



## Aristotle's lantern in echinoderms: an ancient riddle

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**Abstract:** The body structure, life habit and diversity of the sea-urchins were first described by Aristotle in the 4<sup>th</sup> century BC. Early zoologists, having studied his zoological works, introduced the name "Aristotle's lantern" for the jaw apparatus of echinoids. The term has become fully accepted in the vocabulary of modern invertebrate zoology, but it has been disputed by scholars claiming that the original description actually addressed the test and not the mouth of the sea urchin. The problem remained long unsolved due to lack of evidence. The combined investigation conducted in the classical literature and the archaeological findings from the area and the period Aristotle lived, unravelled the riddle. Bronze, perforated lanterns diffusing and protecting the lamp light inside were found during excavations in Northern Greece localities, confirming the relevant descriptions given by classical authors. These lanterns with their lamp proved to be the model for Aristotle's description, corresponding to the test and the jaw apparatus respectively. Thus, it is suggested that the term "Aristotle's lantern" should be correctly used for the test of the sea urchin and not for its jaw apparatus traditionally referred to as such. These results demonstrate how tracing back to the historical roots of the science of zoology and combining data from different disciplines can help in redefining scientific terms and concepts.

**Résumé :** *La lanterne d'Aristote chez les Echinodermes : une vieille énigme.* La structure du corps, l'habitat et la diversité des oursins ont été décrits en premier par Aristote au 4<sup>ème</sup> siècle avant J.C. Les premiers zoologistes, ayant étudié ses travaux de zoologie, ont introduit le terme de "lanterne d'Aristote" pour désigner l'appareil masticatoire des oursins. Le terme a été intégré dans le vocabulaire de la zoologie moderne mais il a été décrié par certaines écoles arguant que la description originelle désignait en fait le test et non la bouche de l'oursin. Faute d'évidence, le problème est resté longtemps insoluble. Une recherche combinée à la fois dans la littérature classique et les découvertes archéologiques correspondant à la région et à l'époque d'Aristote a permis de résoudre l'énigme. Des lanternes de bronze diffusant la lumière et protégeant la lampe ont été trouvées lors de fouilles dans des localités du nord de la Grèce, confirmant la pertinence des descriptions données par les auteurs classiques. Ces lanternes et leur lampe ont constitué le modèle de la description d'Aristote et correspondent respectivement au test et à la mâchoire. Il est suggéré d'utiliser le terme de "lanterne d'Aristote" pour le test des oursins plutôt que pour la mâchoire comme c'est habituellement le cas. Ce travail montre comment l'analyse des origines historiques de la zoologie et le couplage de différentes disciplines peuvent nous aider à redéfinir les termes et les concepts scientifiques.

**Keywords:** Aristotle's lantern • Echinodermata • Sea urchin • History of zoology

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## Introduction

The highly developed jaw apparatus of the sea urchin, named after Aristotle, is the most famous and controversial among the eponymous structures of echinoderms. Jacob Klein, in his *Naturalis Dispositio Echinodermatum* was the first to specifically refer to it as "Aristotle's lantern" in 1734 (Lawrence, 2001). His suggestion was based on Rondelet's observation that the structure described by Aristotle in the *History of Animals* (531a3-5) as resembling a lantern was the jaw apparatus of the animal (Cole, 1950).

Modern echinoderm specialists, invertebrate zoologists, and biologists in general (Lawrence, 2001; Ruppert et al., 2004; Sodergren et al., 2006) have fully accepted the term without having thoroughly examined its origin. However, according to scholars and biologists who studied the classical texts (Thompson, 1947; Cole, 1950; Peck, 1970) the passage of the alleged original description remains obscure, still awaiting a satisfactory interpretation. In the present paper an attempt is made to trace back the origin of "Aristotle's lantern" and redefine the term, on the basis of evidence from the archaeological record and the classical texts.

## Materials and Methods

A thorough examination of the written documents from the Greek and Greek-Roman antiquity, as well as the archaeological record of the period in which Aristotle lived was made. This was achieved through: i) a scanning of the classical Greek literature using the Thesaurus Linguae Graecae digital library (TLGE, 2007) offered by the University of California; in this way, all records of lanterns were collected and studied (the citations of the classical works given below refer to their TLG versions), ii) an examination of the archaeological findings exhibited in the archaeological museums of northern Greece, and more specifically, the Archaeological Museum of Thessaloniki and the Museum of Vergina royal tombs.

## Results and Discussion

The confusing three lines in Aristotle's *History of Animals* (531a3-5) describing the sea urchins morphology read: "In respect of its beginning and end the mouth (or body) of the urchin is continuous, though in respect of its superficial appearance it is not continuous, but similar to a lantern not having a surrounding skin".

The main difficulty in interpreting this passage lies in the old manuscripts on which the classical text of *The History of animals* was based: it is not clear whether one should read *stoma*, i.e. jaw apparatus, or *soma*, i.e. body. Another

point of confusion is the real meaning of the contrasting phrases regarding the continuity. The lack of a "surrounding skin" further complicates the situation.

So far, three interpretations have been given. A minority reading *stoma* (Thompson, 1947) retained the use of the zoological term "lantern" for the jaw apparatus. The majority accepted the version reading *soma* (Cole, 1950; Peck, 1970) since this was the case in most of the old manuscripts (Cole, 1950). Under this perspective, the term "Aristotle's lantern" should indicate the test of the urchin (Peck, 1970), or the test and the jaw apparatus together, like a lantern with its lamp (Cole, 1950). In the most recent study Lennox (1984) sides with those reading *soma* but gives an interpretation of his own attributing the "skin" to the test of the urchin, and "the lantern without its skin" to its internal viscera. He also gives two interpretations regarding the lack of continuity in the superficial appearance of the urchin: Aristotle meant either that the test consisted of a mail of plates fitting closely edge to edge, or that the internal viscera was not apparently connected to the outer sphere after dissection.

The main problem in adopting any of the above scenarios according to Peck (1970) and Lennox (1984), who gave the most detailed analyses, was that no archaeological evidence about lanterns (lamp-terres) in Aristotle's time has been found, although very many lamps (lychnoi) have survived. The two classical words had the same meaning as they do today, the lantern indicating a portable lighting device (a lamp holder) with a transparent or translucent protective case, used to illuminate broad areas. The lamp, on the other hand is any device that produces illumination (candle, oil lamp) used on its own or placed inside a lamp holder.

The examination of the written documents showed that lanterns of various kinds have been used since the time of Homer. Empedocles (5<sup>th</sup> c. BC, *Fragmenta* 84.9 and 14) and Aeneas (4<sup>th</sup> c. BC, *Poliorectica* 22.21.3) mention that a lamp was placed inside a lantern to protect the light source from the wind without however giving any information on their structure. Photius (9<sup>th</sup> c. AD, *Lexicon* page 238 line 8) explains that lanterns in antiquity were made of clean translucent skins or perforated ceramic to permit light diffusion. Theophrastus, a contemporary and friend of Aristotle, mentions that at their time they used to protect the lamps inside bronze lanterns which prevented the light from blowing out, since the wind could hardly reach the light source (*De igne* 22.2).

Moreover, the very fruitful investigation in the Archaeological Museums of Northern Greece revealed two lanterns of the bronze type as described by Theophrastus (Fig. 1A & B).

On the basis of the above evidence, we can conclude that Aristotle in the troublesome passage was comparing the test



**Figure 1.** Ancient lamp holders (lanterns) from Northern Greece localities. **A.** The Vergina lantern coming from the tomb identified as that of King Philip II, dated to the third quarter of the 4<sup>th</sup> century BC (Museum of Vergina royal tombs). **B.** The Derveni lantern found in one of the tombs at the necropolis of Ancient Lete, dated to the last quarter of the 4<sup>th</sup> century BC (Archaeological Museum of Thessaloniki).

**Figure 1.** Lampe ancienne (lanterne) du nord de la Grèce. **A.** La lanterne Vergina venant de la tombe identifiée comme celle du Roi Philippe II, est datée du troisième trimestre du 4<sup>ème</sup> siècle avant J.C. (Musée des tombeaux royaux de Vergina). **B.** La lanterne Derveni trouvée dans une des tombes de la Nécropole de l'ancien Lete, est datée du dernier quart du 4<sup>ème</sup> siècle avant J.C. (Musée archéologique de Thessalonique).

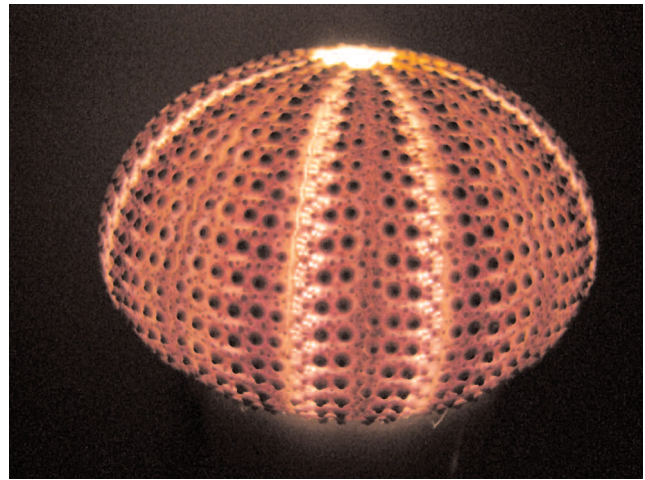
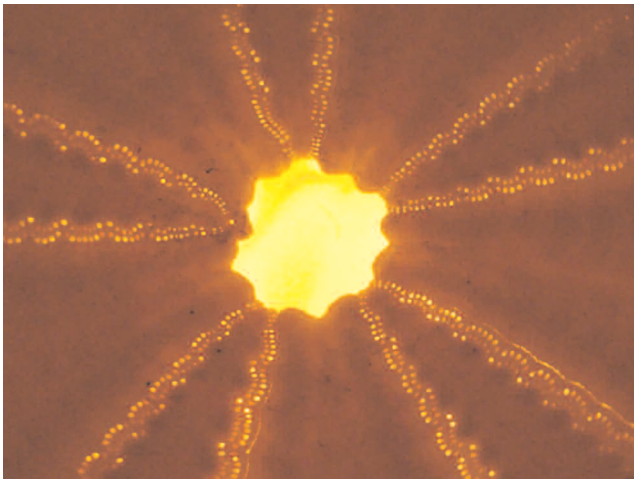
of the sea urchin with a bronze lantern, discriminating it from the lanterns made of skin. Under this perspective, it is clear that by the phrase “in respect to the superficial appearance it is not continuous” he indicated the surface of the sea urchin test perforated by the pore pairs of the tube feet (Fig. 2A). Thus, the interpretation by Lennox (1983) presented above, proves incorrect. The continuity in respect to the beginning and the end most probably refers to the continuous, unified shell starting from the oral and ending in the aboral area (Fig. 2B). Aristotle included the echinoderms in *ostrakoderma* i.e. the animals having a hard shell surrounding the body (Voultsiadou & Vafidis, 2007)

and in this way he most likely contrasted the structure of their shell to that of other *ostakoderma* such as the bivalves (*dithyra*), the conical univalves (*monothyra*) and the spiral-shelled gastropods (*stromvode*).

So, Cole's (1950) opinion that, according to Aristotle, the lantern is the test and the lamp is the jaw apparatus has been confirmed thanks to the evidence offered by the classical texts and the archaeological record. It is therefore proposed that the test of the sea urchin and not the jaw apparatus should be called “Aristotle's lantern”.

The case of the sea urchin is a good example of how multidisciplinary research and the study of the beginnings





**Figure 2.** Sea urchin tests. **A.** Aboral area of the common Aegean species *Sphaerechinus granularis* (Lamarck, 1816) showing the surface perforations. **B.** Entire test of the same species illuminated by a lamp inside.

**Figure 2.** Test d'oursin. **A.** Zone aborale de l'espèce commune égéenne *Sphaerechinus granularis* (Lamarck, 1816) montrant les perforations de surface. **B.** Test entier de la même espèce illuminée par une lampe intérieure.

of a science can help in answering long lasting questions and forming uniform generally accepted scientific concepts.

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