

## A JOURNEY THROUGH TIME : THE HISTORY OF *AMPULLA ROMANA* OF SEMICIRCULAR CANALS

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A JOURNEY THROUGH TIME : THE HISTORY OF “*AMPULLA ROMANA*” OF SEMICIRCULAR CANALS (Abstract) : The location of semicircular canals and ducts in an area not easily accessible for dissections, considerably delayed the arrival of the first anatomical terminology related to the inner ear, which was actually defined during the Renaissance. Our paper aims at presenting a short history of the anatomical discoveries of the inner ear, especially of the semicircular canals and ducts, as well as of their ampullae. **Key words** : AMPULLA, INNER EAR, HISTORY OF ANATOMY

### INTRODUCTION

The human body has fascinated people ever since ancient times and they have constantly strived to understand its complex structure (1). As the sense of hearing also interested them, anatomists and anatomy lovers have made efforts to identify the structures in the petrous part of the temporal bone ever since ancient times, as they suspected that this was the location of hearing (2). Moreover, they attempted to find analogies between the shape of the anatomical structures revealed by autopsy and the shapes of objects surrounding them, especially in sources of inspiration in Ancient Rome (3, 4, 5, 6). Thus, the ampulla located at the bone and membranous semicircular canals was said to resemble the *ampulla Romana* used in Antiquity. Our paper is designed as a time travel that takes the reader through the history of the inner ear, from Aristotle, who considered it filled with *aer ingenitus*, to the 19<sup>th</sup> century, when the Italian Antonio Scarpa accurately de-

scribed the anatomy of the *ampullae* of semicircular ducts.

### AMPULLA IN ANCIENT ROME

Every Roman house had certain vessels called *ampullae* (Fig. 1), which were actually small containers usually made of ceramic or glass. The Romans used these bottles to keep their water, wine, oil or perfume (7) and they bought them from a person that they called *ampullarius* (ampullae merchant) (7, 8). There were several types of bottles : *ampulla olearia* used to hold oil, which the Romans would take with them to public baths to moisturize their skin after the bath, *ampulla cosminae* holding perfumed oils (8) or *ampulla rubida*, a leather-covered bottle used by travelers to carry water, vinegar or oil (9).

### THE ARRIVAL OF THE WORK “AMPULLA” IN ANATOMY

In anatomy, the word *ampulla* applies to the bony dilatations at one end of the three semi-

circular osseous canals (called *ampulla ossea*), lodging the *membranous ampullas* (called *ampulla membranacea*), which are other dilata-tions from the end of the membranous semicir-cular ducts of the inner ear labyrinth (10) (Fig. 2). Depending on their location, they are clas-sified as anterior, posterior and lateral. All these ampullar structures are, morphologically speaking, very similar to the Roman bottles, the only difference being that they do not hold oil or wine, but perilymph or endolymph, and the history of their discovery is relatively recent, since the location of the bony and membranous labyrinth made it difficult for specialists to reach in to perform anatomical dissections.

### EARLY BELIEFS

The history of the discovery of the inner ear starts with *Aristotle (384-322BC)* and *Galenus (129-c.200/216 BC)*, who provided the first information about this anatomical structure. They believed that the inner ear was full of some type of purified air, which they called *aer ingenitus* (11, 12). Early Greek doctors in the 5<sup>th</sup> century BC suspected that hearing was lo-cated here. Moreover, surprisingly for those times, Galenus thought that the auditory nerve (2), responsible for the function of hearing, was also located here.

### THE FIRST OBSERVATIONS AND FINDINGS

Due to the findings related to the middle ear structures (especially the ossicles) dating back to the 15<sup>th</sup> and 16<sup>th</sup> centuries, made by *Jacobus Berengarius Carpensis (1460-1530)*(13), *Alex-ander Achillinius (1463-1525)* (14), *Niccolo Massa (1489-1569)* and *Giovanni Filippo In-grassias (1510-1580)* (15), the information about the anatomy of the petrous part of the temporal bone has become increasingly accurate. In his monumental work entitled *De humani corporis fabrica*, *Andreas Vesalius (1514-1564)* sheds light on the topic, as he accurately describes and draws the middle ear structures (16) and claims that he was able to examine them better after he had macerated the petrous bone (14). Vesalius was also the first anatomist who sug-gested that the organ of hearing (e.g. the pe-trous part of the temporal bone) should be re-moved from the skull in order to be able to examine it better (17). Due to their revolution-ary findings related to the middle ear, the Re-naissance anatomists started to get increasingly

closer to inner ear anatomy and to “ampulla Romana”.

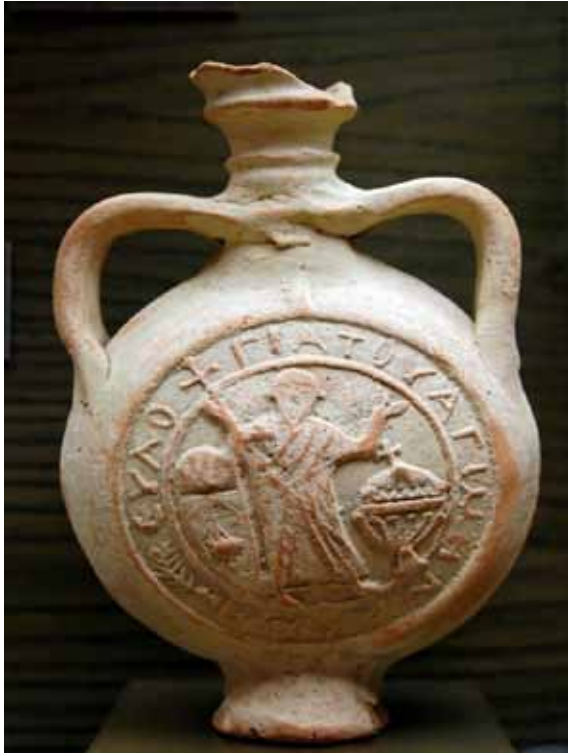
### PASSING THROUGH THE MIDDLE EAR TO GET TO THE INNER EAR

The Italian anatomist *Giulio Cesare Cas-serio (c.1545/1552-1616)* also studied the struc-ture of the middle and inner ear, especially in domestic animals. He pointed out the differ-ences between the temporal bone in adults and the temporal bone in children (18), he drew many accurate and beautiful illustrations of this structure, especially of the ossicles (13), and he described the inner ear with its oval and round window, claiming that there were only three semicircular canals here (18).

In 1561, *Gabriel Fallopius (1523-1562)*, who was professor Vesalius’ successor and one of the greatest anatomists and doctors of the 16<sup>th</sup> century, divided the inner ear in two sections, namely the labyrinth and the cochlea (13). Due to his findings, Fallopius has significantly con-tributed to the gathering of information about the organ of hearing, as he thoroughly described not only the semicircular ducts with their am-pullae, but also the labyrinth, the cochlea and even the auditory nerve (17).

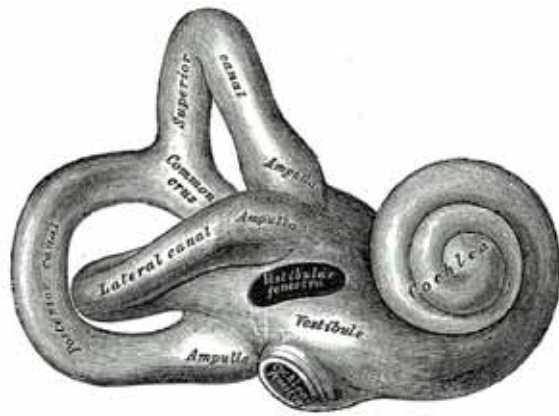
Two centuries later, in 1775, the Italian ana-tomist and surgeon *Domenico Cotugno (1736-1822)* made dissections of cochleae from fresh temporal bones and in his paper entitled *De Aquaeductus Auris Humanae Internae Anatom-ica Dissertatio* claimed that both the cochlea and the vestibular aqueducts contain a fluid and not air as thought by his Antiquity predeces-sors, Aristotle and Galenus. This fluid occur-ring in the bony labyrinth was called *liquor Cotunni*, named after its discoverer, which later became known under the name perilymph (19).

The first accurate description of the bony and membranous labyrinths, and of the ampul-lae is due to a professor from the University of Modena, the Italian anatomist *Antonio Scarpa (1752-1832)*, in his paper entitled *Anatomicae disquisitiones de auditu el olfactu* published in 1789. Scarpa thoroughly describes the bony and membranous labyrinth, relying heavily on his dissections of inner ears of animals. He is the first researcher to thoroughly describe the vestibular system of the inner ear with three curvilinear canals located in the bony portion of the vestibular labyrinth, which includes in its turn three semicircular membranous canals associated to *ampullae*. He accompanied his



**Fig. 1.** Pilgrim's Roman ampulla. Baked clay, 6<sup>th</sup> century AD. Louvre Museum (public domain)

descriptions by extraordinary drawings which he sketched himself and by illustrations of both the bony and the membranous labyrinths with ampullae (19, 20).



**Fig. 2.** Right bone labyrinth where one may notice the semicircular canals and ampullae. Henry Gray, *Anatomy of the human body*-1918 (public domain)

## CONCLUSIONS

Semicircular canals and ampullae of the inner ear have a relatively recent history as compared to other anatomical easily accessible structures, as they started to be described only in late Renaissance and their definition was completed as late as the 19<sup>th</sup> century. Nevertheless, the similarities established by anatomists between these anatomical structures and different objects from Ancient Rome prove their deep understanding of the morphology and functionality of these anatomical structures.

## REFERENCES

1. Turliuc D, Sava A, Dumitrescu GF, Cucu A, Salamastrakis I, Costea CF, Turliuc S. Origins of Neurosurgery and Neuroanatomy part one – ancient period. *Romanian Journal of Functional & Clinical, Macro- & Microscopical Anatomy & of Anthropology*, XIV (1): 100-105, 2015.
2. Gulya AJ, Minor LB, Poe DS. *Surgery of the ear*. Ed. Shelton: PMPH, 2010.
3. Turliuc D, Turliuc S, Cucu A, Dumitrescu GF, Carauleanu A, Buzduga C, Tamas C, Sava A, Costea CF. A review of analogies between some neuroanatomical terms and roman household objects. *Annals of Anatomy*, 204: 127-133, 2016.
4. Turliuc D, Turliuc S, Cucu A, Dumitrescu G, Costea C. An entire universe of the Roman world's architecture found in the human skull. *Journal of the History of the Neurosciences*, online, 2015.
5. Turliuc DM, Turliuc S, Cucu AI, Sava A, Dumitrescu GF, Carauleanu A, Buzduga C, Trandafir D, Costea CF. An unwritten anatomy lesson: the influence of roman clothing on neuroanatomical terminology: in memoriam Albert L. Rhoton, Jr. (1932–2016). *Clinical Anatomy*, 29: 680-690, 2016.
6. Turliuc DM, Sava A, Cucu AI, Turliuc S, Dumitrescu AM, Costea CF. Cribriform plate and Galen's cribrum romanum. *Romanian Journal of Functional & Clinical, Macro- & Microscopical Anatomy & of Anthropology*. XV (1): 123-126, 2016.
7. Smith W, Anthon C. *A school dictionary of Greek and Roman antiquities: abridged from the larger dictionary*. Ed. New York: Harper & Bros, 1846.
8. Smith WS. *A dictionary of Greek and Roman antiquities*. Ed. London: John Murray, 1875.
9. Rich A. *A dictionary of Roman and Greek Antiquities: with nearly 2000 engravings on wood from Ancient originals illustrative of the industrial arts and social life of the Greeks and Romans*. Ed. London: Longmans, Green and Co., 1860.
10. Dorland NWA, *Dorland's Illustrated Medical Dictionary*. Ed. Philadelphia: Elsevier Saunders, 2012.

11. Ross GRT. *Translation - Aristotle : de sensu and de memoria*. Ed. Cambridge : Cambridge University Press, 1906
12. Galen. *De usu partium corporis humani*. Ed. Froben Basileae : Omnia Cl. Galeni opera, 1542.
13. Finger S. *Origins of neuroscience : a history of explorations into brain function*. Ed. Oxford University Press, 2001.
14. Politzer A. *History of otology : from earliest times to the middle of the nineteenth century*. Ed. Phoenix : Columella Press, 1981.
15. Dispenza F, Cappello F, Kulamarva G, De Stefano A. The discovery of stapes. *Acta Otorhinolaryngologica Italica*, 33(5) : 357-359, 2013.
16. O'Malley CD. *Andreas Vesalius of Brussels : 1514-1564*. Ed. Berkeley : University of California Press, 1964.
17. Hachmeister JE. An abbreviated history of the ear : from Renaissance to present, *The Yale journal of biology and medicine* : 76(2) : 81-86, 2003.
18. Riva A, Orrù B, Pirino A, Riva FT. Iulius Casserius (1552-1616) : the self-made anatomist of Padua's golden age. *The Anatomical record*, 265(4) : 168-175, 2001.
19. Van De Water TR. Historical aspects of inner ear anatomy and biology that underlie the design of hearing and balance prosthetic devices. *Anatomical record (Hoboken)*, 295(11) : 1741-1759, 2012.
20. Scarpa A. *Disquisitiones anatomicae de audit et olfactu*. Ed. Ticini et Mediolani, 1789.

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