Art and Symmetry of Scottish Carved Stone Balls

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Abstract

Over 425 Neolithic stone balls with carved knobs have been found in northern Scotland. There is no recorded use of these objects, which has resulted in much speculation about their purpose. In some cases, the symmetry of the knob placements is consistent with symmetry associated with Platonic solids. However, these objects are clearly not polyhedra and thus do not represent examples of Platonic solids, despite recent claims to that effect. Examples are shown along with pictures of modern art that they have inspired. Their symmetric form contributes to their aesthetic appeal, thus they can be considered very early examples of mathematical art.

Background

Scottish carved stone balls are a set of over just over 425 Neolithic stone objects that have been found in northern Scotland. Estimates on their dates' range from 3200-2500 BCE. A paper by Marshall published in 1976 contains a very detailed description of many of these objects, including locations at the time of publication [8]. These enigmatic objects are typically found outside of an archaeological setting, often as a result of modern agricultural activities. Some are well-preserved with very detailed features, while others are quite weathered. Many are about 7 cm in diameter and made from a variety of rock types. New balls are occasionally discovered; one was found in Orkney on August 7, 2013 [1]. Examples are shown in Figure 1.

The interesting feature connecting these objects is their roughly spherical shape and consistent size. Many contain decorative elements, such as spirals and grooves. The majority have knobs carved on their surface, with the number of knobs varying from none to over one-hundred. The knobs are very prominent to subtle with only a faint outline. The set of knob numbers found includes $\{0, 3–12, 14–16, 18–25, 27, 28, 30, 33, 34, 36, 42, 50, 55, 70, 76, 80, 86, 87, 89, 100, 135\}$. The distribution is nonuniform, with over half containing six knobs with the placement of knobs roughly on the front, back, left, right, top, and bottom of the ball, for example items D and K in Figure 1.

There is much speculation about the purpose, meaning, and use of these objects [4]. It is estimated that, starting from a round stone, it took about 12 hours using stone tools to carve a simple stone ball [11]. Theories for their use include: fishing net weights, money, game pieces, ceremonial mace-heads, speaking stones, ritual objects, and a hand-thrown weapon. We may never discover their true use, but the symmetry found in many gives them aesthetic appeal.

Mathematical Connections

The knob placement is related to the problem of uniformly packing n points on a sphere's surface. When the number of knobs is equivalent to the number of faces of a Platonic solid, the knobs can be placed in the same locations as the polyhedral faces. This is observed when the number of knobs is four and six.

A book by Keith Critchlow originally published in 1979 contains a chapter entitled "Platonic Spheres—a millennium before Plato" [3, Ch. 7]. This chapter is richly illustrated with high-quality photographs of

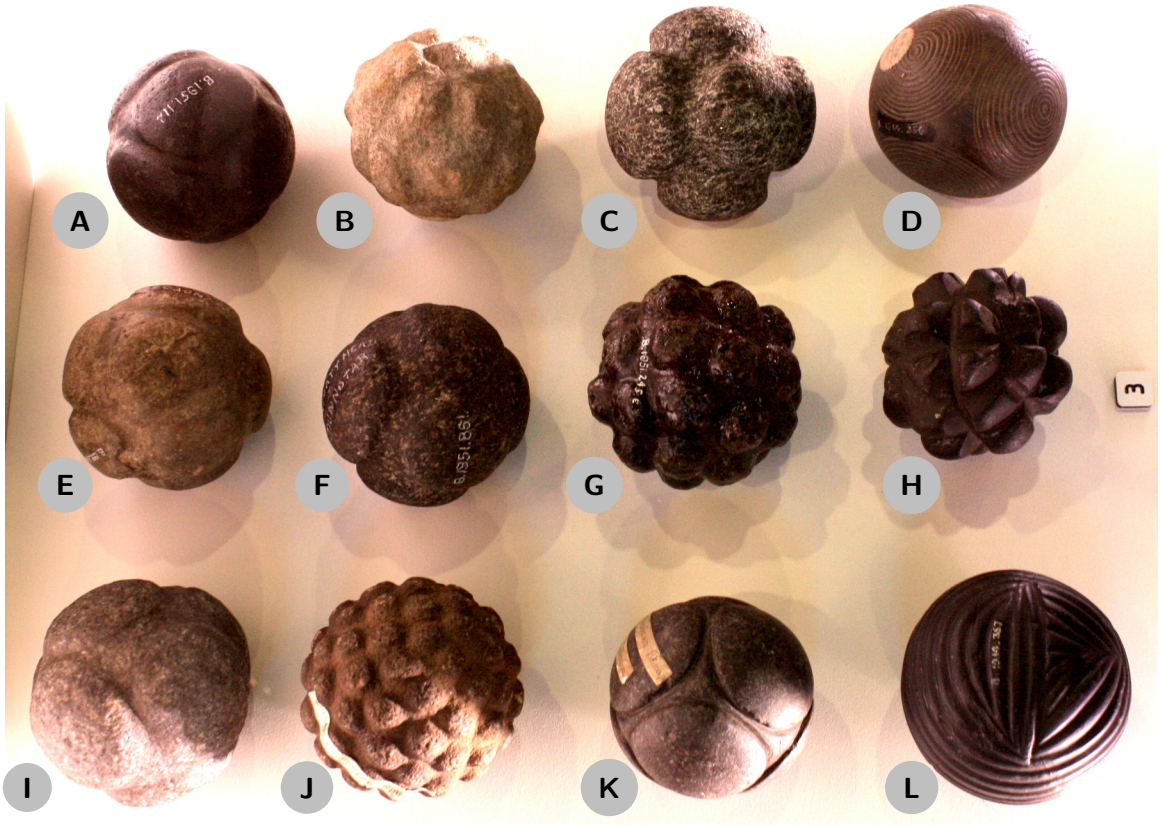

Figure 1: *Example Carved Stone balls. These twelve balls are examples Scottish carved stone balls, located at the Hunterian Museum in Glasgow, Scotland.*

many carved stone balls. Critchlow states "these Neolithic objects display the regular mathematical symmetries normally associated with the Platonic solids, yet appear to be at least a thousand years before the time of either Pythagoras or Plato." Critchlow's claim is that because these objects exhibit symmetry found in Platonic solids, they must be equivalent to them. However, there are only 14 families of spherical symmetry, and half of theses are related to the Platonic solids [2]. In some of the photographs, tape bands have been placed on the stones to help the viewer to see the stones in relationship to platonic solids. While the symmetry of some of the Platonic solids is present, these are not polyhedra and the tape misleads the viewer. Critchlow admits to not seeing an icosahedron, but does observe that some stones have points that exhibit five-fold symmetry.

The idea that these objects represent a complete set of platonic solids is weak, yet is propagated by many viewers without careful inspection of the original objects or reading Critchlow's text. For example, in 1982 Lawlor [6] states "The five regular polyhedra or Platonic solids were known and worked with well before Plato's time." and cites Critchlow's book.

A recent article by Lloyd [7] investigated this issue in detail. It states "there is *no* evidence for a prehistoric knowledge of the set of five Platonic solids." Clearly, Lloyd and Critchlow disagree about the mathematical interpretation of these objects. The twelve objects shown in Figure 1 are representative objects. While one might see a form that contains five-fold symmetry from one angle, there is no information on the symmetry from the reverse angle. Lloyd states that no balls with twenty knobs have icosahedral symmetry. Many of the carved stone balls have six knobs, and thus have approximate octahedral symmetry in their knob placement. Some have four knobs and tetrahedral symmetry.

(a) First Conundrum (2000) by Remco de Fauw, Edinburgh, Scotland.

(b) Eternal Present (2011) by Janet McEwan, Oldmeldrum, Scotland.

Figure 2: Modern artworks based on Scottish carved stone balls.

Public Displays

Although Marshall's paper contains a detailed catalog of many stones, some of the museums have closed and other stones are in private collections. In July 2013, I spent some time in England and Scotland visiting museums to view these objects firsthand. During my travels I had the opportunity to visit the museums listed in Table 1. The artifacts on display show no special connection with Platonic solids. There are a few balls with 12 knobs, and at least some orientations pictured show knobs arranged similarly to the faces of a dodecahedron. Sadly, I did not have the opportunity in my visits to handle and inspect these balls. It seems that Lloyd [7] did not either. There is clearly room for further investigation of these artifacts to determine how closely they meet the symmetry of a dodecahedron.

Modern Depictions

There are two large public art installations in Scotland featuring carved stone balls, shown in Figure 2. Remco de Fouw created *First Conundrum* in 2000 [5], located on Festival Square, Edinburgh, Scotland. It consists of large-scale replicas of carved stone balls and a large (7 m) spherical water feature. The second public art, comprising three large spheres, is found in Oldmeldrum, Scotland. Janet McEwan's *The Eternal Present: Gneiss, Granite, Gabbro* was completed in 2011 [10]. The largest is carved from gneiss and from granite and also has six knobs. The smallest is carved from gabbro and contains over fifty knobs. The artist has a very interesting blog documenting the creation and installation of the artwork [9].

Discussion

Carved stone balls have fascinated people ever since their modern discovery. The symmetry present in some may have a relationship to Plato's account of the Platonic solids. However, they are clearly not examples of Platonic solids as they are not even polyhedra. While the exact original usage of these objects may never be discovered, many are quite beautiful. Marshall states "many are real works of art." Perhaps this is their real use: examples of the earliest known forms of mathematical art!

Museum	Location	Number
Ashmolean Museum	Oxford, England	2
British Museum	London, England	3
Hunterian Museum	Glasgow, Scotland	12
Kelvingrove Museum	Glasgow, Scotland	3
Auld Kirk Museum	Auld Kirk, Scotland	1
St. Andrew's Museum	St. Andrew's, Scotland	2
McManus Museum	Dundee, Scotland	5
Montrose Museum	Montrose, Scotland	5
National Museum of Scotland	Edinburgh, Scotland	7

Table 1: *A list of museums displaying the carved stone balls visited by the author. The number of balls displayed at each museum (in 2013) is indicated. This list is not a complete list of all locations housing these objects. A total of 40 balls were seen, just under 10% of those known.*

Acknowledgments

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