= Gobioolithus =

Gobioolithus is an oogenus of fossil bird egg native to Mongolia . They are small , smooth @-@ shelled , and elongated eggs that were first discovered in the 1960s and early 70s during a series of fossil @-@ hunting expeditions in the Gobi desert . Two oospecies have been described : Gobioolithus minor and G. major . The eggs were probably laid in colonial nesting sites on the banks of rivers and lakes .

G. minor is unusual because it frequently is found with embryonic skeletons of the enantiornithine bird Gobipipus . Interestingly , these embryos have very well @-@ developed wings , which suggest they would be able to fly very soon after hatching , unlike most modern birds .

= = Distribution = =

Gobioolithus is found in the Gobi desert in Mongolia . More specifically , the fossils are found in the Barun Goyot and the Djadokhta Formations of the Nemegt Basin , which is dated to the Upper Cretaceous .

= = History = =

Numerous fossils , including Gobioolithus specimens , were discovered and collected by the Polish @-@ Mongolian fossil @-@ hunting expeditions in the Gobi desert from 1963 to 1971 and by the Soviet @-@ Mongolian expeditions between 1969 and 1996 . These fossils were brought to the Institute of Paleobiology of the Polish Academy of Sciences in Warsaw and to the Paleontological Institute of the Russian Academy of Sciences in Moscow . Eggs now classified as Gobioolithus were first analyzed in 1981 by the Polish paleontologist Andrzej El?anowski , who described several well @-@ developed bird embryos within some of the fossil eggs housed in Warsaw . He identified them as most similar to Gobipteryx minuta , so scientists began referring to them as " Gobipteryx eggs . "

In 1991 , the Russian paleontologist Konstantin Mikhailov introduced the modern parataxonomic system used to classify fossil eggs . While he did not give the " Gobipteryx " eggs a formal name under this classification scheme , he did assign them to the prismatic morphotype in the ornithoid basic type . He believed that they were eggs of volant paleognaths , but probably not Gobipteryx (which was then considered to be a paleognath) . In the same year , the Polish paleontologist Karol Sabath reviewed the entire collection of fossil eggs discovered on the Polish expeditions , including the not @-@ yet @-@ named Gobioolithus eggs . Following El?anowski , he referred them to Gobipteryx , though only tentatively because at the time ongoing studies of similar eggs found on the Soviet expeditions cast doubt on this classification .

In 1994 , Mikhailov , working with Sabath and Kurzanov , divided the Mongolian " Gobipteryx " eggs into two informal groups : G1 , containing the smaller eggs (including the ones with embryos described by El?anowski) , and G2 for the larger eggs . Two years later , Mikhailov went on to classify these eggs parataxonomically as a new oofamily , Gobioolithidae , containing the single oogenus Gobioolithus , with two oospecies : G. minor and G. major , corresponding to G1 and G2 , respectively . In 2013 , Kurochkin , Chatterjee , and Mikhailov described a new genus and species of bird , Gobipipus reshetovi , based on the embryos within Gobioolithus eggs . They classified Gobipipus as an enantiornithine . In 2015 , some of the larger egg specimens previously assigned to G. major were moved into their own new oogenus and oospecies , Styloolithus sabathi .

= = Description = =

Gobioolithus eggs are small and smooth @-@ shelled . They are asymmetrically shaped , similar to many modern bird eggs , with one end pointier than the other . The two oospecies are distinguished mainly by their size : G. major ranges from 50 to 53 @.@ 5 mm long and 25 to 32 mm across , with an eggshell thickness of 0 @.@ 2 @-@ 0 @.@ 4 mm , whereas G. minor is only 30 @-@ 46 mm by 20 @-@ 24 mm and 0 @.@ 1 @-@ 0 @.@ 2 mm thick .

The microstructure of Gobioolithus ' eggshell has not been thoroughly studied , and heavy recrystallization of most specimens makes it difficult to examine the eggshell structure or pore system . The eggshell consists of two (or possibly three) structural layers . The inner layer , called the mammillary layer , is about half the thickness of the outer , or continuous , layer . On the outside , many specimens have a recrystallized outer layer . This could simply due to diagenesis or it could be a true external zone , which is a third layer present in most bird eggs but is rare in non @-@ avian dinosaurs . However , a few specimens are unaffected by recrystallization . These do not have a third layer , but this does not rule out the possibility that the eggshell originally had a three layers since the external layer can easily separate from the rest of the eggshell . These specimens also reveal an angusticanaliculate pore system , which means that the pores have a low density , and are long , narrow , and straight .

Styloolithus , another fossil enantiornithine egg from the Gobi , differs from Gobioolithus in that it is larger and has a thicker eggshell with a proportionately smaller mammillary layer . Laevisoolithids , which are also eggs of enantiornithines , are also larger than Gobioolithus , but they have a much thicker mammillary layer .

= = = Embryos = = =

Many Gobioolithus minor specimens contain embryonic remains of the enantiornithine genus Gobipipus . The embryos have well @-@ ossified skeletons , implying that they were at a late stage in development when they died . Their wings and shoulders are especially well @-@ developed . Only the modern megapodes and the little tern exhibit a comparable degree of embryonic ossification in the arm and shoulder bones . It is likely that Gobipipus hatchlings , like megapodes and little terns , would be able to fly very soon after hatching .

No embryos are known from G. major eggs , but they are usually assumed to have been laid by a similar type of bird .

= = = Nests = = =

Gobioolithus eggs were probably laid in open nests on the banks of ephemeral rivers or lakes , which could frequently flood the nesting areas and bury the eggs . The distribution of the eggs suggests that they had a long @-@ term colonial nesting site at the Khermeen Tsav locality in the Barun Goyot Formation . At the Bayn @-@ Dzak locality , the eggs are typically arranged in clutches , whereas elsewhere they are scattered randomly , each oriented nearly vertically in the substrate . The solitary eggs may have been laid and buried individually , similar to the nesting habits of modern megapodes . It is also possible that they were originally laid in clutches , but flooding separated them and deposited them vertically as the water level dropped . Water damage would also explain why Gobioolithus shells are frequently heavily recrystallized .

= = Classification = =

According to the parataxonomic system used to classify fossil eggs , Gobioolithus is classified in the oofamily Gobioolithidae , which , in turn , is classified in the prismatic morphotype (also called the neognath morphotype) of the ornithoid basic type . A cladistic analysis performed by Varricchio and Barta (2015) (pictured below) found Gobioolithus to be a sister taxon to Styloolithus . However , they considered Styloolithus different enough from Gobioolithus to warrant its excluslion from Gobioolithidae .