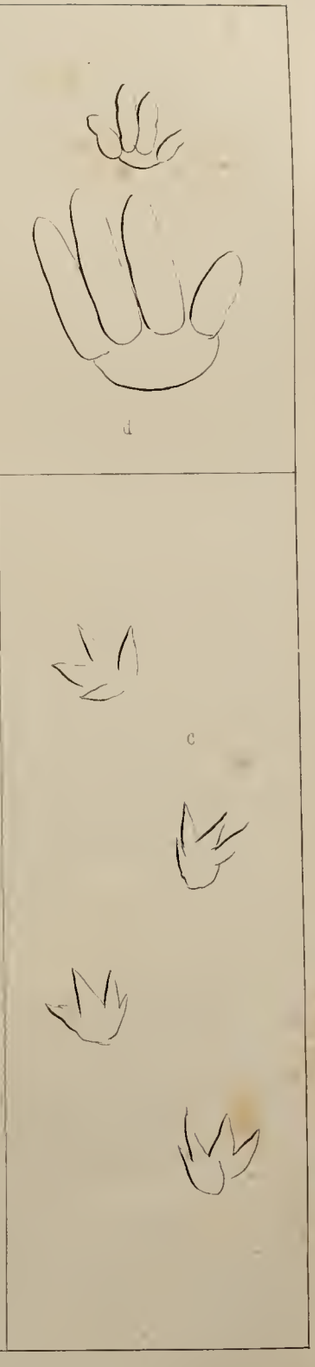


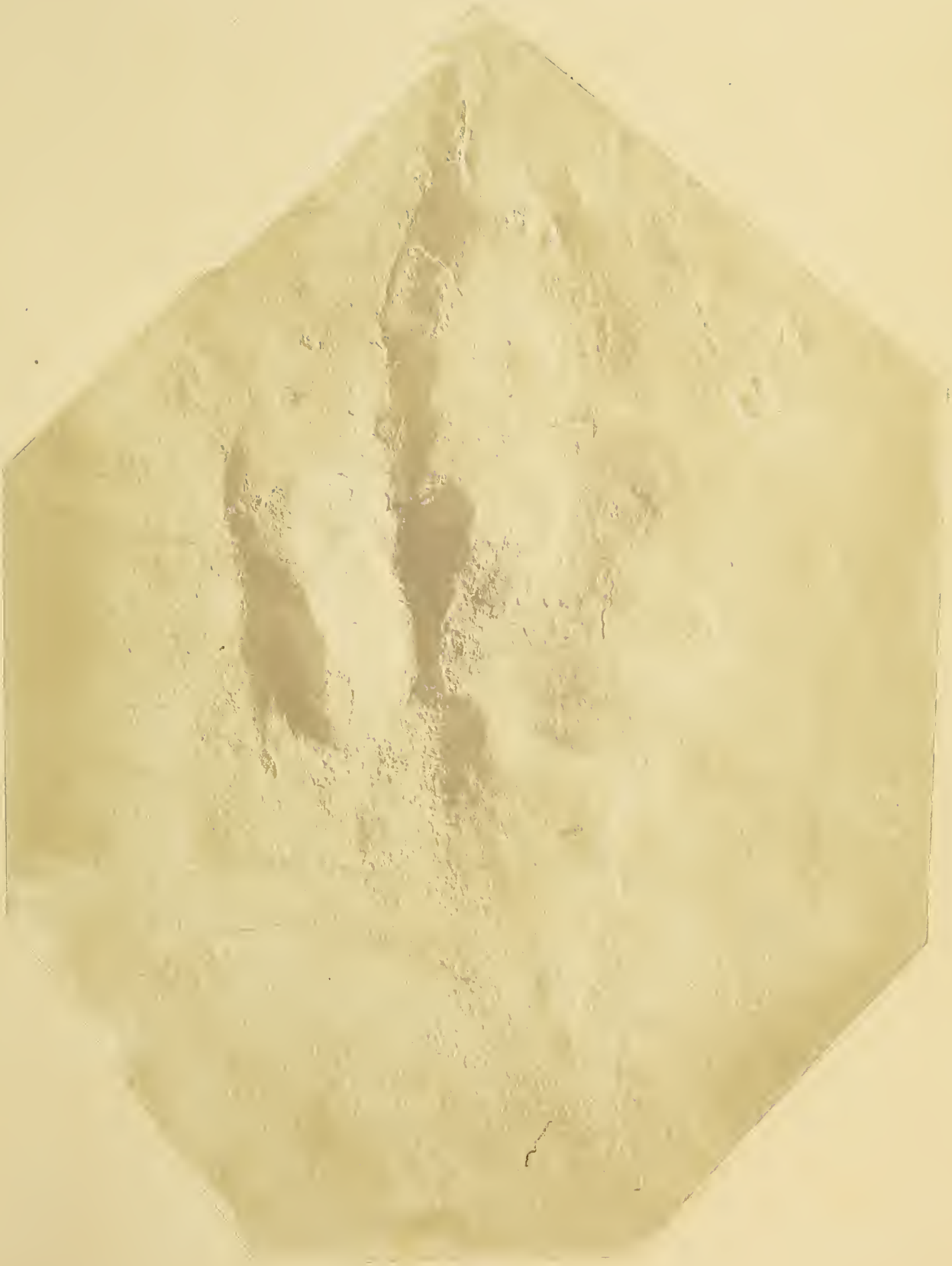
d

c

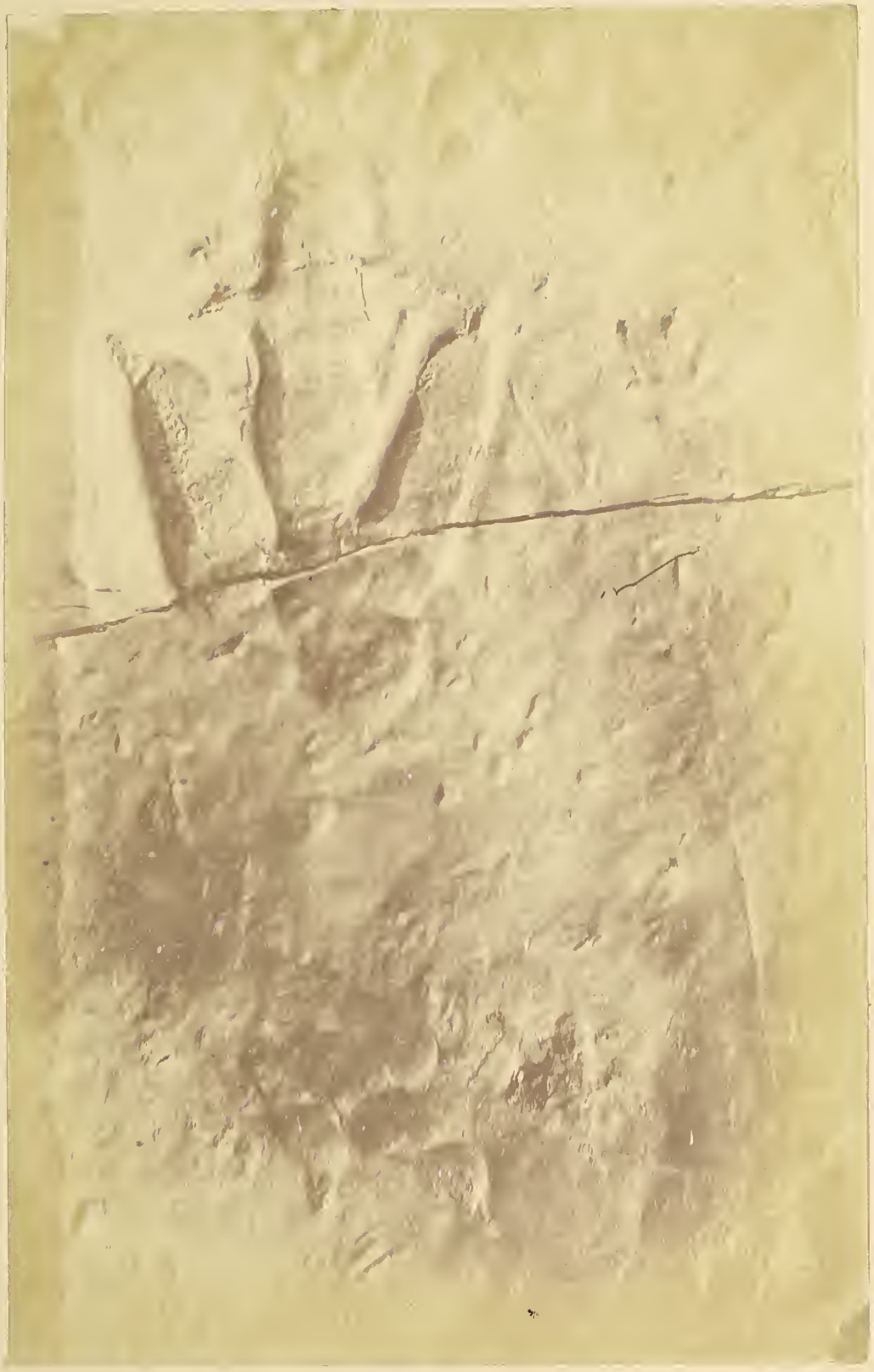
DIAGRAM A.

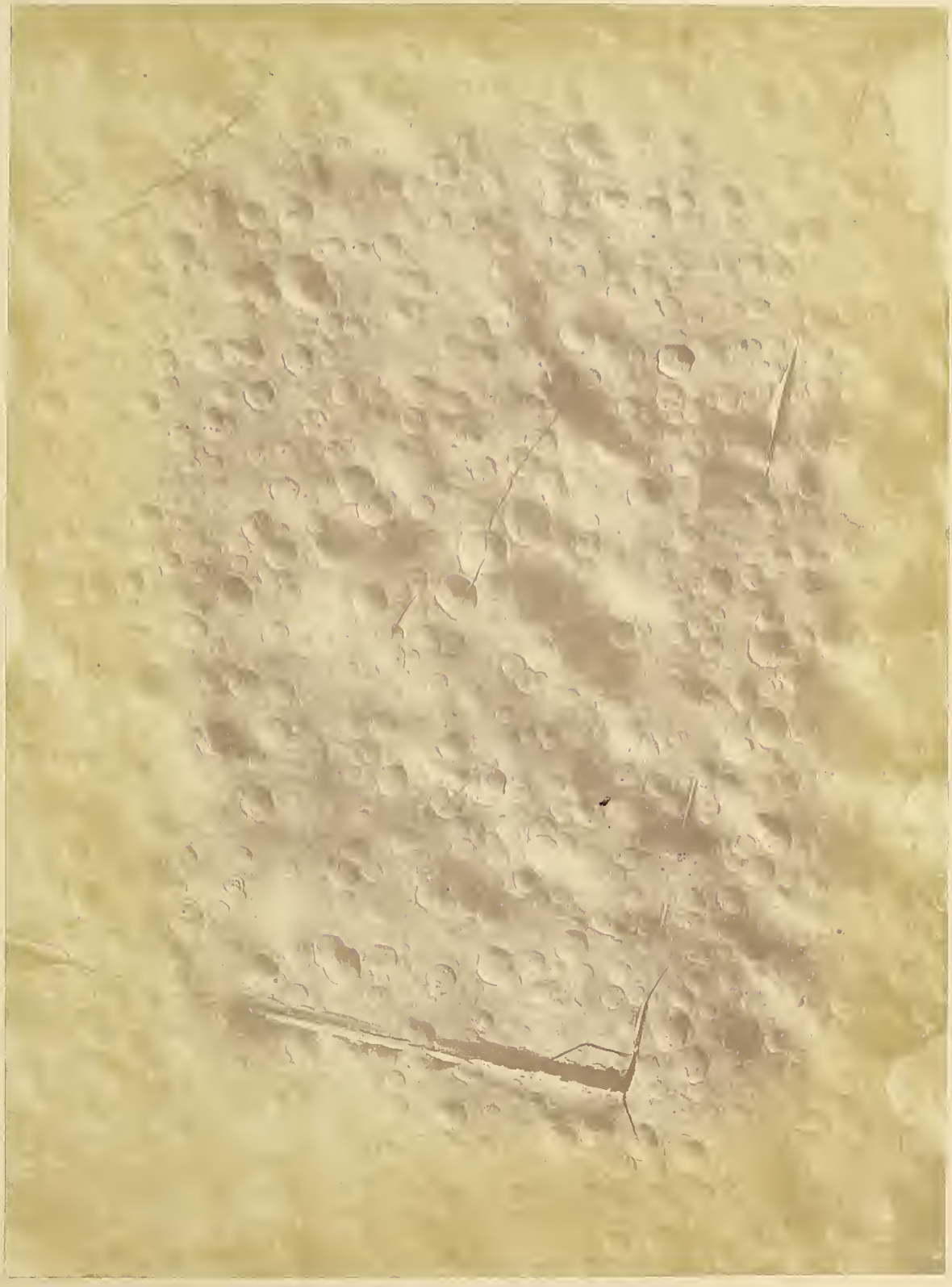
DIAGRAM B.

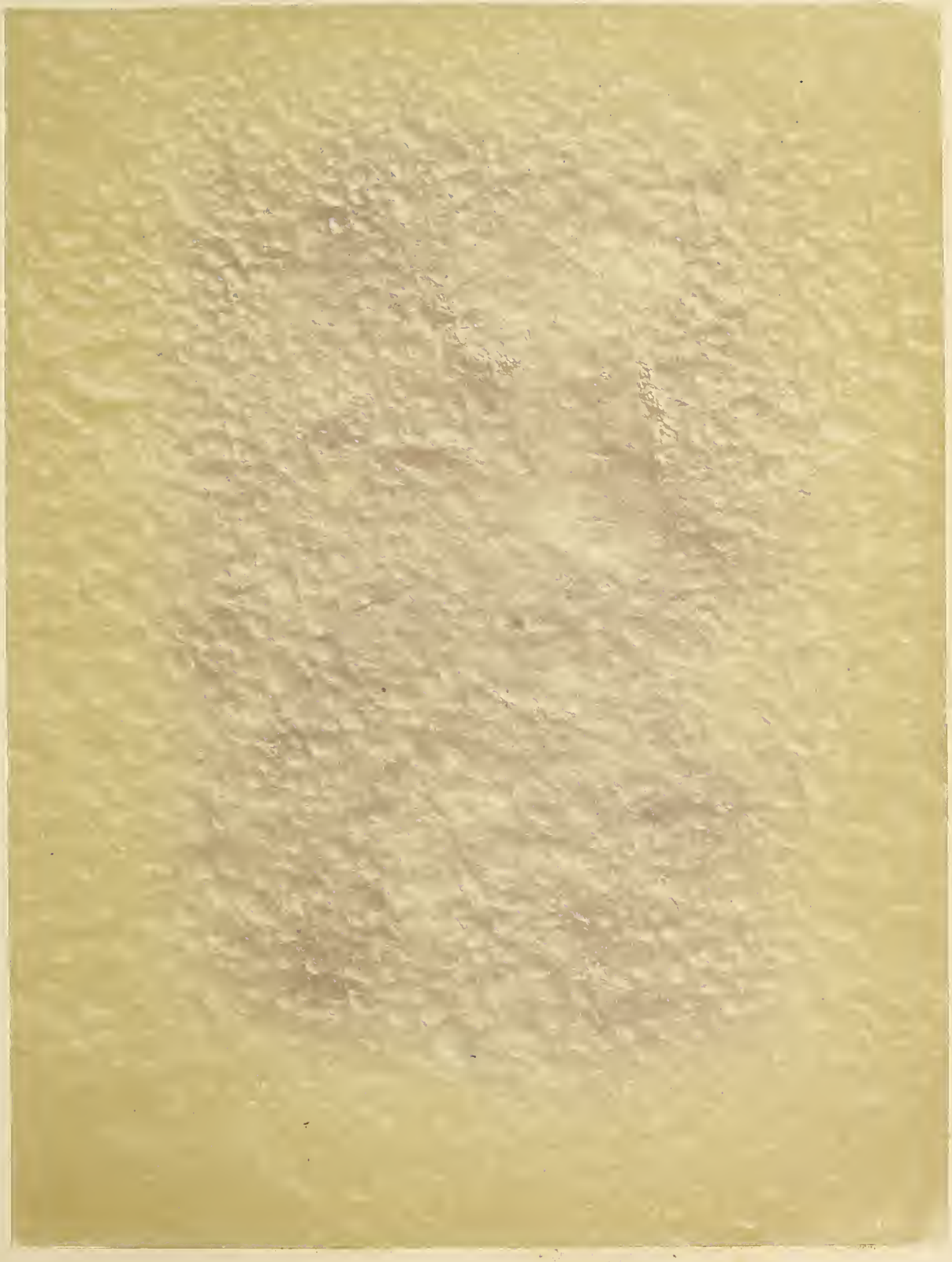
DIAGRAM C.

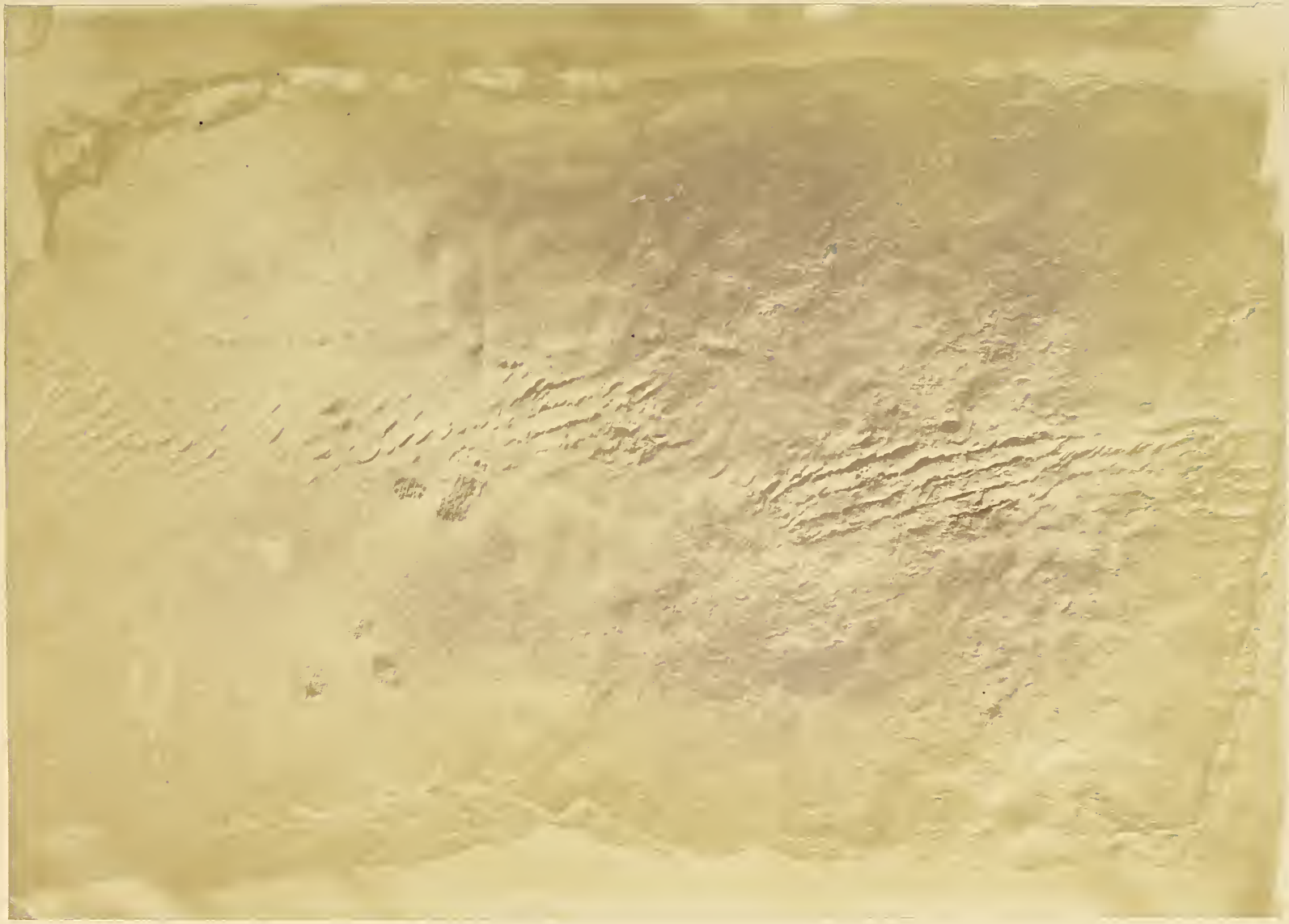


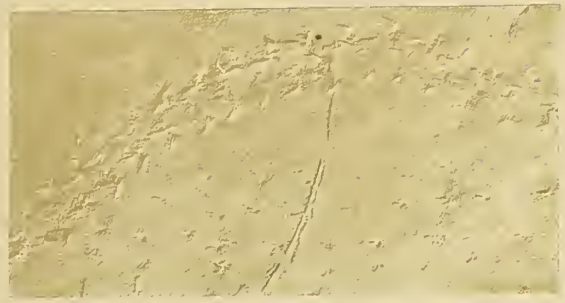

A
B
C
D
E
F
G

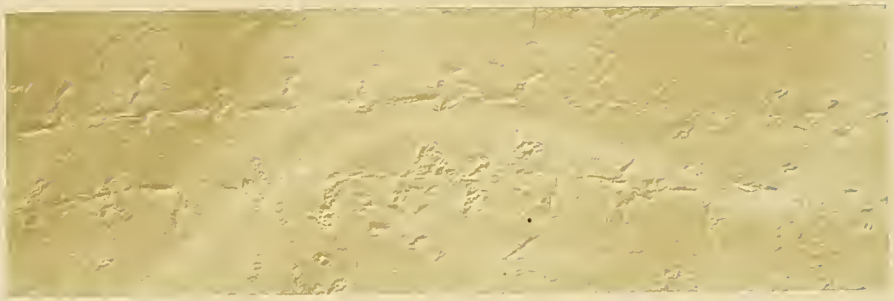


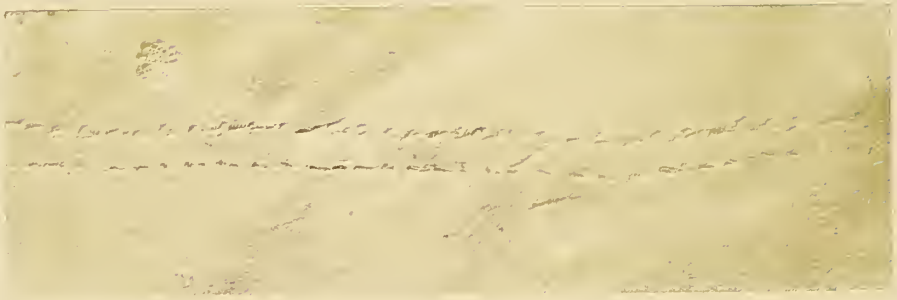


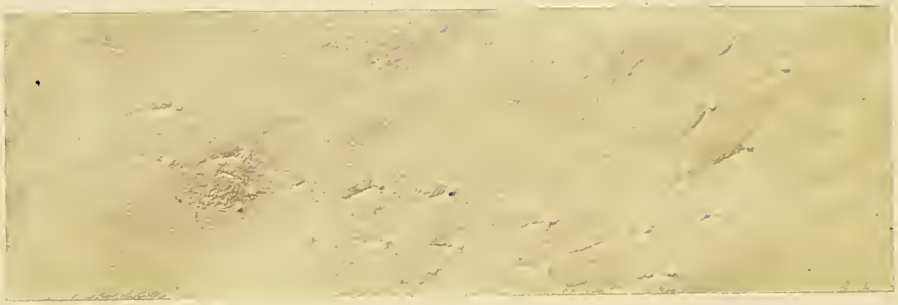












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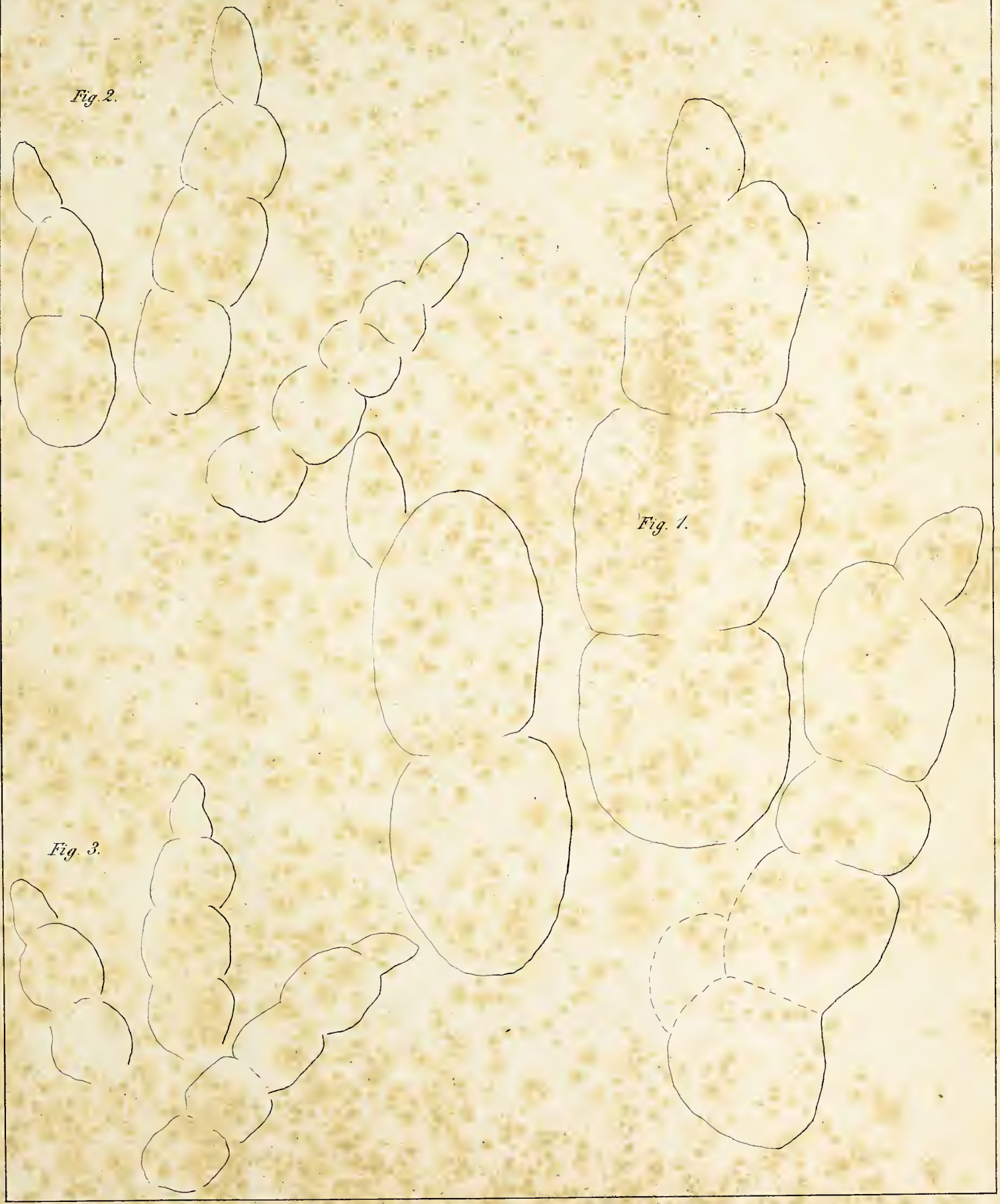

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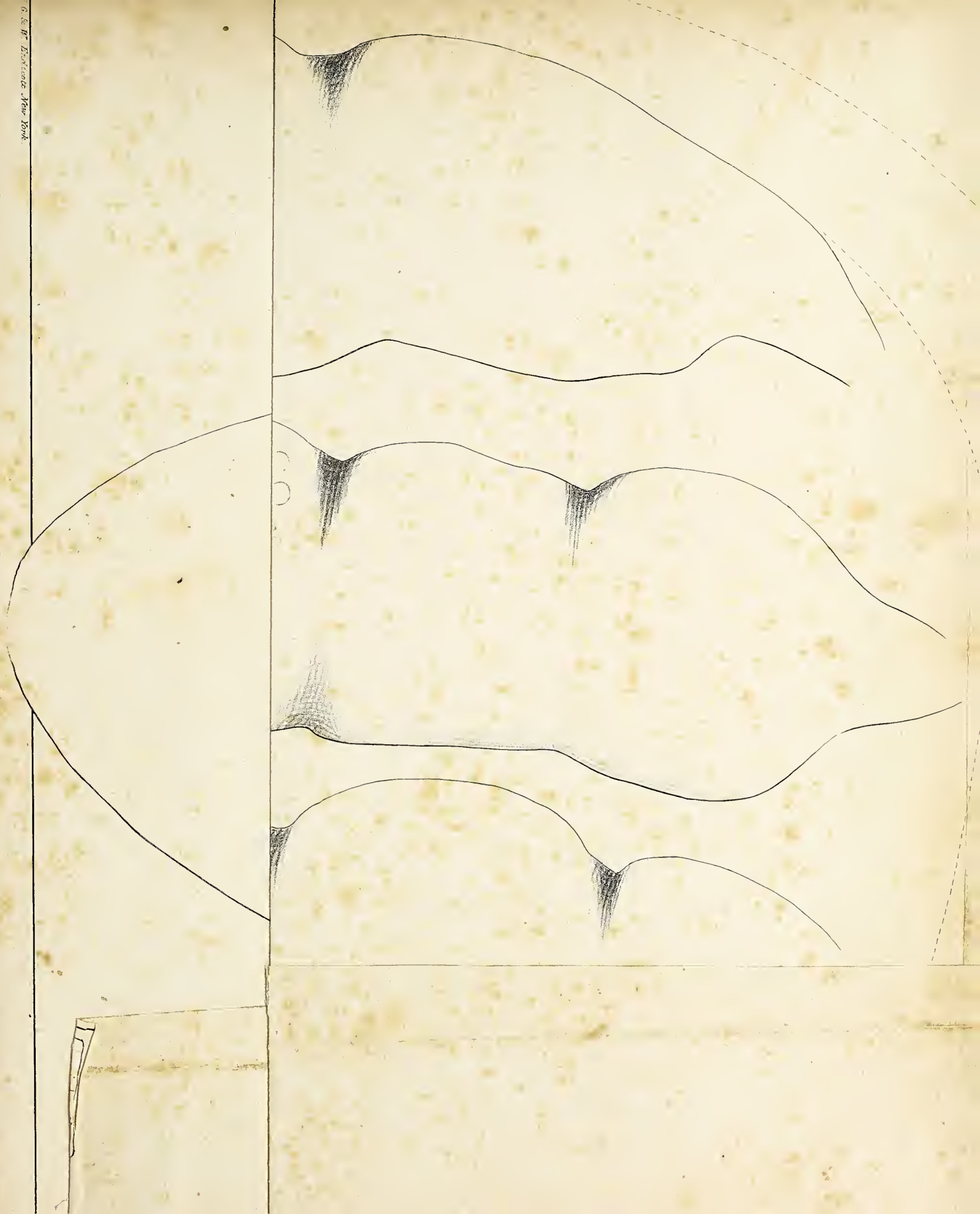


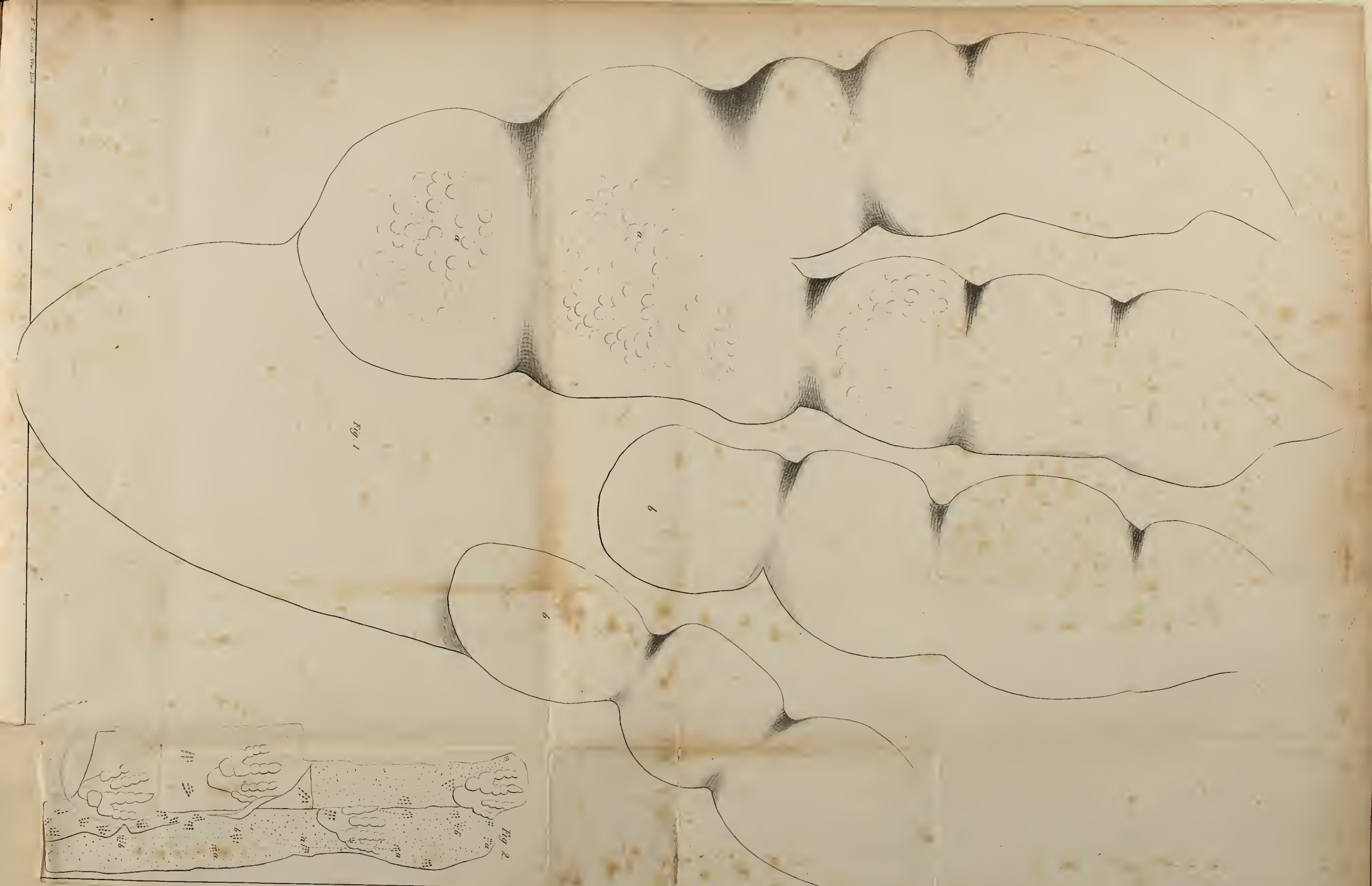
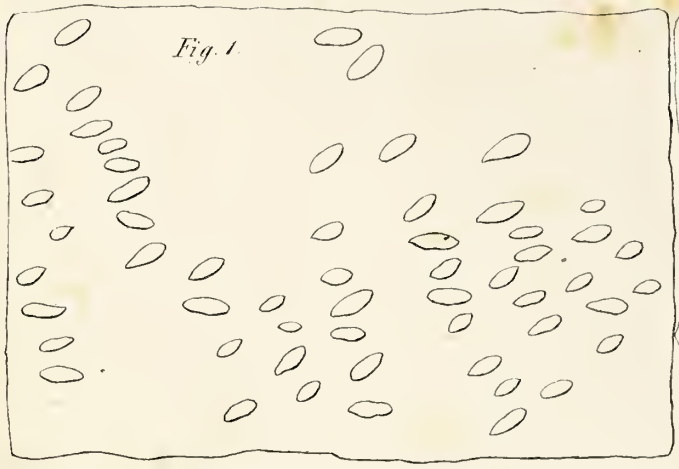


Fig. 1

Fig. 2.



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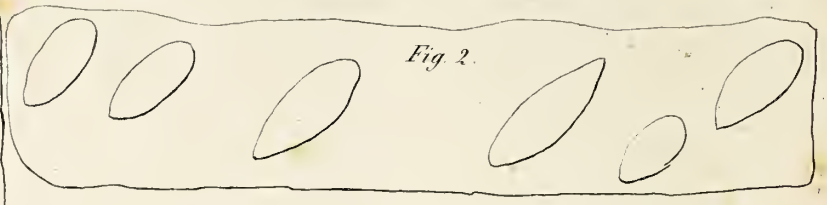

Fig. 2

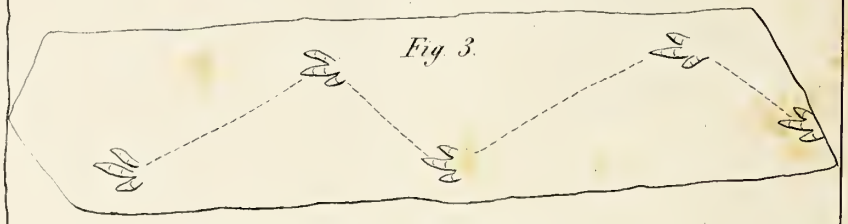

Fig. 3

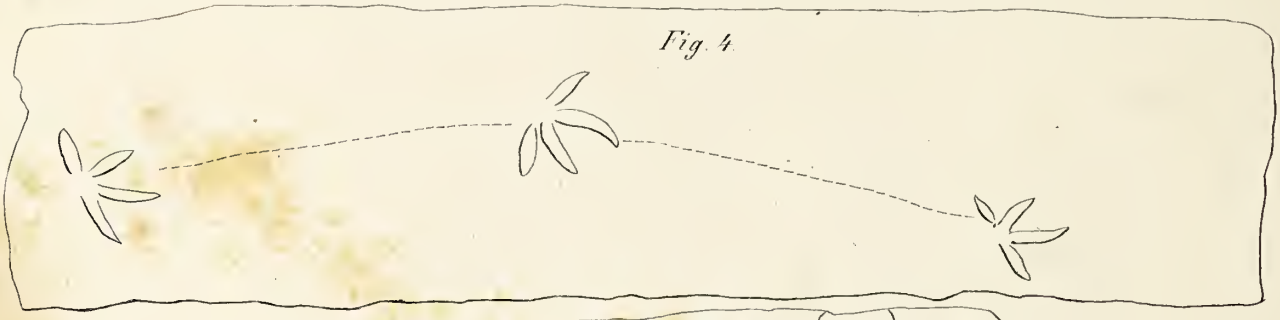

Fig. 4

Fig. 5

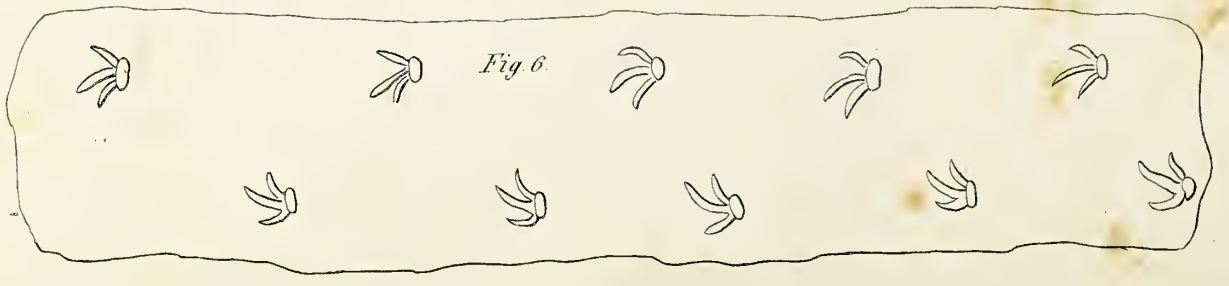

Fig. 6

Lith. of G. & W. Endicott New York

Lith. of G. & W. Endicott N. York.

Fig 1.

Fig. 2.

Fig. 3.

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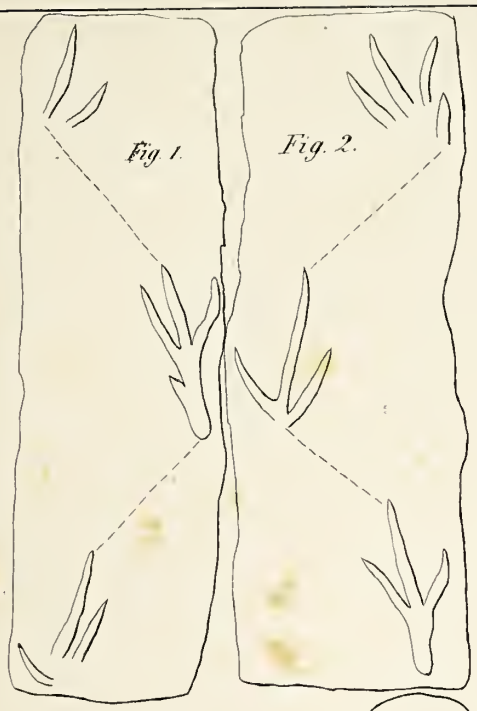

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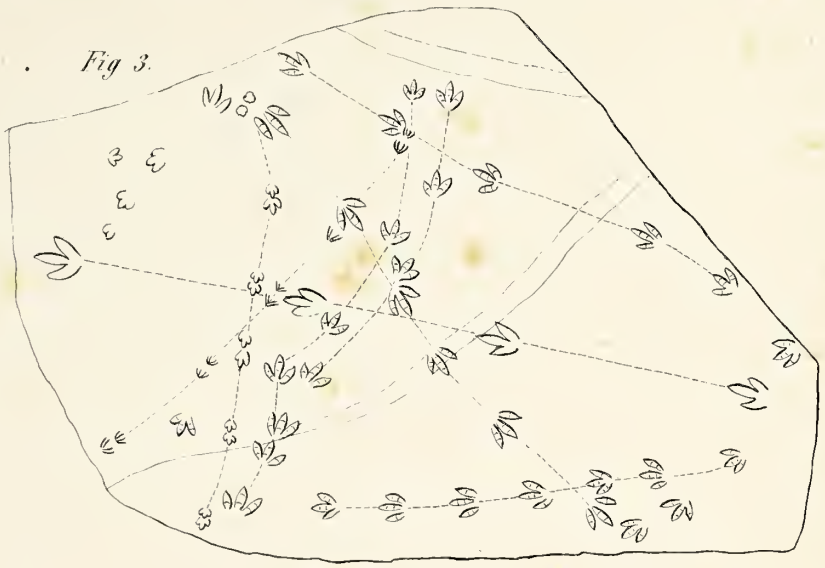

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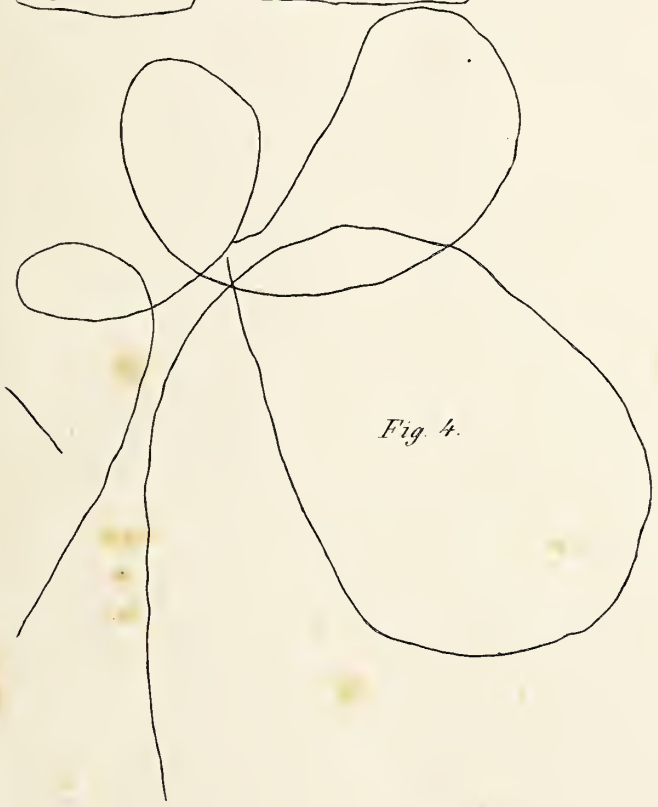

Fig. 4.

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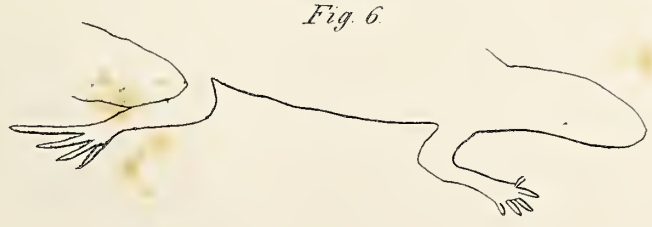

Fig. 6.

Fig. 7.

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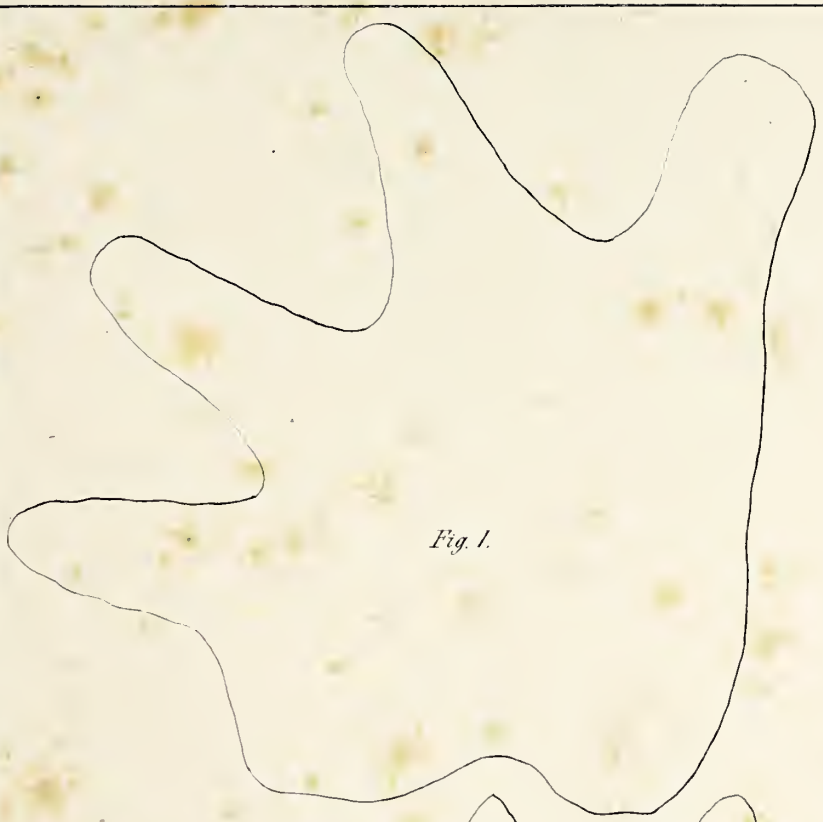

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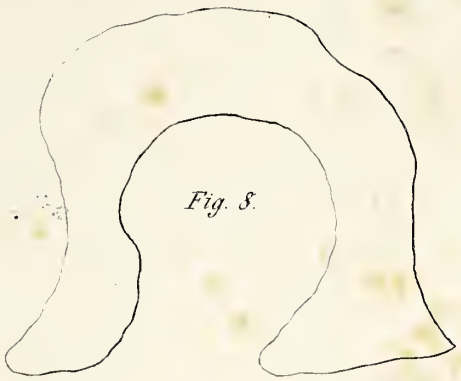

Fig. 8.

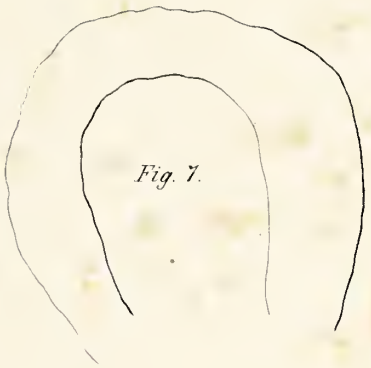

Fig. 7.

Fig. 2.

Fig. 6.

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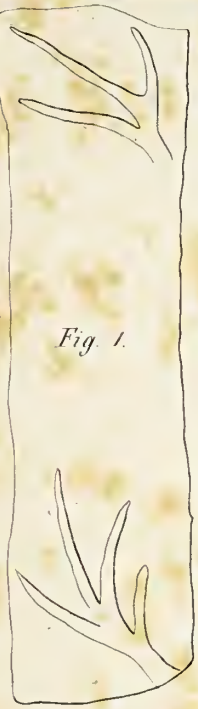

Fig. 1.

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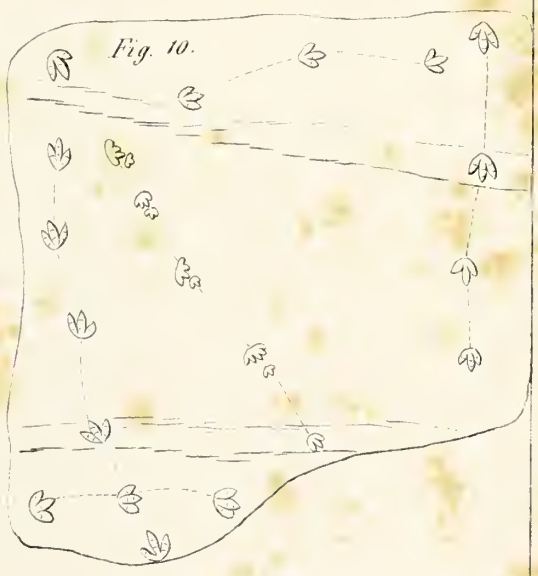

Fig. 10.

Fig. 9.

Lith. of G. & W. Endicott New York.

Lith. of G. & W. Endicott. New York.

Lith. of H. & F. Endicott N. York.

Lith. of G. & W. Endicott N. York

Lith. of G & W Endicott New York