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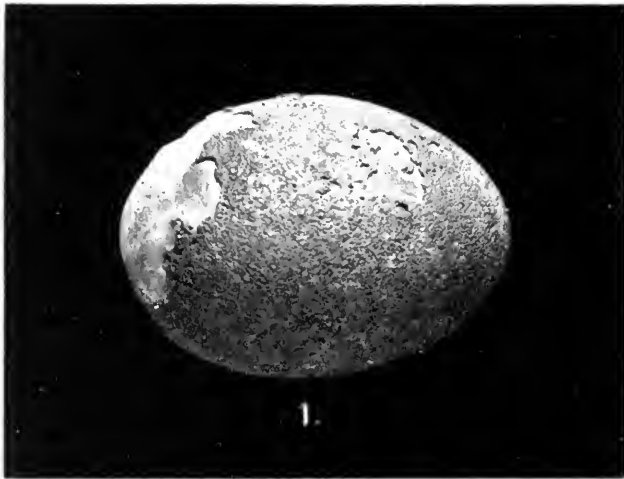
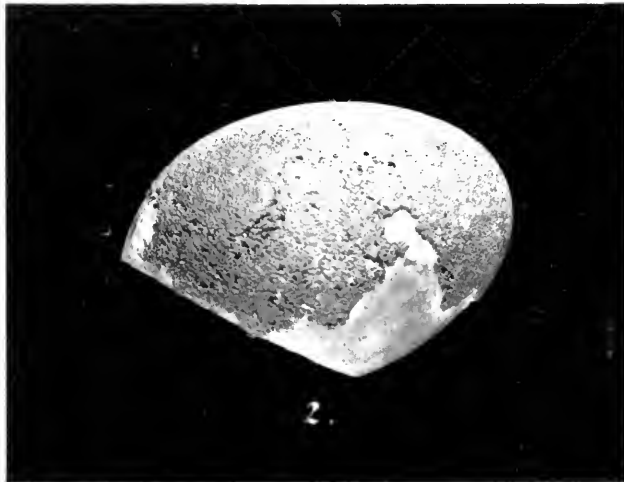
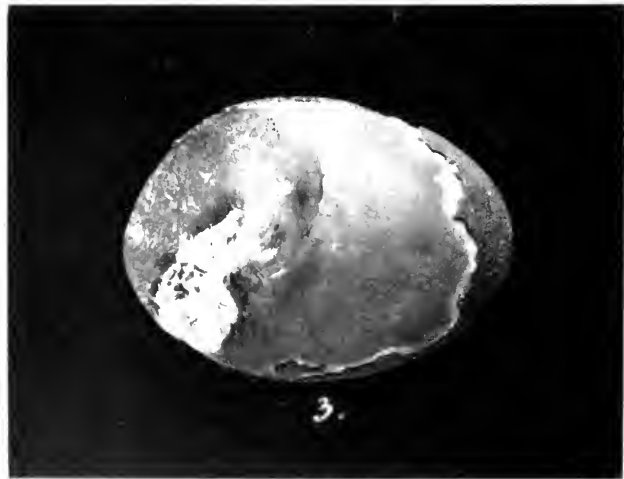
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[FROM PHOTOGRAPHS BY H. W. MENKE.]
FOSSIL EGG IN THREE DIFFERENT POSITIONS, SHOWING FORM AND STRUCTURE.
[NATURAL SIZE.]

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A FOSSIL EGG FROM
SOUTH DAKOTA

BY

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189.



A FOSSIL EGG FROM SOUTH DAKOTA.

The specimen (Museum No. P 5734) described in this paper is believed by the author to be a petrified egg of an Anatine bird of Early Miocene age. If this supposition be correct, the specimen seems to warrant description both as an interesting case of petrification and as indicating the presence of aquatic birds about the waters of the great lake which is generally considered to have occupied in early Tertiary times the region where the specimen was found. The original finder of the specimen was Mr. Kelly Robinson of Dakota City, South Dakota. He stated to the writer that while riding one day in the summer of 1896 in the region of the Bad Lands he saw this object lying at the foot of "a bad land"* and in a shallow gully. It had apparently washed there from "the bad land" above. Mr. Robinson picked it up and concluding, on examination, that it was a petrified egg, took it home for a curiosity. From him it was obtained by the writer for the Museum in the winter of 1897. The specimen is not quite completely ovoid in form since from one end a portion has been broken away. Mr. Robinson stated that this portion was missing when he found the specimen. The form of the specimen is fully indicated by Figs. 1, 2 and 3, Pl. XX, where are shown photographs of it in three different positions. As may be seen from these figures, the resemblance of the specimen both in form and structure to an egg is very striking. Covering most of the exterior is a thin, black layer .017 of an inch in thickness which closely resembles in thickness and appearance an egg shell. Within this and constituting the major portion of the specimen, is a mass of pale gray translucent chalcedony, corresponding in appearance and amount to the white of an egg. Near one side but enveloped in the preceding is a white, opaque, ovoid mass .66 of an inch in diameter which can be easily seen to correspond in size and position to the yolk. If the specimen be not a petrified egg, therefore, it is as perfect an imitation of one in external appearance as can be conceived of.

In order to determine the existence of any special characters in the mineral matter of the specimen this was studied somewhat in

* In modern Western parlance "a bad land" is any knoll or slope barren of vegetation.

detail. The portion which may sufficiently be designated as the shell, was found to be translucent chalcedony similar to that of the main mass, or what may be called the white, and for the most part confluent with it. It is, however, dark brown to black in color. On heating to redness this color disappeared, indicating organic matter to be the coloring ingredient. In one or two spots the shell was not homogeneous throughout, a thin white layer separating it from the main portion. This, on testing, proved to be carbonate of lime, indicating that here some of the original shell had not been replaced by the petrifying siliceous solutions. No definite structure or markings could be distinguished on the shell. While generally smooth in outline, under a lens it is seen to be rough and porous, owing doubtless to the action of the infiltrating waters. The original markings, if any, must have been destroyed by such an action.

The portion designated as representing the white of the egg is, as has been said, made up of pale gray translucent chalcedony. It is homogeneous throughout except for occasional black blotches, some of which resemble in arrangement those of moss agate, while others show concentric distribution. It could not be determined without sacrificing too much of the specimen, whether these were formed by organic matter or by mineral matter such as oxides of iron or manganese. The chalcedony resembles in its characters that of the veins of that mineral which traverse the region and which have been described by other authors.* On heating fragments of the chalcedony it turns white and opaque but yields only a trace of water. It is infusible and has a hardness of 7.

It is to the portion designated as the yolk that the greatest interest attaches. This has already been described as a white opaque ovoid mass .66 inch in diameter, enveloped in the chalcedony. On close examination this white mass can be seen to be made up of two portions of about equal size which have different structure. That nearer the center of the egg is made up of little spherules and thin curving plates. The spherules average about 1 mm. in diameter and have a distinct concentric structure, coats of alternately opaque white and translucent dark matter being deposited around each center. So far as can be judged from the color of these coats they are opal and chalcedony, respectively, but color is not, of course, in such a case, an accurate criterion. The thin curving plates are similarly made up of white and dark layers.

The other portion of the "yolk" is composed of a yellowish-

* J. B. Hatcher, *Am. Naturalist*, March, 1893, p. 218. E. C. Case, *Am. Geologist*, April, 1865, p. 248.

white opalescent substance quite homogeneous except for occasional darker spherules, which show a concentric structure similar to those of the other portion. The opalescent substance appears both in its chemical and optical characters to be true opal. It is considerably cracked. It is infusible B. B., but has a hardness less than 7. On heating in the closed tube it gives off a little water, turns black in spots and emits a distinct odor of burning nitrogenous matter. This I conjecture to come from some of the original organic matter of the egg, which has not as yet been replaced by siliceous matter. As such an occurrence had not come within my observation before, I thought it well to test some other petrified substance to learn if it contained any organic residue. Accordingly, fragments of the well-known petrified wood from Sonoma County, California, were put to a similar test, and somewhat to my surprise an odor of smoking wood was distinctly given off. It therefore seems probable that in many petrified substances some of the original organic matter may remain imprisoned.

In order to determine whether any remains of cell structure were to be observed, a fragment from the portion where the "white" and "yolk"—in other words, the chalcedony and opal—join, and which showed as well a spherule of chalcedony, was ground thin for microscopic examination. As shown by the drawings, Figs. 1 and 2, nothing like cell structure is to be seen in the section. The chalcedonic portion shows several spherules, but these do not differ in character from those usual to chalcedony. In the portion made up of opal an elongated cavity is to be seen which suggests in form a compressed air bubble. This is lined with two successive layers which may follow some membranous structure, but of this there is no certainty. The portion of the section made up of opal, when viewed in ordinary light, is of a yellowish-brown color, and shows no other structure than that mentioned. In polarized light it becomes wholly dark, showing its amorphous and singly refracting character. The portion made up of chalcedony is colorless in ordinary light except for the spherules previously mentioned. These are bounded by a thin, yellow ring, within which is a transparent area, and within this, making up the central portion, is another yellow mass, having a distinctly radiated fibrous structure. The general appearance of the spherules in ordinary light is thus very much like that of those of the siliceous *öblite* of Pennsylvania, which has been described by Barbour and Torrey* and E. O. Hovey.†

* *Am. Jour. Sci.*, 3d Ser., Vol. XL, p. 246.

† *Bull. Geol. Soc. of America*, Vol. V, p. 627.

In polarized light the yellow outer ring of the spherules remains dark during a revolution, indicating it to be opal. The interior portion assumes an appearance like that of granular quartz. This is similar to that described by Hovey as characterizing the interior of some of the spherules of the Pennsylvania oolite. The spherulitic interference cross is, however, clearly to be seen, and the optical character is negative. Hence the method of formation can not be regarded as similar to that proposed by Hovey for the siliceous oolite, but is probably a simple spherulitic structure, in accordance with which any foreign matter, such as the opal, was arranged. The main portion of the chalcedony shows a typical radially fibrous structure



FIG. 1. Section from "yolk" in ordinary light. Dark portion opal; light portion, including spherules, chalcedony.

X22.



FIG. 2. Same in polarized light. The opal becomes black; the chalcedony shows a fibrous structure and the spherules interference crosses.

X22.

A section of chalcedony from the veins of the region, studied for comparison, showed a similar strongly marked fibrous character and tendency to radial arrangement.

The specific gravity of the specimen as a whole was found to be 2.594, or about that of chalcedony.

It is of course desirable, if possible, to obtain an explanation of the way in which so unique a case of petrification could occur, if petrification it be. I have been unable to find any account of a similar occurrence as having been noted before. The fossil Chelonian eggs of Tertiary age from Auvergne, France, are simply shells filled with hardened mud. The fossil eggs of the New Zealand birds are

likewise only shells, which have been preserved by reason of their thickness. Neither of these occurrences are, therefore, cases of true petrification. At first thought, an egg of the sort here described may seem too perishable for preservation by a process of true petrification. It is difficult to understand how, in such a mass as an egg, petrifying liquids could pass to and fro, removing particles of organic matter and replacing them by particles of silica, in the way that it is generally understood that petrifications usually take place. On further consideration, however, the natural petrification of an egg need not seem to be an impossible phenomenon. If covered as soon as deposited, by mud or earth, as it is likely to have been in this region, its substance might endure for months or years. Or, the process of petrification might have begun at once, since the present chalcedony veins of the region show that circulating siliceous waters are abundant there.

Given conditions of this sort, I believe that petrification could have gone on by a process of endosmose and exosmose similar to that believed by M. Forster Heddle* to produce the formation of agates. As the cases seem so similar in their conditions, his theory may be quoted in full: "We have now a cavity slightly lined with chalcedonic matter, containing, within, water more or less pure, while without (that is, outside the now double skin, delessite and first layer), we have a strong solution of colloidal silica constantly supplied. Endosmose and exosmose are set up with resistless force. The *strong* solution finds its way through the two or any number of increasing skins; the *weak* water is forced out through the point of infiltration, and so in its passage out thins all the successively deposited layers at that place. By the continuous flow of colloidal silica (held in solution by liquid) through the already coagulated or deposited layers, continuous coagulation of the silica in the yet hollow agate, and continuous extrusion of the residual water, we have the ultimate filling up of the cavity, and a solid agate formed." The parallelism of conditions in the two cases is so apparent as to need no emphasis. The shell of the egg and its lining membrane furnish the "skin," the albuminous or watery substance within the egg the weak solution, and the circulating siliceous waters known to abound in the region the strong solution of colloidal silica. Or the positions of the latter may have been reversed, the thicker liquid having been within and the thinner without. In either case a transference would take place. While I cannot say that Professor Heddle's theory, that agates have been formed in this way, is altogether the adopted one, the stages of

* Nature, Vol. XXIX, p. 419.

the process as he describes them at least seem logical and reasonable, and may well have brought about petrification in the case of an egg. Of course it is not held as proved that, in the specimen under consideration, those portions which I have designated as white and yolk have been preserved in their original structure and proportions. While this may be the case, it is again quite as likely that the portion which I have designated as the yolk represents the shrunken residue of the egg substance as a whole. Its appearance, indeed, rather indicates this, since the curved plates that have been described resemble shrunken membranes. The remainder of the interior may then have been filled simply with water at the time petrification set in.

It is more difficult to explain the fact that most of the "yolk" is composed of opal while the rest of the interior is made up of chalcodony. The difference is, however, not essentially greater than that often found to exist in different layers of agates.

For establishing any conclusions as to the nature of the parent of the egg, no other data are available than its form. For a knowledge of what this indicated I referred to Mr. Wm. A. Bryan of the Museum, who has very kindly furnished the following report: "The form of the specimen suggested to me on the first examination that it was that of an egg of one of the Anatidæ or Duck family. Further study confirmed this conclusion, the similarity in form to that of eggs of Anatine birds being marked and such as to distinguish it from the eggs of birds of other families. Measurements of the fossil egg, too, showed it to have the same proportions as those of members of the Anatidæ, while they differed to a marked degree from those of other families. These similarities and differences are illustrated in the eggs shown in Pl. XXI. The eggs there shown were selected to represent as nearly as possible types having the general oölogical characters of the different families of birds whose eggs might resemble the fossil form, or whose habits would lead them to deposit eggs under conditions favorable for petrification. To complete the form of the fossil egg for this purpose, the outline on the broken end was filled out with plaster. By this method the form of the egg was reproduced, any error being probably within $\frac{1}{100}$ of an inch. The measurement of length was therefore made on this completed egg."

“The following table shows the species of eggs chosen and their measurements:”

No.	Order.	Family.	Species.	Common Name.	Measurements. (Eng. inches.)
1				Fossil Egg...	2.03 × 1.49
2	Anseres.....	Anatidæ.....	Anas fulvigula	Florida Duck.	2.05 × 1.52
3	Longipennis...	Laridæ.....	{Sterna fuligi- nosa.....	{Sooty Tern....	1.84 × 1.28
4	Gallinæ.....	Tetraonidæ.....	{Tympanuchus americanus.	{Prairie Hen ..	1.72 × 1.28
5	Limicolæ.....	Charadiidæ....	{Charadrius do- minicus....	{A m e r i c a n/ Golden Plover	1.86 × 1.40
6	Herodiones...	Ardeidæ.....	Ardea cærulea	{Little Blue/ Heron.....}	1.73 × 1.30
7	Pygopodes....	Podicipidæ....	{Podilymbus podiceps....	{Pied-billed/ Grebe.....}	1.71 × 1.19
8	Steganopodes.	{Phalacrocora- cidæ.....	Phalacrocorax p. robustus...	{Violet Green/ Cormorant.}	2.52 × 1.51

It will be seen that in form and proportional measurements the fossil egg resembles most closely that taken as the type of the Anatidæ. The probability of its parent belonging to that family is also increased when one considers the nature of the formation in which the egg was found. This is of lacustrine origin, and birds of this family are well known to frequent the waters of lakes. Unfortunately, from the manner in which the egg was found, it cannot be stated positively that it came from the beds immediately adjacent. These are of White River age, but as the specimen was not found *in situ* it may of course have come from later and higher beds, or, as has been suggested, be even an egg of a comparatively modern bird. Yet the probabilities are strongly in favor of the supposition that the specimen was, until just before it was found, imbedded in the formation immediately adjacent, and was brought to light by erosion, just as bones of extinct vertebrates are continually being exposed in the same region at the present time. If these suppositions are correct, the specimen affords evidence of the existence of birds of the order Anatidæ in Early Miocene times.

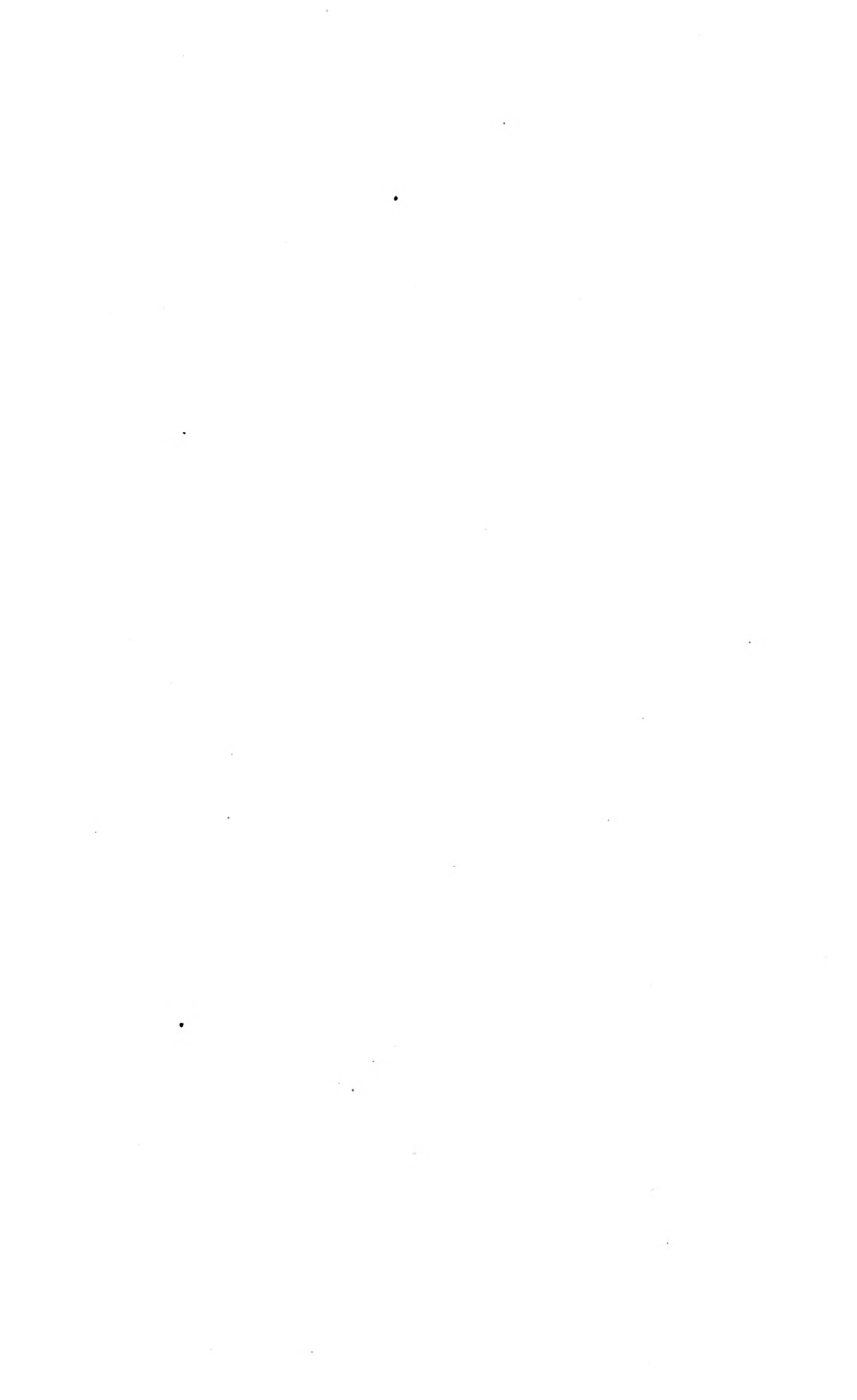
The only other mention of the finding of bird remains in rocks of this period, in this country, of which I am aware, is that of two species of birds from the Amyzon shales of Nevada. These remains consist of scattered bones and feathers, and represent birds

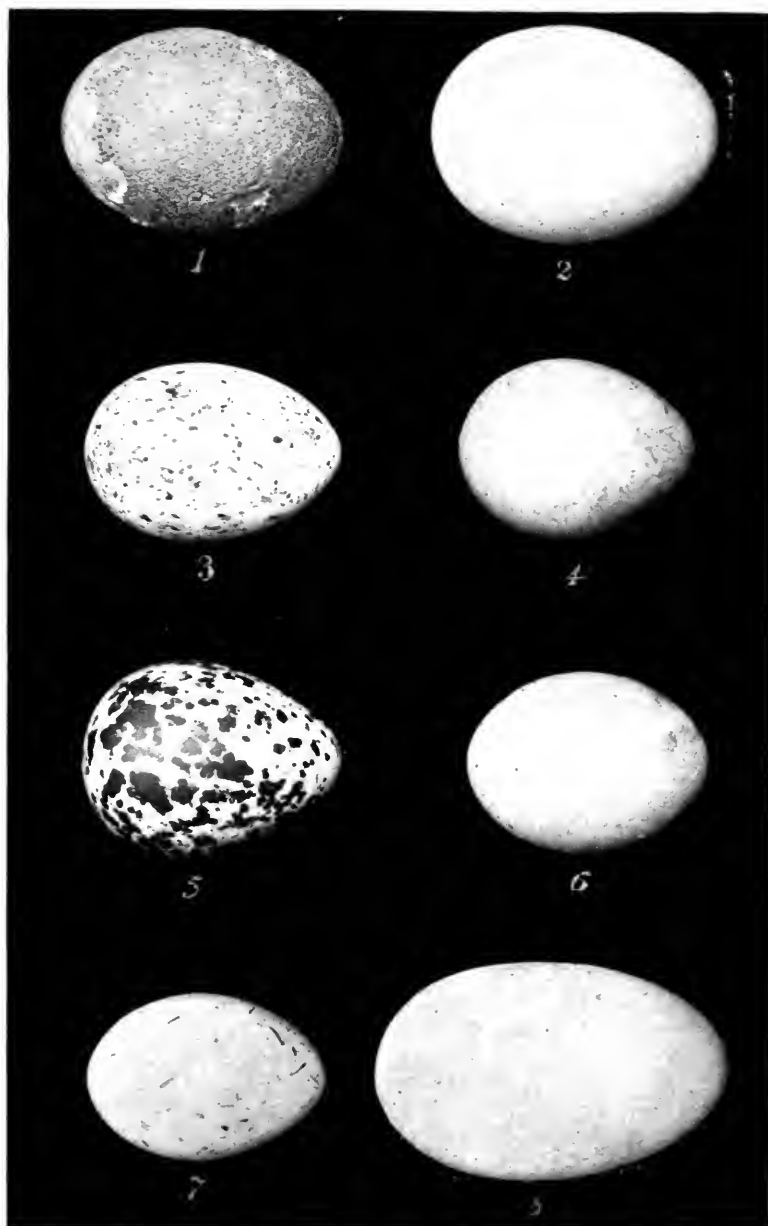
one species of which has been described by J. A. Allen* as a passerine bird of the family Fringillidæ, the other by E. D. Cope† as a species of the order Grallæ and tribe Limicolæ.

In conclusion, the hope may be expressed that if any specimens of similar character are known they will be fully described, so that more evidence may be at hand to clear up the difficulties encountered in the study of this one. I have reports of the finding of at least two other petrified eggs at different times in the same region, but have been quite unable to verify the reports or see the specimens. A systematic study of the forms of eggs seems also desirable, so that in the future definite conclusions may be drawn regarding the order or family to which a parent belonged when an egg is the only relic of the parent to be obtained.

* Bull. U. S. Geol. Surv. Terrs., IV, 1878, p. 443, Pl. I.

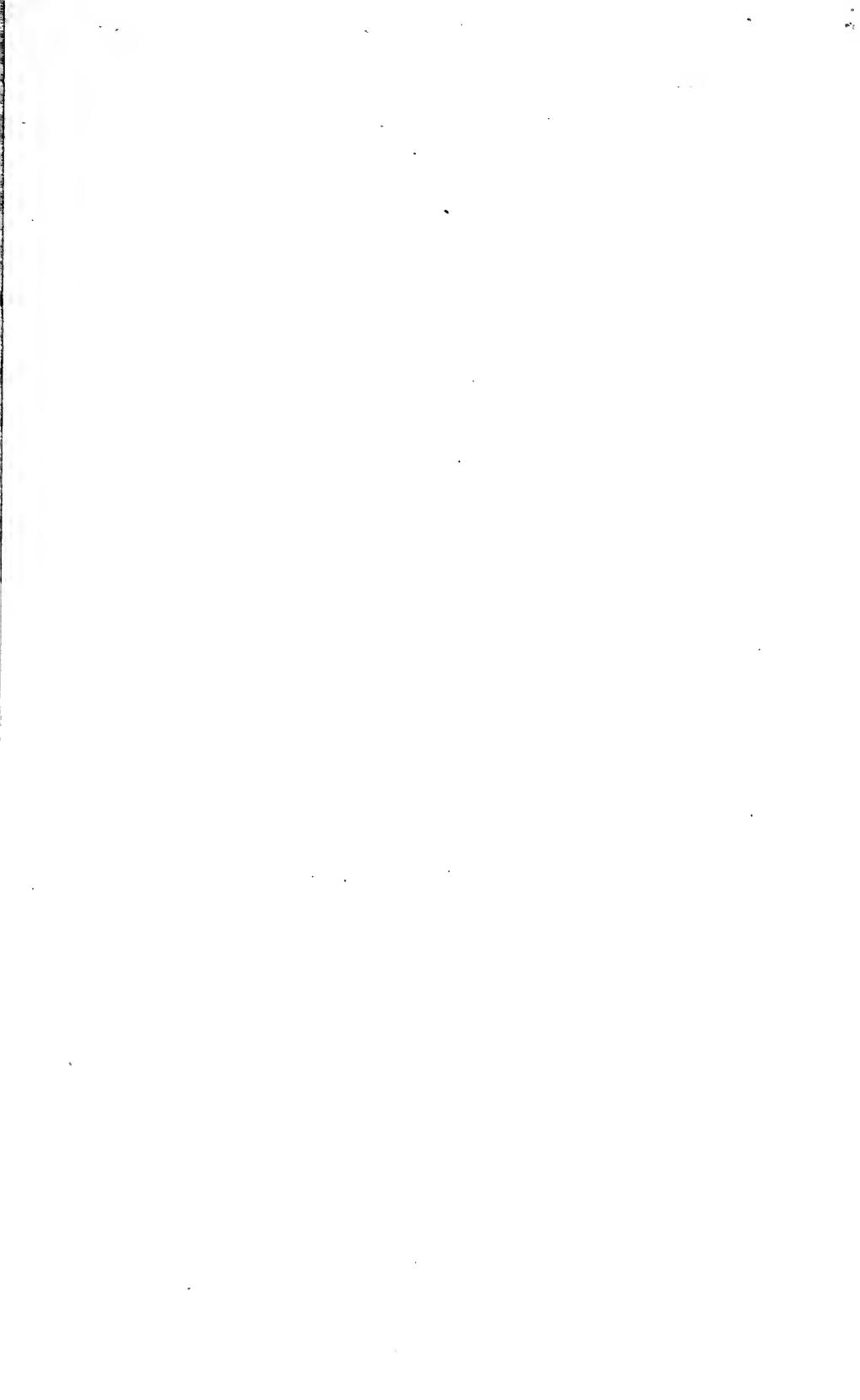
† Rept. U. S. Geol. Surv. Terrs., Vol. III, Book I, p. 754, Pl. LIX.





FOSSIL EGG AND EGGS RESEMBLING IT IN FORM AND PROBABLE HABITAT OF PARENT.





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