

**A METHODOLOGY FOR THE IDENTIFICATION OF AVIAN EGG SHELL  
FROM ARCHAEOLOGICAL SITES**

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**ABSTRACT:** Eggshell is often found on archaeological sites, yet is rarely identified. The potential information which could be gained from analysis is outlined, covering questions of economy, e.g. diet, and ecology, such as the distribution of breeding grounds. A methodology for the identification of eggshell using a combination of structural characteristics is given, the basis of which is the comparison of the archaeological material with a modern reference data and photographic collection. A seven step process is outlined, referring to both macro- and microscopic analysis. A brief introduction to previous application of the technique is presented and some of the results which have so far been obtained. This study highlights the questions which may be studied following identification of eggshell, and presents a methodology for carrying out the identifications.

**KEYWORDS:** EGG SHELL, SCANNING ELECTRON MICROSCOPY, MAMMILLAE, RESOURCE EXPLOITATION, ENVIRONMENTAL RECONSTRUCTION

**RESUMEN:** Las cáscaras de huevos de ave se recuperan con frecuencia en yacimientos arqueológicos aunque raras veces se identifican. En este estudio comentamos la información potencial que su estudio puede proporcionar y que incluye tanto cuestiones de economía (por ejemplo, dietas) como de ecología (distribución de áreas de cría). Proporcionamos asimismo una metodología para la identificación de cáscaras sobre la base de una combinación de características estructurales y la ayuda de material fotográfico y de comparación reciente. Se describe un proceso de siete pasos referido tanto al análisis macroscópico como al microscópico. También se valoran sucintamente aplicaciones previas de la técnica así como algunos de los resultados obtenidos con ella hasta la fecha. Nuestro estudio enfatiza las cuestiones susceptibles de abordarse con un estudio de cáscaras y presenta una metodología para llevar a cabo la identificación.

**PALABRAS CLAVE:** CASCARA DE HUEVO, MICROSCOPIA ELECTRONICA DE BARRIDO, MAMILA, EXPLOTACION DE RECURSOS, INFERENCIA AMBIENTAL

## **INTRODUCTION**

### **The uses of eggshell identification.**

Several types of information may be gleaned from the identification of eggshell. The most obvious use is to study past diet and resource exploitation. Other points include seasonality of site occupation and egg exploitation, evidence of breeding and also reconstruction of the palaeoenvironment.

If it can be determined that the eggshell derives from food waste, which may be possible from a study of the deposit and context type, then inferences may be made concerning the role of eggs in past diet. It should also be possible to look at the use made of domesticated stock and the degree of fowling carried out. Additionally, from urban sites, there is the possibility that exotic eggs were imported, as found in Spitalfields, London (Sidell, 1991). However, in all these cases, it is practically impossible to approach the study quantitatively. It is not even possible to calculate a 'Minimum Number of Individuals' due to the nature of eggs which have no distinguishing features, but are uniform across the surface. One possible approach would be to weigh all the recovered fragments, but this incurs all the problems of incomplete preservation and retrieval as well as the weight variation of eggshell within species.

Eggshell found on occupation sites may also be derived from breeding waste. It is possible to detect this from modification of the internal microstructure (Simons, 1971). Unfortunately, this may also be mimicked by abrasion caused in the deposition matrix, and so may be extremely difficult to recognise. However, if it can be identified, then the breeding of birds is a further area of study. The potential for tracking the introduction of domestic stock is also obvious.

Once the eggshell has been identified, studying the behavioural patterns of the particular species will generate further information. This requires the extrapolation of modern analogue data to the past, which can be problematical. However, if it is done with caution and awareness of the difficulties, then it is a valid attempt to gain more information. From such studies it is possible to look at the months of the year when eggs would have been available, and therefore when the eggs were supplementing diet. This naturally only applies to wild birds.

The nesting preferences of birds may also help in local environmental reconstruction. It is likely that if eggs were only being used as a dietary supplement, people would not travel far to collect them. Therefore, the habitat types represented may well have been local to the occupation site.

A further use of eggshell identification is the tracking of past breeding distribution. Very little is known about this; reliable records do not stretch far back in time. Studies using bird bones to look at breeding distribution are likely to be unreliable because birds may travel great distances in flight. Therefore it is from the actual by-product of breeding that the most reliable information may be obtained. One example of the application of this is the identification of Fulmar (*Fulmarus glacialis*) from the Norse and pre-Norse levels at Freswick Links, Caithness (Sidell, forthcoming). Previously this species was only known to have nested on St Kilda and the island of Grimsey (north of Iceland) prior to A.D.1750 (Serjeantson, 1988)

Therefore the potential uses of identifying eggshell include study of past diet and resource exploitation, breeding of birds, determination of the season of occupation and exploitation, reconstruction of palaeoenvironment and the tracking of breeding and domestication. Other possibilities include a study of material culture; e.g. the ostrich eggshells which were used at the site of 'Deir 'Ain 'Abata, Jordan as artefacts in a church (Sidell, forthcoming b).

## STRUCTURE

Eggshell may be divided into two principle components: organic and inorganic (see Figure 1). When the shell is fresh, it will have an organic coating on both the internal and external surfaces. Eggshell has two keratin membranes which lie between the albumen and the 'true shell'. The inner 'egg' membrane surrounds the albumen and rests on the outer 'shell' membrane which is so firmly attached to the shell that it can only be removed chemically. The cuticle is the organic covering of the external surface of the shell. It is mostly proteinaceous. Not all species have an organic cuticle; some have a 'chalky' cover, e.g. the gannet (*Sula bassana*).

The inorganic part of the shell consists of several distinct layers.

1. The mammillae layer. This is attached to the shell membrane. As the membrane develops inside the bird, small crystalline cells develop upon it, known as the centres of crystallization (Tyler & Fowler, 1978), from which roughly hexagonal calcite crystals grow upwards and outwards,

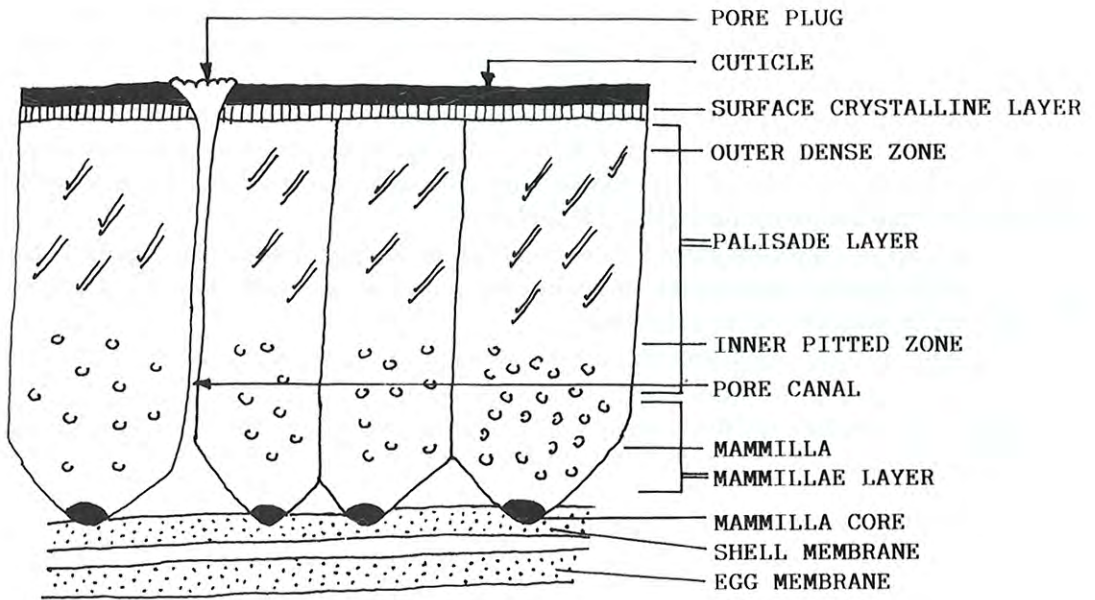


FIGURE 1 - Cross section of eggshell

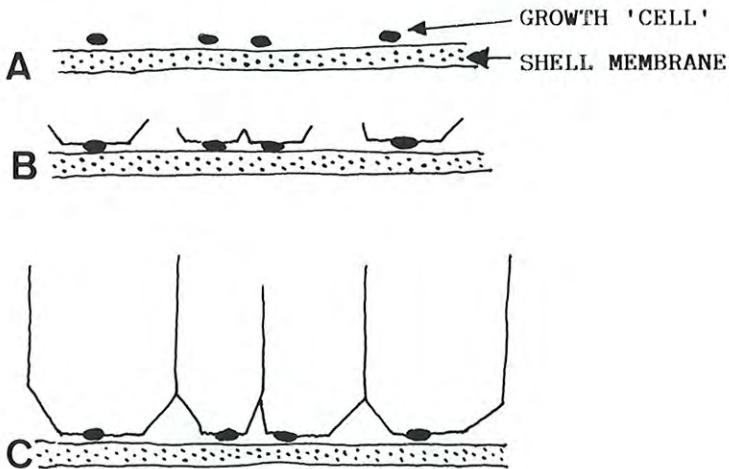


FIGURE 2 - Growth stages of mammillae. a) Cells on membrane; b) beginnings of crystal development with early fusion on two mammillae; c) completion of mammillae layer with two "simple" mammillae and one "compound" mammilla

forming the mammillae. As they grow, they will eventually touch and fuse (see Figure 2). The spacing is generally irregular and so the mammillae will be either 'simple' or 'compound' depending on the initial spacing. When they have all fused, and the entire shell is sheathed in calcite, the mammillae layer terminates (see plate 1).

2. The palisade layer. The name derives from the elongated palisade-like crystals which form the majority of this layer (Tyler & Fowler, 1978). Two zones are visible; an outer dense zone, and an inner zone containing vesicular pits. The palisade layer is the main area of calcification, confirming the shape of the egg and giving it its rigidity and strength.

3. The surface crystalline layer. This is mentioned by Keepax (1981) as an extremely thin layer of crystals running perpendicular to the external surface of the shell. However, it is very difficult to see and may only be one micron thick.

The entire structure is perforated by pores for the transfer of gases and water vapour.

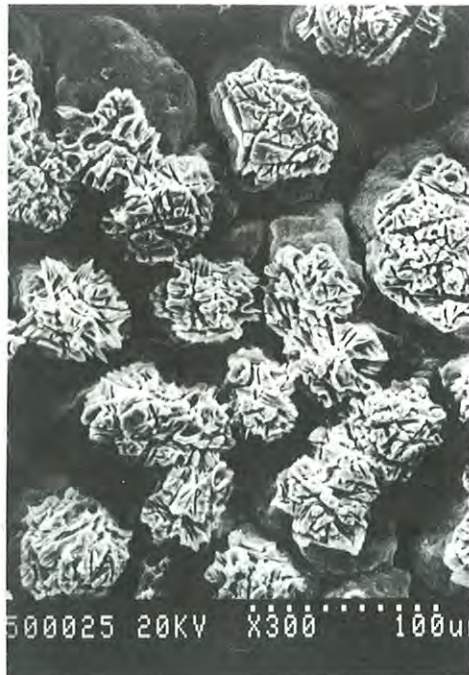
One major problem in reporting on eggshell is the absence of a standardised terminology for the internal surface features. In light of this, it was necessary to create some simple descriptive terms for the diagnostic characteristics (Sidell, 1991b). (See Plates 2 and 3).

Gaps between the mammillae - 'fissures'

Joins of the mammillae in the fissures - 'sutures'

Sculpturing on the mammillae surface - 'membrane facets'

Marks left by the membrane - 'membrane tracks'



## IDENTIFICATION TECHNIQUES

Generally when eggshell is recovered from archaeological deposits, it will have lost its colour and be in small fragments. This renders the application of the gross physical characteristics unuseable for identification, with the exception of shell thickness. Size, shape and colour may not be used, although occasionally some pigment may remain if the material has been waterlogged. This was found at the Iron Age site of Haddenham Delphs where the colour persisted, aiding identification to mute swan (*Cygnus olor*) (Sidell, forthcoming c). Thickness is used, although the possibility of post-depositional damage exists, however, this has not yet been noted to a significant degree. Without the survival of the characteristics used in studies of modern shells, it was necessary to find some new criteria of identification. This was done by a study of inter-specific variation in the microstructure.

The basis of this method is the comparison of archaeological material with a modern reference collection. The assumption has to be made that eggshell characteristics have not altered since the archaeological period in question. The identifications are made using a combination of several characteristics.

1. Colour. Although this disappears in the majority of cases, some burial conditions will preserve it, i.e. waterlogging. If present, the colour is compared to modern specimens. Colour may also be used in the initial stages to separate the material into superficial types.

2. Thickness. This is measured with a binocular microscope using an eyepiece graticule. Several measurements are taken from each specimen, which are then calibrated and given as a range of values in millimetres, which are then compared to a table of modern eggshell thickness ranges.

3. Pores. The pore openings on the external surface vary in number and shape between species. There are generally less pores per unit area in the eggs of larger species. A count is made with a binocular microscope using a gridded eyepiece graticule. The result is given as number of pores per square millimetre.

4. Mammillae. These vary within species, following no apparent pattern related to size or thickness. The variation is sufficient for use as a diagnostic characteristic. A count is carried out under Scanning Electron Microscope (SEM) at a magnification of two hundred times. Every whole mammilla on the screen is counted, including individual elements of compound mammillae. Twenty counts are taken across the surface of the specimen, and a mean is calculated. The result is given as number of mammillae per square millimetre.

5. Vesicular pits. This is a difficult count to carry out, due to the small size of the pits, which require a magnification of five thousand times to see. The count is carried out using SEM in the same way as the mammillae count is made. The result is presented as number of vesicular pits per square millimetre.

6. Ratio of the mammillae to palisade layer. These layers vary in thickness between species and so provide a diagnostic characteristic. The measurement is either carried out directly on the SEM screen, or from electron micrographs.

7. Surface description. This gives an account of the size, shape and spacing of the mammillae and the surface sculpturing. The depth of the fissures and the quality of the fusion is also noted, as are any peculiar characteristics.



PLATES II and III

From these methods, a catalogue of modern data has been compiled and counts, measurements, descriptions and photographs are compared to this body of data in order to make an identification.

### APPLICATION

Practical experience has shown that some material from archaeological sites will not be identifiable. This is generally due to the internal surface being obscured, whether from mineralization or damage to the surface. Without analysis of the internal surface, it would be unwise to attempt identification. Insufficient reference material can potentially be a problem, particularly in the case of exotics.

Eggshell has now been studied from a number of sites, from the Bronze Age to the Post-Medieval period, and from urban sites to cliff-side ones. Good results have been obtained in the majority of cases.

One example is the site of Norton Folgate, Spitalfields, London (Sidell, 1991). The breakdown of identification is as follows:

64% was firmly identified

24% was inconclusive between several species due to mineralization.

12% was unidentified due to extreme mineralization and the presence of an exotic.

At this stage the most interesting results have come from the site of Freswick Links, Caithness, Scotland (Sidell, forthcoming). Sixteen wild species have been identified from this site, and several domesticates. From the species list, it was possible to study the diet of the inhabitants of the site, their fowling activities, the seasonality of wild egg consumption, the proportions of wild versus domestic eggs. It was also possible to make an attempt at reconstruction of the local

palaeoenvironment. However, the major contribution that this study made was to highlight the potential for study of the distribution of past breeding grounds. From the Norse and pre-Norse levels, eggshell was found of the Fulmar, (*Fulmarus glacialis*), in sufficient number to assume that the birds were breeding, rather than chance finds or imported eggs.

From this study, the potential of eggshell studies is revealed. Until now, very little research has been carried out, and generally excavators will discard eggshell if it has been recovered. However, the initial work has demonstrated the possibility of identification to species level, leading to implications for the study of site economy and ecology.

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