

## HISTORY CORNER

# The discovery of stapes

## La scoperta della staffa

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## SUMMARY

Giovanni Filippo Ingrassia revisited and redefined some of Galeno’s reports, and was recognized as one of the leading Italian Physicians of the 16<sup>th</sup> century. Ingrassia principally studied the skull, and gave very important contributions to otorhinolaryngology, including the discovery of the stapes. He also isolated the inferior nasal concha from the maxillary bone, described the frontal sinus, the pterygopalatine fossa and several foramina of the skull. Ingrassia firstly attributed a sensorial function to the middle ear bones, which he called *ffifth particular function*. He also added some details to the description of the VIII cranial nerve, which introduces the concept of bone conducting sound. The most important discovery in Ingrassia’s study about the hearing organ was the first description of the third bone of the ossicular chain that he called “stapes”. Ingrassia should thus be reconsidered under a new light for his important discovery and for his intuitions about the stapes and its role in hearing. It is appropriate for a Sicilian physician to be placed at his rightful place side-by-side with Eustachio and Valsalva in the history of otology.

KEY WORDS: History • Otology • Stapes • Hearing • Ingrassia • Ear

## RIASSUNTO

*Giovanni Filippo Ingrassia riconsiderò e ridefinì alcune descrizioni di Galeno e fu riconosciuto come uno dei principali Medici Italiani del XVI secolo. Ingrassia studiò principalmente il cranio e diede un contributo importante per la moderna otorinolaringoiatria, come la scoperta della staffa. Egli descrisse l’osso del turbinato inferiore isolandolo dall’osso mascellare; descrisse inoltre: il seno frontale, la fossa pterigopalatina e diversi tra i fori cranici. Per primo, Ingrassia attribuì una funzione sensoriale agli ossicini dell’orecchio medio, funzione che chiamò quinta funzione particolare. Aggiunse anche alcuni dettagli alla descrizione dell’VIII nervo cranico, introducendo il concetto di conduzione ossea del suono. La scoperta più importante di Ingrassia, durante lo studio della funzione uditiva, è stata la prima descrizione del terzo ossicino della catena che chiamò “staffa”. Ingrassia deve quindi essere riconsiderato sotto una nuova ottica per le sue importanti scoperte e per la sua intuizione sulla staffa e sul suo ruolo nella funzione uditiva. Sarebbe appropriato per il medico Siciliano essere posto accanto ad Eustachio e Valsalva nella storia dell’otologia.*

PAROLE CHIAVE: Storia • Otologia • Staffa • Udito • Ingrassia • Orecchio

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Around the year 200 AD, the island of Sicily (Italy) saw the physician-philosopher Galeno landing on its coasts nearing the end of his life (in Misilmeri, Palermo, Italy), as Ibn Jubayr tells us in his chronicles<sup>1</sup>. About 13 centuries later, the Mediterranean island gave birth to another, although less noted, great physician-philosopher of early medical history, Giovanni Filippo Ingrassia, who revisited and redefined some of Galeno’s reports. He was born in Regalbuto (province of Enna, Sicily) in 1510 and died in Palermo in 1580 (Fig. 1)<sup>2</sup>. He was recognized as one of the leading Italian Physicians of the 16<sup>th</sup> century<sup>3</sup>.

Ingrassia’s work was done under a new scientific approach of studying anatomy introduced by Vesalius, utilizing human cadaver autopsy as the main method to teach anatomy. Ingrassia acquired this method during his frequent

visits to Vesalius’ lessons at Padua University. At that time, study of medicine was a mix of science and philosophy, and the latter allowed theoretical speculation about the evidence in medical practice; in today’s world this is represented by the – more scientific – statistical analysis of data. Most of the anatomical descriptions and discoveries of Ingrassia were reported in his book titled “In Galeni librum de ossibus doctissima et expertissima commentaria”<sup>2</sup> (Fig. 2). This ancient anatomic book was a commentary to “De Ossibus” of Galeno. In his work, Ingrassia wrote 24 chapters about human bones introducing his discoveries, intuitions and criticism regarding some incorrect ideas of Galeno and Vesalius (his teacher). This great collection of his work was published posthumously by his nephew Nicola Ingrassia (also a physician).

Ingrassia studied principally the skull<sup>4</sup> and provided some very important contributions for future otorhinolaryngological disciplines. Galeno identified the upper and lower jaws, and the parietal, temporal, frontal and occipital bones. Several centuries later, Vesalius and Realdo Colombo illustrated two additional segments, namely the ethmoid and sphenoid bones. Contemporary to these descriptions, Ingrassia added several details about these two bones: he described the lesser wings of the sphenoid, the crista galli, the cribriform plate, and the perpendicular plate of ethmoid, as well as describing for the first time sutures of the skull<sup>5-7</sup>. Furthermore, Ingrassia isolated the inferior nasal concha from the maxillary bone, described the frontal sinus, the pterygopalatine fossa and several foramina of the skull<sup>7</sup>. Additionally, he hypothesized that the paranasal sinuses may exert a function in phonation (theory that is not widely

accepted today), rather than “attracting air for healthful vital spirits, as well as in purging blood flowing to the brain”, as Realdo Colombo had previously asserted<sup>7</sup>.

One of the most important intuitions of Ingrassia was the attribution of a sensorial function to the middle ear bones, which he called *fifth particular function* (“quintus igitur usus est trium ossicularum auditus”)<sup>8</sup>. The old scientific method implemented by Ingrassia starts from the anatomy (description of the structures), passing through pathological anatomy and then making a hypothesis about function<sup>9</sup>. Adopting this approach to medicine, he was able to hypothesize the “fifth function” of the ossicular chain, an early intuition of a sensory function confirmed later.

Ingrassia added some details to the description of the VIII cranial nerve (V in the ancient Galeno’s classification) and in this description introduces the concept of bone conducting sound: “if one closes the external ear canal [...] keeping between the teeth or accosting near the mouth the hand of a guitar [...] he can hear sound, if after this he turns away the instrument no sound is then perceived”<sup>2</sup>. Although the intuition of the Sicilian physician was brilliant, the mechanism that he thought of was different from the physiologic actual model, as he believed that the VIII nerve directly conducted the sound from the skull bones. However, Ingrassia described in detail the cochlea, the semicircular canals and the stapedius muscle. Also, the first description of the auditory tube, in the opinion of some authors, should be attributed to Ingrassia rather than Eustachio<sup>3,7</sup>, but the evidence for this is not clear. The most important discovery in Ingrassia’s study about the hearing organ was the first description of the *third bone of the ossicular chain* that he called “stapes”. In this regard, we would like the Sicilian physician to narrate his own story of the discovery. For this, we provide an excerpt from the original version of his scripts: “I want to tell now how this little bone was discovered by me for the first time. In the year of world redemption 1546, while I was teaching in Naples the theory and



Fig. 1. Portrait of Ingrassia, as reproduced in the book *In Galeni librum de ossibus doctissima et expertissima commentaria* (see also the shadow in transparency of Fig. 2) (courtesy of Prof. F. Cappello).

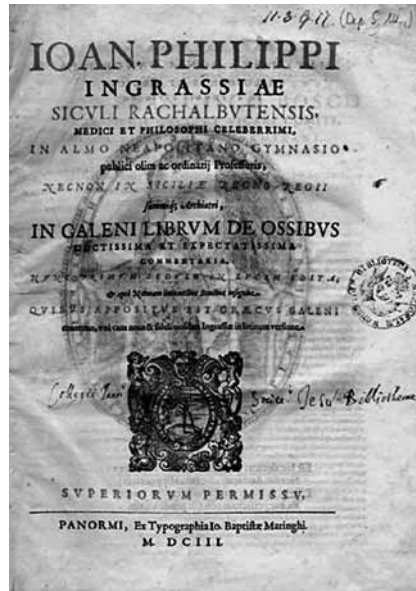


Fig. 2. Inside cover of the book *In Galeni librum de ossibus doctissima et expertissima commentaria*, published 13 years after Ingrassia’s death (courtesy of Prof. F. Cappello).

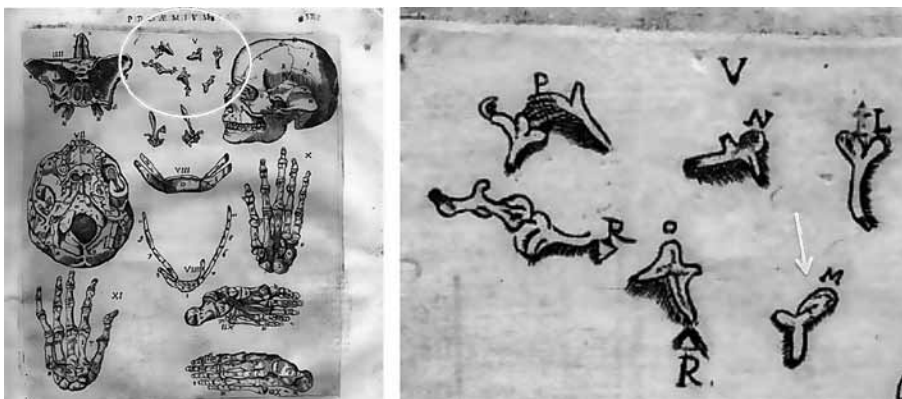


Fig. 3. Photograph from the book *In Galeni librum de ossibus doctissima et expertissima commentaria*, showing the picture drawn by Ingrassia describing the human bone. Right part of the figure shows the group of ear ossicles (red circle) depicted by Ingrassia, and the stapes is indicated by a red arrow.

practice of medicine and also anatomy, I didn't intend to find, but I discovered (by chance) this third bone: I didn't search for it, because I had no notion or suspicion of it being there. While I was chiselling the ear bones to demonstrate to the students the little internal cavities and the substances contained within them, after I showed the first two little bones, there was, I don't know how, this third little bone I saw on the table. After having considered and observed it with precision, I realised that it did not appear by chance, but by an act of the Nature. [...] I then started to dissect heads of several animals, the cow in particular and started observing one by one the parts of the bone in which resides the hearing. In the end I found this third bone remaining and linked to one of the two sticks of the incus, namely the longer and thinner one. Immediately I returned to human head dissection, straight almost with the eyes closed I found that ossicle, which, due to its analogy, I called it "stapede" (stapes): effectively it is more similar to the stapes than the other two to a malleus or to an incus..."<sup>2</sup> (Fig. 3).

Ingrassia wrote in the same pages the reason behind the name chosen. He compared the third ossicle to a stirrup made of wood used in Sicily to ride horses and donkey at that time. This was different in shape from the classical iron stirrups used in other parts of Italy in order to comply with a law forbidding the use of metal stirrups in the Sicilian island. Indeed, the shape of the third ossicle is closest to the Sicilian stapes than to other kinds known elsewhere<sup>10</sup>.

This important discovery in the anatomy of middle ear had a long and hard polemic dispute in its attempt to attribute the merit among several anatomists of that time. The first person to attempt a claim on the discovery was Realdo Colombo, successor of Vesalius at the anatomy school of Padua, followed by Eustachio and the two Spanish physicians Collado and Ximeno. However, Vesalius himself eventually re-established the truth by attributing the first description of the stapes to Ingrassia<sup>11</sup>. Subsequently, Fal-

loppio also acknowledged the Sicilian anatomist for this important discovery<sup>12</sup>.

In our opinion, Ingrassia should be reconsidered in a new light for his important discovery and for his intuitions about the stapes and its role in hearing. It would be appropriate for the Sicilian physician to be placed at his rightful place side-by-side with Eustachio and Valsalva in the history of otology.

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