THE TURKEY OR THE EGG?

An analysis of egg shell fragments from Tijeras Pueblo

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MEASURMENTS OF TURKEY EGG SHELL FRAGMENTS FROM TIJERAS PUEBLO

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INTRODUCTION

When Coronado and his entourage came through New Mexico in 1540 they reported that many pueblo settlements raised turkeys (*Meleagris gallopavo*), a species of large ground dwelling birds native to the New World. Since that time numerous excavations of pueblos have revealed the presence of egg shell fragments and bones assumed to be from domesticated turkeys (Windes 1993). One question has been pondered for decades --whether the eggs, (and the turkeys themselves) were used for consumption or for their feathers to be used for both ceremonial purposes and as clothing or blankets. Numerous blankets made from turkey and a variety of other bird feathers have been recovered and examples can be viewed at Bandelier National Monument and Zia Pueblo in New Mexico.

Hatchling birds can be organized by how developed the hatchlings are when they hatch and leave the nest. Birds which hatch and are naked, blind, and basically helpless are known as altricial birds. This group is represented by robins, bluebirds, sparrows, swallows and other passerine birds that have relatively short incubation periods of two weeks or so. They acquire some of the calcium needed for bone growth by absorbing calcium from the yolk prior to hatching and the rest from the food provided by the parents.

Conversely, birds that hatch and leave the nest within hours are called precocial and are represented by ducks, geese, chickens, turkeys and grouse. These birds usually have a longer incubation period (28 days in turkeys) than altricial birds and leave the nest with the parent within hours of hatching. The longer incubation times for these birds allow the embryo not only to absorb calcium for bone formation from the yolk but from the egg shell itself. Consequently, egg shells from hatched precocial birds are substantially thinner than from freshly laid eggs. If the goal was to hatch the eggs and raise turkeys it would be expected that egg shell fragments from hatched eggs in pueblo ruins would be substantially thinner than unhatched eggs. Several sources report the thickness of an fresh turkey egg to be approximately 0.41 mm (see Discussion). If the majority of thickness measurements are around 0.41 mm or so this shows the eggs were not incubated or hatched. If the majority of shells show a thickness of less than 0.41mm we can assume the eggs were incubated and hatched. This exercise tests that hypothesis.

METHODS AND MATERIALS

Approximately 58 shell fragments were obtained from the Tijeras Pueblo collections housed in the Hibben Center of the University of New Mexico. Permission to obtain the shells was obtained from both the US Forest Service who manage the Tijeras Pueblo site and from the curator of collections at the University. The fragments are eventually to be placed on permanent loan for new exhibits at the Tijeras Pueblo Museum.

Egg shells are conventionally measured for thickness by opening the egg and, after washing the albumen away, the shell is measured in four places around the equator of the shell. The resultant data are then averaged. This is impossible with nothing but small fragments available so the shell fragments were gently cleaned with a Q -tip and distilled water to remove soil particles and the thickness of each fragment was measured (Figure 1) once. A digital TRESENA micrometer accurate to + - 0.001 mm was used to measure the thickness of the shell fragments.

Figure 1. Egg shell fragments from Tijeras Pueblo.

DATA

The data show considerable variation in shell thickness, ranging from 0.532 mm to a thickness of 0.288 mm (Table 1). Several show a thickness of approximately the same as the published data for unhatched turkey eggs (.417mm, .414mm,) which one would expect from a collection of shell fragments (Grimes 1996). Many of the other observations fall in the region one would expect to find from egg shell fragments from hatched eggs.

Table 1

Thickness (mm) of 58 egg shell fragments from Tijeras Pueblo.

.366	.380	.347	.308
.360	.388	.434	.340
336	.436	.433	.333
.368	.442	.371	.337
.370	.387	.366	.416
.384	.386	.355	.366
.401	.383	.352	.351
.385	.414	.336	.302
.338	.364	.398	.378
.396	.393	.376	.475
.359	.341	.360	.344
.402	.532	.330	.330
.417	.339	.288	.366
.372	.377	.330	
.313	.368	.288	

Table 2

Percentage of thinning of shells from Tijeras Pueblo.

Thinning	**# Observations**	**Percent**
No thinning	9 of 58	15.00%
Some thinning	49 of 58	84.00%
1-15 Percent thinning	31 of 49	65.00%
15-20 Percent thinning	13 of 49	26.00%
Greater than 20 Percent thinning	5 of 49	10%

DISCUSSION

Two factors contribute greatly to the preservation of eggshells that are primarily calcium carbonate, or limestone. First, the southwest part of the United States receives considerably less rainfall than the eastern part of the country. When rain falls it combines with carbon dioxide to create carbonic acid. Carbonic acid, although a weak acid, dissolves limestone (and eggshells) and in many places dissolves cavities in limestone which create caves. Most caves in limestone are formed by the action of weak carbonic acid, although there are notable exceptions. Carlsbad Caverns and Lecheguilla Cave in Carlsbad Caverns National Park in New Mexico were created when sulfur as sulfuric acid from the underlying Permian Basin petroleum deposits dissolved the limestone. Low precipitation leads to low carbonic acid production so eggshells are not dissolved as they are in moister areas. Second, the soils of the west are mostly basic in nature (i.e. pH > 7). In the eastern U.S. the soils are primarily acetic, so bones, mollusk and bird shells often show considerable dissolution.

There are a variety of factors which can influence the thickness of eggshells. The presence of calcium in the diet is of primary importance but age, genetic makeup, nutrition, disease and numerous other factors all can influence the thickness of an eggshell. Measurements from different locations on the same egg can show considerable differences since the thickness of egg shells is not uniform throughout the shell.
Christianson *(*2006) reports that turkey egg shell thickness varies from .44 mm to 0.39 mm in freshly laid eggs involved in feeding trials. They designate "thick shells (0.44mm) and thin shells (0.39mm). Another report (Romanoff and Romanoff 1949) states the mean thickness of turkey egg shells to be 0.41 mm. The 0.41 mm value will be used for this analysis.

Egg shell thinning as a result of re-absorption of eggshell by the embryo is well documented. It would be expected that precocial species have the greatest percentage of thinning because of the relatively longer incubation period. Some examples are *Coturnix japonica* (Japanese quail) 19-33 % decrease, *Anas platyrhynchos* (Mallard duck) 15-22 % decrease, *Colinus virginianus* (Bobwhite quail) 17% decrease, *Alectoris rufa* (Red legged partridge) 24% decrease (Kreitzer*, J. F. 1972)*. Given these figures we can assume that turkey eggs would show between 15% and 20% thinning of the shell by the embryo between the time they were laid and the time they were hatched. If the recently laid shells were 0.41mm on average then we would expect the hatched egg shells to measure between .348 mm (15% thinning) and 0.328 mm (20 % thinning).

It should be noted that any site in which turkey eggs were hatched would contain fragments of eggs that did not hatch. In a survey of commercial turkey hatching facilities 166.5 million eggs lead to 127.4 million hatched eggs—a success rate of 76% (Grime and Pardue 1996). Native Americans could not be expected to exceed this hatching rate and one would expect at least a 25% hatching failure of their eggs.

However, this does not mean that information cannot be gleaned from the data. Tom Windes cites a personal communication with John Weske, acting chief of the Bird Section of the National Museum of Natural History (Windes 1977) who reports an eggshell thickness of 0.35 mm in a wild turkey egg presumed to be from an archaeological site—precisely what one would expect from a shell of an egg that had hatched.

Until very recently it has been assumed that Native Americans in the Southwest domesticated the local turkey (*Meleagris gallopavo*) subspecies merriami. This is a perfectly reasonable assumption but past research comparing faunal remains from ancient pueblos to Merrimans local turkeys may have to be reexamined. Recent DNA research (Speller 2010*)* shows that the turkeys raised by pueblo peoples were (*Meleagris gallopavo)* subspecies silvestris, the Eastern wild turkey or subspecies intermedia, the Rio Grande turkey. This implies a long distance transport of the domesticated turkey from eastern or central United States to the Southwest.

CONCLUSIONS

The data clearly show a thinning from the published thickness of a freshly laid turkey egg. No statistics were performed on the data since there is no semblance of randomness in the samples. The excavators did not sample the shells--they collected all they could find. The number of eggs involved is unknown. In fact, all 58 fragments could have come from less than one egg shell (Windes *1987)*. Even though rainfall is relatively scarce in the Tijeras area, several hundred years of exposure to small amounts of carbonic acid could well have eroded the eggshells.

The value of 0.52 mm in Table 1 is anomalous. The 0 .52mm value may have come from a shell that is not from an egg. Several small pieces of mollusk shell were found in the collection and this value may have been from one of them. Other errors in measurements could have been from soil fragments adhering to the shell or from operator failure to properly zero the instrument.

On the low end a value of 0.28 mm represents a thinning of 32% which is somewhat more than the 20% anticipated although Japanese Quail show up to 33% shell thinning by the embryo. Environmental influences may explain this or the eggs may have been thinner than 0.41mm when laid because of diet or other factors.

A host of environmental influences could have influenced the shell fragment thickness over the centuries but speculation about these influences is unjustified because of the vast number of unknown environmental influences.

Table 2 shows that nine of the 58 shell fragments or 16% show no thinning whatsoever. In all probability these fragments are from eggs that were not incubated for any significant period of time, at least not long enough for the embryo to begin the shell dissolution process, or were intentionally opened shortly after being laid. It is also possible that the eggs were not fertile at the beginning of the incubation period.

Of the measured shells, 84% show some degree of thinning. Of that 84% those showing shell thinning of 1-15% number 31 of 49 which is 63%. Of the shells showing some thinning, 13 of 49 or 26% fall in the arbitrary 15-20% thinning hypothesized for the thickness of a hatched egg. Among those showing some thinning only 5 of 49 or 10% of the measurements show a thinning of more than 20%.

Finally, 18 of 49 or 37% of the data points show an eggshell thinning of more than 15%. These shell fragments show a thickness consistent with hatched eggs. Surprisingly, after being buried and exposed to the elements for more than seven hundred years, 40% of the shell fragments still contained useful information.

The data indicate that most of the shell fragments came from eggs that have hatched, adding evidence that the raising of turkeys during the time that Tijeras Pueblo was occupied involved the utilization of adult turkeys rather than using the eggs as food.

Future Considerations

1. One assumption we have made is that the shell thickness of prehistoric turkey eggs is not substantially different than those of eggs from the 20th century. Future research may disprove that assumption but this analysis seems to support it.
2. It would be of interest to apply the same technique to shell fragments from a Basketmaker 11 site since there is some discussion of how turkeys were used at that time.
3. Although the micrometer used is accurate to one millionth of a meter, there is still a subjective element of how the operator determines when the two surfaces of the

micrometer are “firmly” closed on the shell. A method that would eliminate the subjective element would be useful.

REFERENCES

Christianson, V.L, Bagley, LG. et al . 2006 *Shell Thickness of Turkey Eggs Affects Cardiac Physiology and Embryo Survival.* International Journal of Poultry Science 5(8)793-80.

Grimes, J.L and S.L. Pardue 1996 *A Survey of Commercial Turkey Hatcheries in the U.S.* Journal of Applied Poultry Research 5:231-238

Kreitzer, J.F, 1972 *The Effect of Embryonic Development on the Thickness of Egg Shells of Coturnix Quail.* Poultry Science 10/ 1972 Sept. 51(5): 1764-5

Romanoff, A.L., A.J. Romanoff (1949) *The Avian Egg* pp 150. New York, Wiley.

Speller, Camilla F. et al. 2010 *Ancient Mitrochondral DNA Analysis Reveals Complexity of Indigenous North American Turkey* Domestication. Proceedings of the National Academy of Science. Volume 107 Number 7, February 16 2010 pp. 2807-2812.

Windes, Thomas C, 1993 *The Spade-foot Toad Site: Investigations at 29SJ 629, Chaco Canyon, New Mexico: Artifactual and Biological Analysis* Volume 11 pp. 499-501 Reports of the Chaco Center Number 12 National Park Service, Santa Fe, NM.

Windes, Thomas C. 1987. National Park Service Publications in Archaeology 18F Chaco Canyon Studies. Chapter 10 “*The Use of Turkeys at Pueblo Alto Based on the Eggshell and Faunal Remains.”* Investigations at the Pueblo Alto Complex, Chaco Canyon Volume 111 part 2 . Artifactual and Biological Analysis. Edited by Francis Joan Mathien and Thomas C. Windes.

Windes, Thomas C. 1977. *Dwellers of the Wood, a Preliminary Eggshell Report* Chaco Cultural National Historic Park Museum Collection 0002/042.001-56

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