AN AMNIOTE EGG FROM THE UPPER CRETACEOUS OF WYOMING

by BRUCE R. ERICKSON
Curator of Paleontology
The Science Museum of Minnesota

SCIENTIFIC PUBLICATIONS OF
THE SCIENCE MUSEUM OF MINNESOTA

New Series Vol. 4, No. 3

THE SCIENCE MUSEUM OF MINNESOTA
Saint Paul, Minnesota 55101

March 15, 1978

Standard Book Number 911338-24-1

Published by
THE SCIENCE MUSEUM OF MINNESOTA
Saint Paul, Minnesota 55101

March 15, 1978

AN AMNIOTE EGG FROM THE UPPER CRETACEOUS OF WYOMING

by BRUCE R. ERICKSON

An almost perfectly preserved egg, by any measure, is an extraordinary fossil. Such a specimen has been recently discovered, and its description provides the basis for the present paper. As Zangerl (1969) pointed out, the conditions by which some fossils are "perfectly preserved" are unusual and therefore of least general concern to the paleontologist because most fossils are, indeed, "imperfectly" preserved. Transport, dissolution, crushing, and so forth, are factors of importance. In the case of the new fossil egg, which had, presumably, been buried by the mother, thereby escaping the effects of these altering forces, a fortuitous and unusual situation exists that allows additional comment on its taphonomy and paleoecology as well.

The specimen is a biological entity, and one must weigh the compulsion to assign it to a particular taxon against its mere description. The majority of fossilized eggs, either complete or represented by shell fragments only, have been attributed to dinosaurs. This has been facilitated by such evidence as associated skeletal remains in a few instances, and the impressive embryonic series, so well known, of the small Mongolian form *Protoceratops,* for example. Unfortunately, such evidence is lacking here. There is neither surface sculpturing nor other apparent physical features of the shell which are presumed characteristic of certain dinosaur types (Jensen, 1966). The absence of any of these "diagnostic" features does, however, contribute to the analysis of the new specimen. In light of this, and more important, the existing evidence, the new fossil would seem best regarded as belonging to a non-dinosaurian reptile. It is herein hypothesized as having possible crocodilian affinities.

ACKNOWLEDGEMENTS

I wish to express my appreciation to Chris Czech, who found the specimen and brought it to my attention, and to Peter Ganzel, of the Paleontology Department of The Science Museum of Minnesota, for his fine photographs. Nancy Petschauer and Marguerite Hawkinson provided valuable assistance with editing and proofreading. Publication costs were borne by the Geneste M. Anderson Paleontology Research Fund and the John R. Stoltze Publication Fund.

DESCRIPTION

Amniote eggs possess various external shell characteristics, such as shape, texture and color, by which they may be rather routinely identified. This is especially applicable to birds. To a lesser degree, the same applies to reptiles. The new fossil egg lacks the advantage of being able to be compared directly to others of its kind; hence, any set of characters ascribed to it must be viewed cautiously. As with any other such fossil, these may not actually point to the most diagnostic aspects of the form, nor be restricted to the particular form in hand. Nevertheless, the characteristics of this intact specimen do afford a certain insight into its relationships.

Size. – The Cretaceous fossil by avian standards (Romanoff, 1949) would be just of medium size. By comparison to living reptiles, *viz.*, crocodilians, it is in the somewhat smaller size range. Its volume would have been around 34 cc. Being slightly greater in one transverse diameter than the other, its maximum critical measurements are: 58 mm. x 36 mm. x 31.2 mm.

Shape. – As noted, the shell is a bit compressed through the central region. This is apparently due to plastic deformation which occurred during the lithification process. A perfect ellipse silhouette is observed when viewed in either its least, or greatest, width. Although the eggs of some birds are elliptical in shape (having both ends about equally rounded) conformance to the shape of the eggs of some crocodilians is remarkably closer (fig. 1).

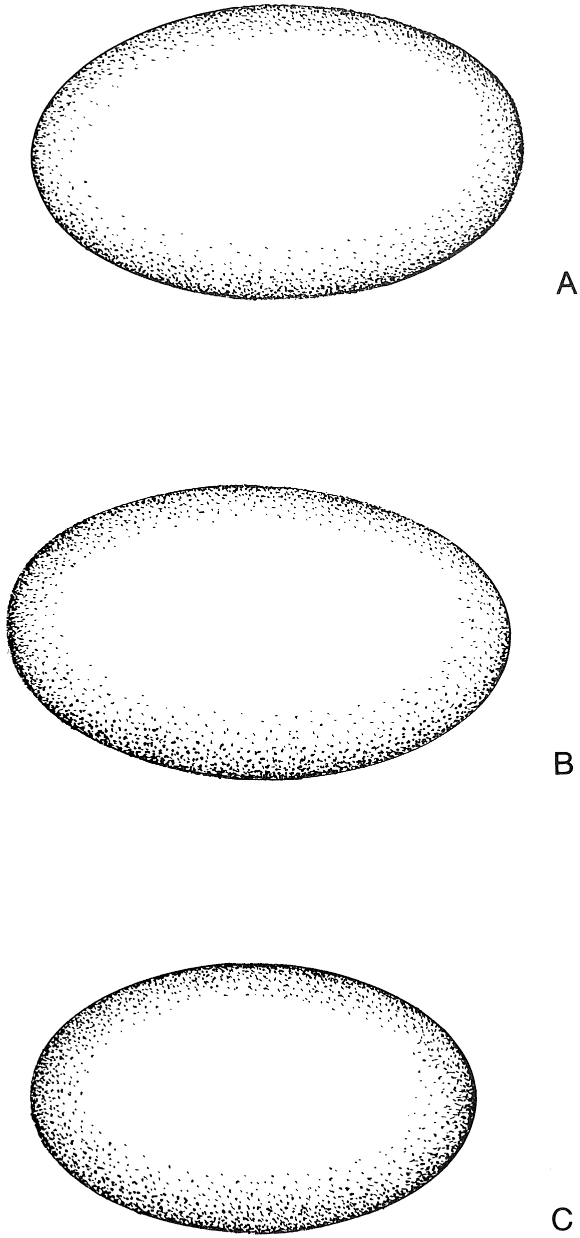

Figure 1
Shapes of crocodilian eggs. a. reconstruction of specimen from the Geiseltal, Eocene of Germany; b. *Alligator mississipiensis,* Recent; c. new Cretaceous specimen; all approximately natural size. (a. modified from Krumbiegel, 1959)

Shell surface. – As preserved, the shell portion is about two-thirds complete. Greatest loss has been in the mid-region, with only minor areas of both ends missing as well. This loss is attributed to secondary damage after fossilization. The remaining shell surface is highly fractured into a mosaic of pieces, 0.50 mm. or less across. This surface is also quite smooth and devoid of the texturing seen in the eggs of many birds, or the pitting and corrugations, especially at the ends, as may occur in those of crocodilians.

Pores. – Minute pores (figs. 2 and 3a) are distributed over the existing shell surface. They appear best developed and most numerous toward the ends. Their shape varies from circular to irregular. Differentiation is difficult because of their diminutive size, and due to the filling with mineral matter that nearly all exhibit. Because of the rather fragile nature of the calcareous shell, its surface has suffered slight deterioration of detail from the corrosive effects of the atmosphere. However, in a few places, a shallow depression surrounds the pore, not unlike the arrangement found in shells of birds and crocodilians.

Shell thickness averages about 0.18 mm. The outer region, representing the spongy layer, is appreciably more durable than the rest of the shell. The mammillary layer has sustained significant reduction of its surface; yet, discrete mammillae are discernible, as are their radiating crystal structures (fig. 4).

Interior. – Replacement of the entire interior structure, inward from the area formerly occupied by the shell membrane, has occurred. Infilling with mud has preserved a negative surface of the mammillary region (fig. 3b) which is most conspicuous where the shell has been removed. A radiograph (fig. 5) illustrates an internal layering. These layers are strikingly uniform in their concentric pattern and may represent successive stages of the lithification process rather than specific internal structures. A dense central mass, with a less dense surrounding zone (indicated by the lighter area in fig. 5), is interpreted as the space possibly once occupied by the amnion. Failure to hatch, however, indicates an addled condition.

Specimen number. – SMM P77.29.1

Horizon and locality. – ''Lance'' Formation, Upper Cretaceous, T. 35 N, R. 67 W, Converse Co., Wyoming.

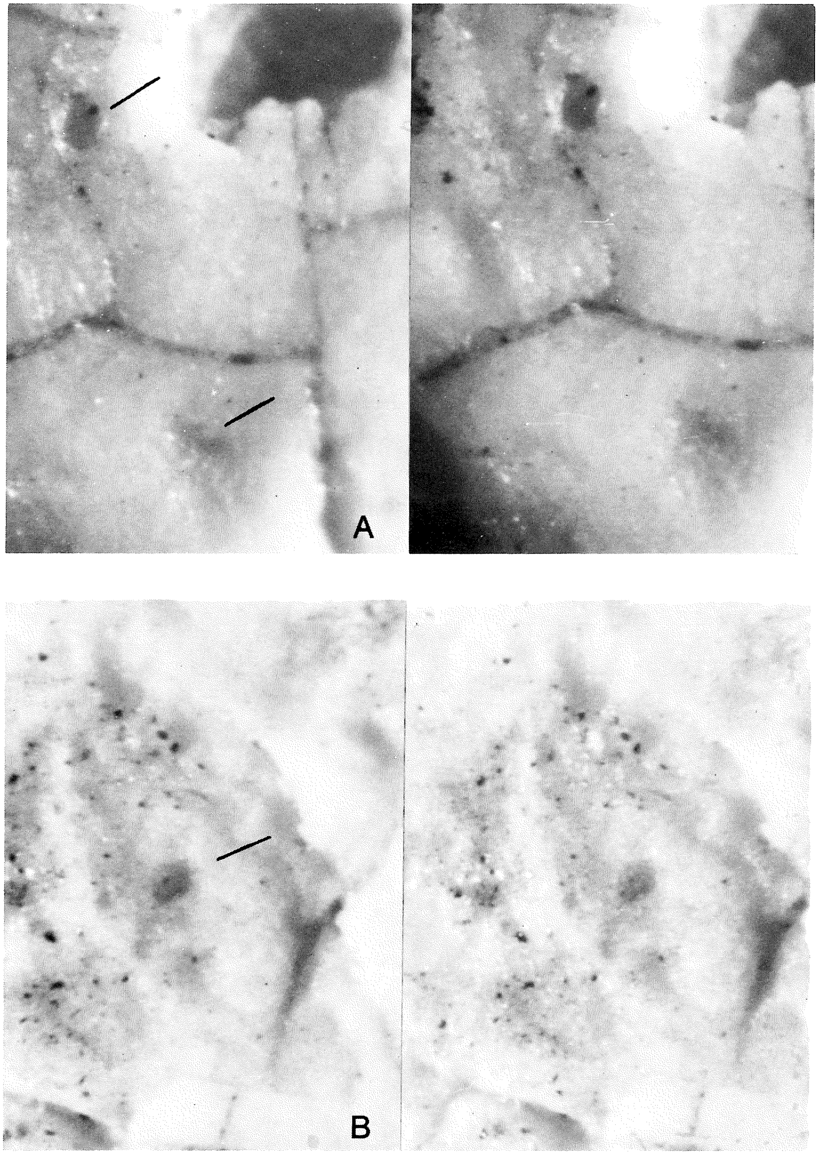

Figure 2
New Cretaceous specimen. a. two pores in shell, upper is open, lower pore filled; b. open pore with surrounding depression. Both x 130. Stereo pairs.

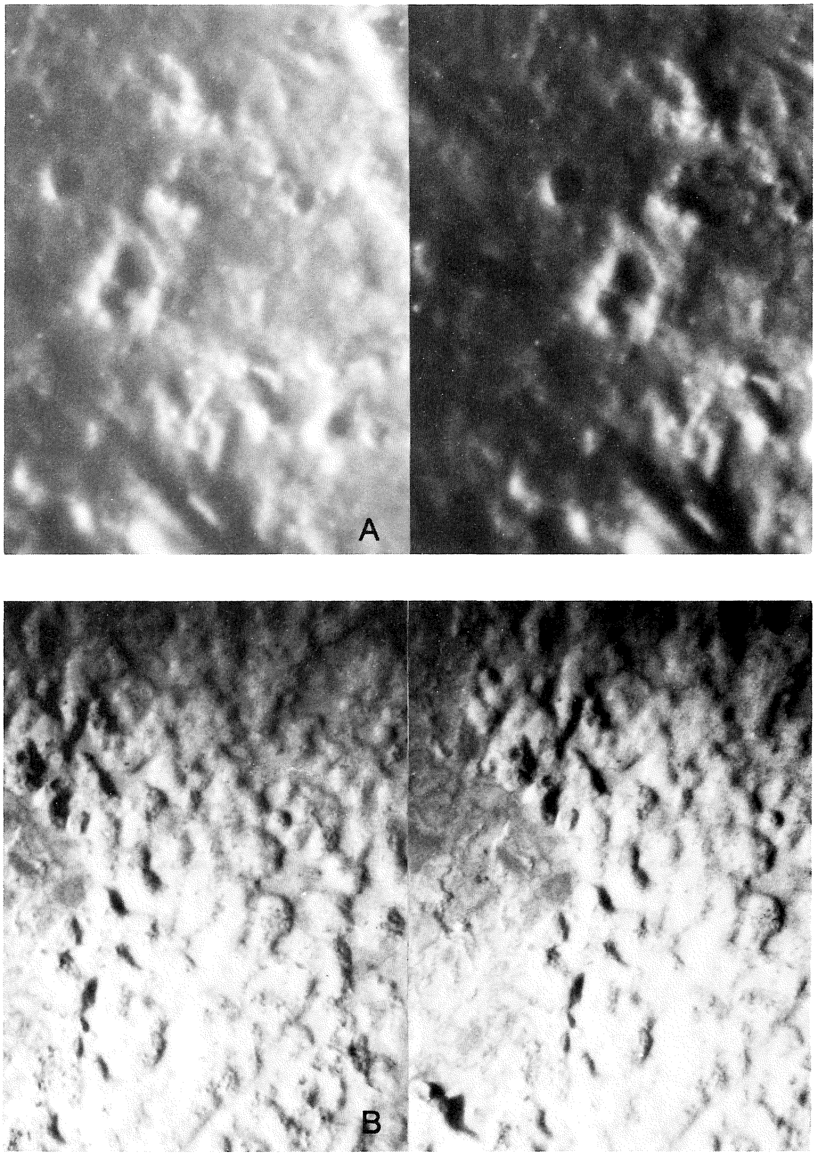

Figure 3
New Cretaceous specimen. a. pores near end of shell x 50; b. negative of mammillary surface x 10. Stereo pairs.

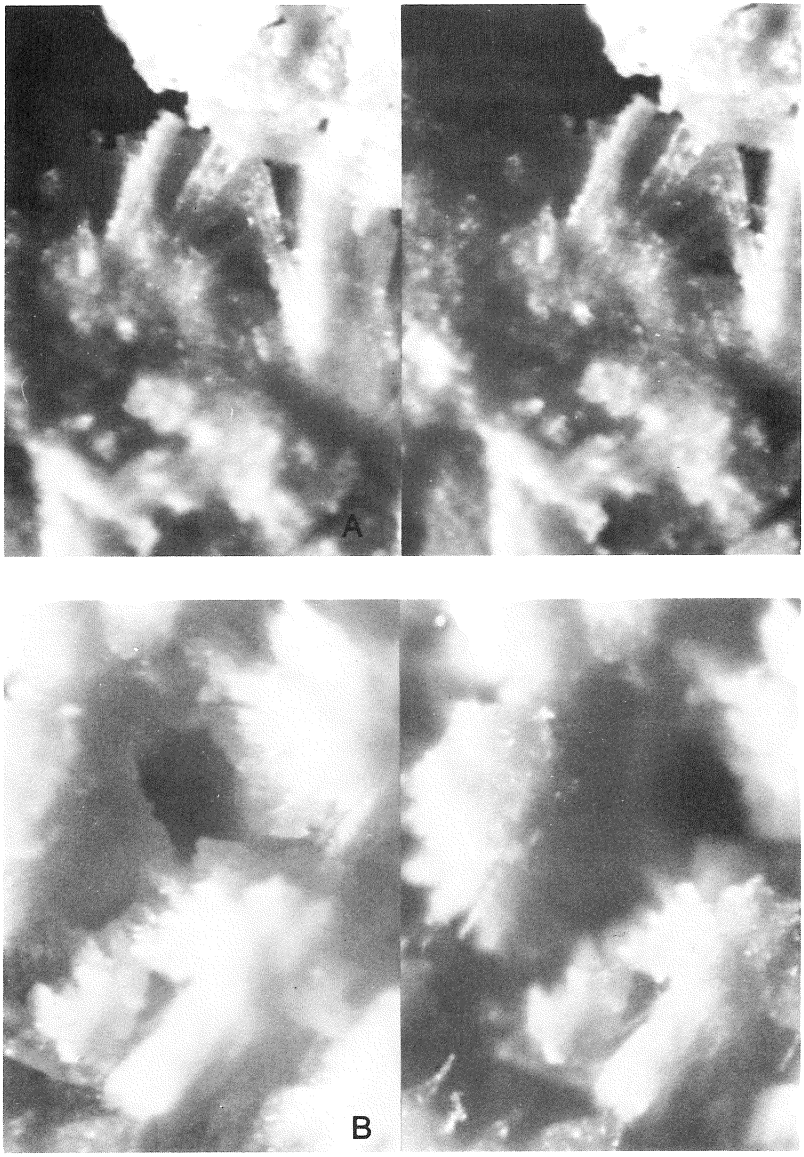

Figure 4
Mammillary surface of shell showing crystal structure and individual mammillae. a. new Cretaceous specimen; b. *Crocodylus niloticus*. Both x 130. Stereo pairs.

TAPHONOMY AND PALEOECOLOGY

It may be inferred from the nature of the shell, and its apparent, slight modification of shape, that certain taphonomic events took place. The first was quick burial, most likely achieved when the egg was deposited in a depression (nest) in the earth, either excavated, or naturally occurring. Secondly, coverage of the depression by the mother may possibly have been accomplished as a part of the normal egg-laying procedure, much in the fashion of the behavioral patterns of most living reptiles. Thus situated, the contents of the "nest" would have been afforded maximum protection.

Subsequent lithification of the confining sediments resulted in the infiltration and gradual replacement of the entire interior structure, leaving only the shell intact. The pores of the shell allowed quick and total permeability, and eventual filling of the pores as well. Whatever the rate of sedimentation, the intensity of compaction of the enclosing sediments was low enough to prevent cracking of the shell, but just severe enough to account for the aforementioned distortion.

It may seem presumptuous to speak of the paleoecology of a specimen when the chances of its specific identity are so remote; yet, the occurrence of such a short-lived biological phenomenon as an egg may offer a unique insight into the paleoenvironment by establishing a peculiar set of environmental requirements which may otherwise go undetected. Unlike the ecologist's goal of interrelationships, which we can only surmise here, restoration of a bit of the habitat seems a more feasible goal to attempt.

In relating the new fossil to other finds, *viz.,* the Krokodileier of des Geiseltales, also extraordinary fossils, preserved in this famous Eocene swamp deposit of Germany, and the hypothesized nesting sites of the early eusuchian crocodile *Leidyosuchus formidabilis,* in the Paleocene of North Dakota (Erickson, 1972), one may make the following observations about the environment of the new fossil.

In the above paleoenvironments, as well as the one under consideration, a special set of conditions had to persist, at least for a time, to be available, and to be selected for nesting sites in the first place — to have allowed successful incubation of the eggs, and to have provided the hatchling crops with a reasonable survival potential. In other words, these environments had certain basic conditions in common during the Cretaceous, Paleocene, and Eocene. If we further assume analogy with living crocodilians, these environments comprised beaches of sediments, such as mud or sand, that were constantly above high water levels, amiable climatic conditions, vegetative cover, access to open and permanent water, and a food source for the young as well as the adult. Finally, a fairly rapid sealing over with sediments, bringing about the end of these environmental episodes, would have provided the means of preservation. The sum of these strongly indicates a swamp or lakeshore environment in all cases. The significant uniqueness of the Cretaceous site would have been its associated fauna and flora, but this is apart from the present discussion.

Considering the magnitudinous quantity of eggs, first of reptiles, and then of birds, that might have become fossils since the advent of the amniote egg in the upper Paleozoic (Romer, 1957), the number of finds is extremely small. The obvious reasons for this relate to the inherent fragility of the eggshell, and the inhospitable environments (at least in terms of fossilization potential), in conjunction with the habits of most birds and many reptiles. It is reasonable, then, to assume that the majority of the relatively few eggs that do survive as fossils are those belonging to forms whose ''nesting grounds'' are subject to sudden sedimentation, caused either by

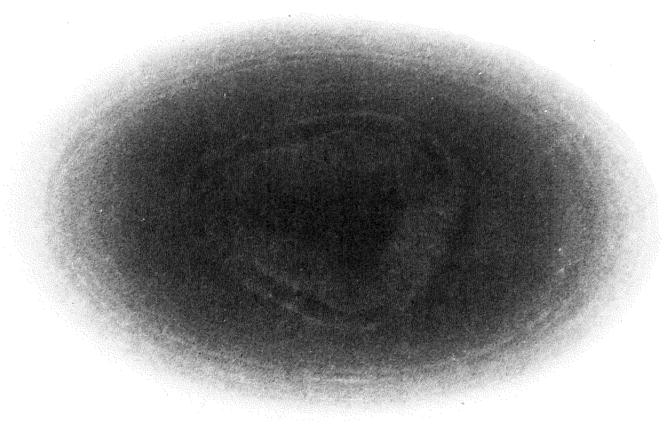

Figure 5
Positive print of radiograph of new Cretaceous specimen x 1.75.

deliberate action of the animals themselves (act of burying), or by environmental forces, or both. Furthermore, those forms most suited to these requirements are dinosaurs, crocodilians, and a few other reptiles. Most chelonians, champsosaurs, and squamates were probably more aquatic in their habits and did not produce a hard-shelled egg.

If, on the other hand, we seek an alternative to a reptilian progenitor, the only reasonable choice would seem to be one of avian affinities; and, on the premise that the specimen began its journey from formation to discovery by being buried, an interesting possibility arises. It may well be that primitive, ''water-loving'' birds of the Cretaceous nested on beaches and did, perhaps, even bury their eggs in a manner not unlike that suspected of the reptilian stock from which they were derived.

If the new egg is of crocodilian origin, it presents the earliest evidence that reproductive behavior may have resembled, rather closely, that of later members of the group. A ''proavian'' or avian origin suggests only the possibilities of more reptilian-like behavior. We know nothing of the reproductive methods of pterosaurs. Whether or not the foregoing analysis is correct will have to await future discoveries of fossilized eggs, and especially their places of deposition.

REFERENCES

Erickson, B.R. 1972. Osteology of the Early Eusuchian Crocodile *Leidyosuchus formidabilis,* Sp. Nov., *Monograph Vol. 2: Paleontology, The Science Museum of Minnesota.*

Jensen, J.A. 1966. Dinosaur Eggs from the Upper Cretaceous North Horn Formation of Central Utah, *Brigham Young University Geology Studies,* Vol. 13, December.

Krumbiegel, G. 1959. *Die Tertiäre Pflanzen – und Tierwelt der Braunkohle des Geiseltales,* A. Z. Verlag, Wittenberg, Lutherstadt.

Romanoff, L.A. and Romanoff, A.J. 1949. *The Avian Egg,* Wiley and Sons, Inc., New York.

Romer, A.S. 1957. Origin of the Amniote Egg, *The Scientific Monthly,* August, pp. 57-63.

Zangerl, R. 1969. On the Geologic Significance of Perfectly Preserved Fossils, *Proceedings of the North American Paleontological Convention, Part 1,* Allen Press, Inc., Lawrence, Kansas, pp. 1207-1222.

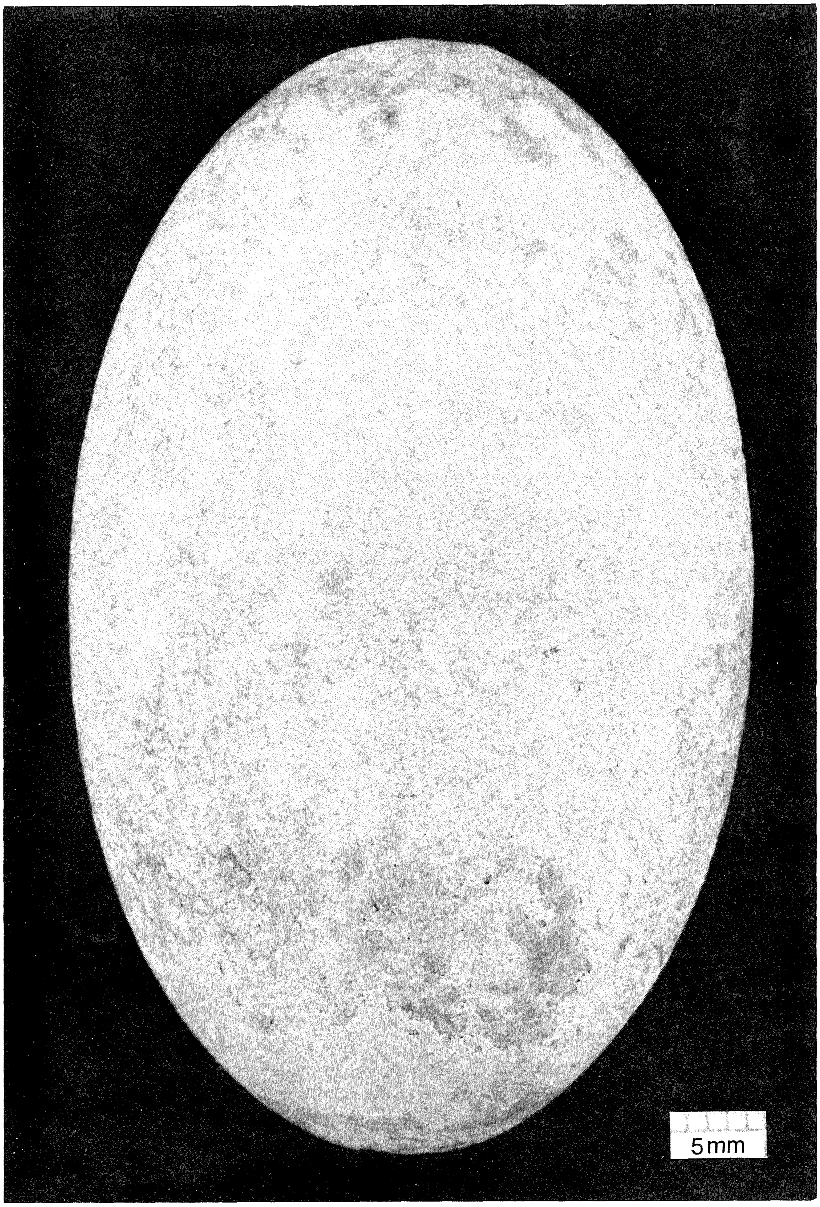

Figure 6
New Cretaceous specimen, lateral view.

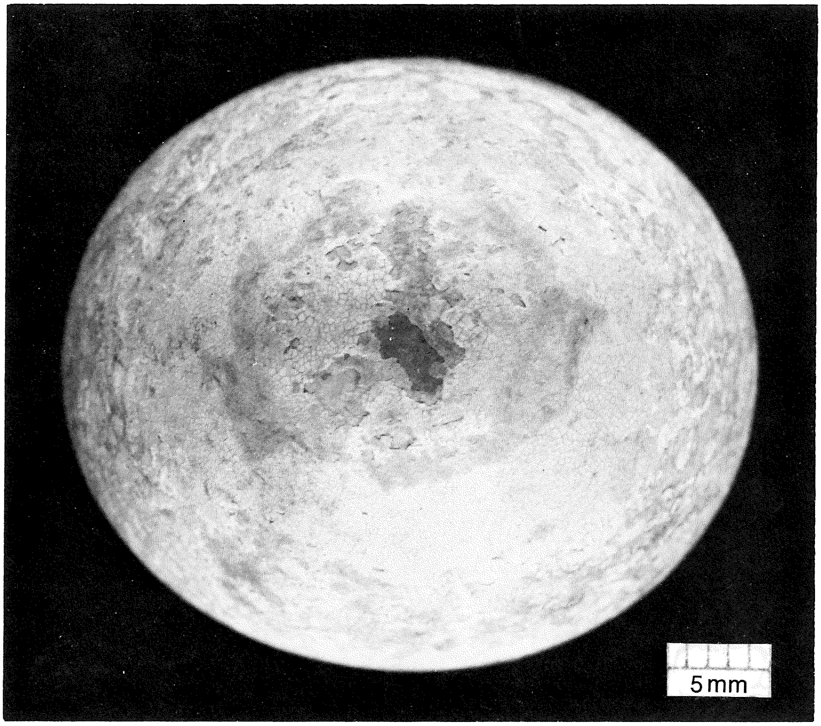

Figure 7
New Cretaceous specimen, end view.