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De Auditu: De Dissectione et Historia Auris

Lawrence University

De Auditu: De Dissectione et Historia Auris

Hieronymus Fabricius ab Aquapendente.

Venice, 1600.

Translated with a Commentary by

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Dedicated to my sister

And in memory of Professor J. Bruce Brackenridge of Lawrence University,
whose contributions to the field of the history of science will not be forgotten.

My sincere thanks go to…

Professor Daniel J. Taylor, who served as an advisor and mentor not only during this project but also throughout my time at Lawrence.

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Hieronymus Fabricius ab Aquapendente (1537 – 1619) was an Italian surgeon and anatomist who practiced and taught at Padua during a time when anatomists were redefining their field. Student of Fallopius and mentor of William Harvey, Fabricius was a prolific author, writing the first texts on embryology and the famous text *De Venarum Ostiolis*, '*On the Valves of the Veins*' (1603), which would influence Harvey's own work on circulation. Medical students and practitioners read and revered Fabricius' work for generations, and several posthumous compilations of his work were prepared. Scholars have translated many of his works into several languages, including Italian, German, French, and English, but no English translation exists of his first work, *De Visione, Voce, Auditu*, '*On Vision, Voice, [and] Hearing*' (1600). The following is a translation of and commentary on the first book of *De Auditu: De Dissectione et Historia Auris, 'On the Dissection and History of the Ear.'* This work does not address the later two books (i.e., *On the Action of the Ear* and *On the Functions of the Parts*) of *De Auditu*.

The introduction to and commentary on the text are not intended to be complete analyses of Fabricius' life, his works, or the history of anatomy in the Renaissance. Rather, the introduction is designed to provide the reader with the necessary background to appreciate *De Dissectione et Historia Auris* as a fairly technical anatomical text that is a section of the work that launched Fabricius' *opera*. The commentary highlights the anatomical features mentioned in each chapter and how, if at all, the Renaissance understanding of these features differs from the modern understanding.

This work also includes an emended version of the original Latin text. Emendations to the text provide the reader with a clean and clear text upon which the translation is based.

A Brief Biography of Hieronymus Fabricius ab Aquapendente (1537 – 1619).

Born Girolamo Fabrici, the son of Fabrico Fabrici in 1537 at Aquapendente, Hieronymus Fabricius ab Aquapendente began studying Greek, Latin, and philosophy at the University of Padua as a teenager. By his twentieth birthday he was studying medicine and had already become the favored pupil of Gabriel Fallopius (1523 – 62). At Fallopius' death the twenty-five year-old Fabricius became a professor of surgery and succeeded his mentor. Fallopius had succeeded the famed anatomist Andreas Vesalius, and so Fabricius continued a legacy of anatomists at Padua during the Renaissance.

In the introduction to *The Embryological Treatises of Hieronymus Fabricius* (1942) Howard Adelmann describes Fabricius as a renowned and popular teacher who did everything he could to avoid teaching. Fabricius' dedication to academia is hardly questionable, as he devoted his life to the university and built for his students the first theater for dissections and anatomical demonstrations. Nonetheless, Adelmann describes a scholar who preferred his research to the teaching of medical students. Students often noticed – and even lamented – his inclination towards anatomical research rather than clinical training of students, but they still filled his theater and demanded that he lecture every semester.

For almost fifty years Fabricius taught anatomy and practiced surgery at Padua, and in 1600 he was recognized by the Venetian Senate and made Professor Supraordinarius. A member of an aristocratic family, Fabricius treated the aristocracy of Italy and, indeed, Europe, including the Grand Duke of Florence, the son of Ferdinand I and Christina di Lorena, and the King of Poland (Westfall, The Galileo Project On-line, 2002). In 1607 the Republic of Venice made him a Knight of St. Mark for his medical services to the city (Walsh, Catholic Encyclopedia On-line, 2003). When he began writing in the latter half of his career, Fabricius remembered his patrons by dedicating several of his works to them. He dedicated the three parts of his first work, *De Visione, Voce, Auditu* (1600) to the three influential Venetian Senators who ensured his appointment as Professor Supraordinarius at Padua: Jacobus Foscarenus (*De Visione*);

Leonardus Donatus (*De Voce*); and Johannes Delfinus (*De Auditu*). He dedicated *De Locutione* (1601) to the Polish magnate Thoms Zamoyski, *De Venarum Ostiolis* (1603) to the entire German nation, and *Operationes Chirurgicae* (1619) to the King of Poland (Westfall, The Galileo Project On-line, 2002).

After spending the first two thirds (ca. 1560 – 1600) of his career teaching and practicing medicine, Fabricius spent the final third (ca. 1600 – 1619) writing up his research. In his first work *De Visione, Voce, Auditu* (1600) he discussed the anatomy and physiology of vision, voice, and hearing. In the same year he wrote his and perhaps *the* first major work in the Renaissance on embryology and developmental biology: *De Formato Foetu*, '*On the Formed Fetus*' (1600). In the following three years Fabricius pursued the subject of speech in *De Locutione et Eius Instrumentis*, '*On Speech and its Instruments*' (1601), and *De Brutorum Loquela*, '*On the Speech of Animals*' (1603). Shortly thereafter Fabricius became the first anatomist to describe the valves in veins in *De Venarum Ostiolis*, '*On the Valves of the Veins*' (1603).[1] Fabricius wrote not only on specific subjects; in *Tractatus Anatomicus Triplex*, '*Three-fold Anatomical Discussion*' (1614), he wrote a more general compilation of anatomical subjects, and in *Operationes Chirurgicae*, '*Operations of a Surgeon*' (1619), he wrote on a variety of surgical techniques.

While still writing, Fabricius died at his villa, La Montagnola, near Padua on May 21, 1619, where a commemorative statue still stands (Westfall, The Galileo Project On-line, 2002). He left behind several incomplete texts, including *De Formatione Ovi et Pulli, 'On the Formation of the Chick and the Egg,'* and the text that he was preparing as a capstone to his life's work: *Totius Animalis Fabricae Theatrum, 'An Overview of the Entire Animal Fabric.'* Students of medicine read the works of Fabricius for years to come, and two compilations of his works were published posthumously: *L'Opere Chirugiche Del Signor Girolamo Fabritio*, '*The Surgical Work of Mr. Girolamo Fabrici*' (1678), and *Opera Omnia Anatomica & Physiologica*, '*All the Anatomical and Physiological Works*' (1687).

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[1] Fabricius' most famous pupil, William Harvey, relied heavily upon *De Venarum Ostiolis* in his own work, *Exercitatio Anatomica De Motu Cordis et Sanguinis in Animalibus*, '*An Anatomical Exercise on the Motion of the Heart and Blood in Animals*,' (1628), wherein he first demonstrated the flow of blood through the body.

The Philosophy of Fabricius and Renaissance Anatomy

Fabricius studied, taught, and practiced medicine at the height of the Italian Renaissance, a time when scientists, artists, architects, poets, and playwrights revived and examined classical traditions in a new light. As art and literature changed, so did anatomy. Anatomists in the Renaissance valued the classical tenets of anatomy proposed by Aristotle and Galen, but they strived for a more practical and technical study of anatomy than classical authors provided. Fabricius exemplifies the Renaissance anatomist by relying heavily upon classical traditions while using human dissections to fill in many of the gaps left by Aristotle, Galen, *et al.*

Andreas Vesalius (1514 – 1564) revived the study of anatomy in the early sixteenth century at Padua. He was the first physician and anatomist in the Renaissance to prepare a highly detailed work on the anatomy of the human body. In a very real sense Vesalius founded the study of anatomy as its own discipline, independent of clinical medicine (Senfelder, Catholic Encyclopedia On-line, 2003). Moreover, he earned a reputation by challenging the works of Galen, claiming that the Roman physician never dissected a human body.[2] Although contemporaries of Vesalius felt he went too far with his criticisms of Galen, Vesalius clearly brought anatomy into the Renaissance by embarking upon a fresh and more systematic investigation of the human body (Senfelder, Catholic Encyclopedia On-line, 2003). At Vesalius' death Gabriel Fallopius continued his mentor's work, and a generation later Fabricius succeeded Fallopius in what quickly became a Paduan school of medical thought.

In his writings Fabricius continues the Paduan revitalization of anatomy, but with less criticism of Galen and more respect for Aristotle. Fabricius uses a highly systematic, Aristotelian approach in describing anatomical features and their functions (Cunningham 202). Fabricius proposes that the study of an organ must begin with a detailed analysis of each part separately, much to the dismay of some medical students who lamented their professor's lengthy lectures on only one or two parts of the body (Adelmann 8). After

[2] Vesalius accused Galen of making poor speculations about human anatomy based solely upon the dissection of apes.

examining the structures of the parts, Fabricius discusses the actions and functions of the parts, first individually and then in relation to each other in the body. Only then, he argues, can one appreciate the importance and discover the *notitia organorum tota*, 'the entire knowledge of the organs' (Cunningham 202). The modern anatomist employs this interdisciplinary or even holistic approach, but at Padua in the sixteenth century, Fabricius' Aristotelian approach is novel.

Cunningham describes Fabricius' work as the 'Aristotle project,' not only because of Fabricius' Aristotelian methodology in discussing anatomy but also because of Fabricius' purposes for examining the anatomy of a variety of animals. Unlike previous Paduan anatomists who consider primarily human anatomy, Fabricius considers the anatomy of a wide range of animals, including humans, sheep, pigs, dogs, rats, snakes, etc. Like Aristotle, Fabricius discusses how the anatomical features of these various animals are similar and different (Cunningham 203). Nonetheless, Cunningham is quick to claim that Fabricius is not a comparative anatomist, whom he defines as one who studies two animals' anatomical features in an attempt to understand the features of one with respect to the other. With this as his tacit definition, Cunningham argues that the term 'comparative anatomy' does not carry the proper philosophical weight to describe Fabricius' and, indeed, Aristotle's work. According to Cunningham, comparison for the purpose of understanding one thing in reference to another is not Fabricius' Aristotelian goal; comparison for the purpose of discovering the true forms of organs is his goal:

> Fabricius just is not interested in 'comparative' findings. He just is not offering accounts of given organs or parts which compare the form, structure, or function of the organs or parts in different creatures; nor is he offering accounts of human organs or parts elucidated by comparison with those of other creatures...What he is in fact offering are accounts of '*the* eye,' of '*the* larynx,' of '*the* ear'... (Cunningham 203).

Although Cunningham does not use the term 'Platonic,' he is clearly suggesting that Fabricius attempts to describe the 'true' or Platonic form of an organ by examining the many representations of the 'true' form found in various animals. Cunningham uses the

term 'Aristotle project' for Fabricius' endeavors to elucidate the forms through examinations of the representations.

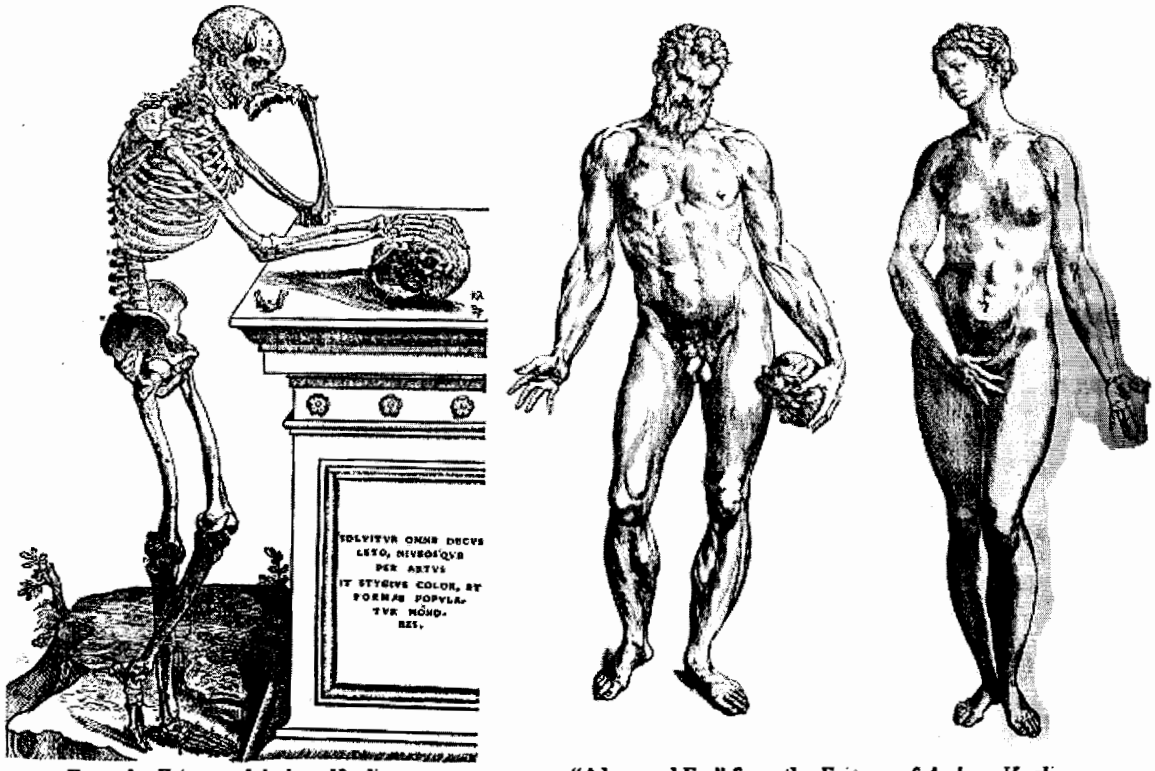
Fabricius clearly uses comparisons between species to elucidate forms in some but not all of his works. Fabricius' *De Formato Foetu* (1600) exemplifies the 'Aristotle project' described by Cunningham, i.e., Fabricius examines the structure and development of the fetus in a variety of animals, including humans, sheep, cows, horses, pigs, dogs, mice, rats, guinea pigs, sharks, and snakes. Fabricius' approach in other works, however, is not always the wide-ranging comparative approach described by Cunningham. In *De Formatione Ovi et Pulli* (1621), for example, Fabricius focuses solely upon the chick and its egg. In the first book of *De Auditu* he seems to be describing solely the human ear and makes no attempt to compare its structure with the structures of animals' ears. He does once mention the auditory meatus of a fetal pig but goes no farther than to say that the Eustachian tube can be found in the pig. His larger figures are all clearly human, and for any smaller ones that may be ambiguous (e.g., the ossicles), he makes no attempt to claim that all animals have similar features. Finally, at the close of *De Dissection et Historia Auris* Fabricius himself admits that his work is not meant to compare animals (which he does, however, consider to be a valuable approach):

> Likewise, I shall abstain from recounting or describing the construction of various animals which traduce the reader to a great admiration of the sense organ, since we shall follow up precisely these and many others in an important work elsewhere.

Therefore, although Fabricius uses a comparative, Aristotelian approach in his later works to elucidate the true forms of organs, Cunningham's description of the 'Aristotle project' does not apply to Fabricius' first work.

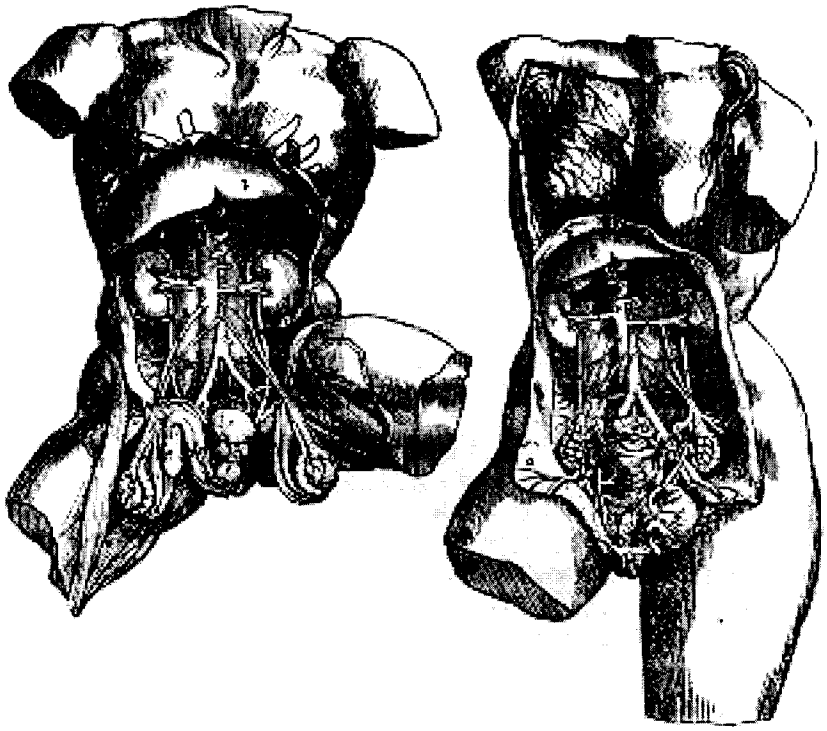
In addition to employing a novel, comparative approach to the subject of anatomy, Fabricius' works are part of a novel approach to the representation of anatomy. Art and anatomy were closely related throughout the Renaissance, and artists like Michelangelo and DaVinci studied anatomy and prepared their own anatomical texts. Artists studied anatomy in order to gain a better understanding of and appreciation for the beauty of the human body. Indeed, in order to paint or to sculpt the perfect body, many

studied the muscular and skeletal structures of the body. Likewise, anatomists were artists, i.e., in order to portray the structure of the body accurately, many anatomists turned to art. In Vesalius' famous portraits of the skeleton, the human body seems very much alive, striking a pose in a field while its skin, muscles, and organs are dissected. Vesalius' works also include some less artistic and more technical figures, and some scholars point to his figures as the beginning of more detailed scientific drawing (Loechel 7). Vesalius may begin to abandon artistic flair (e.g., a complete skull with facial expressions or a countryside background for his cadavers) for technical accuracy in some of his figures, but Fabricius uses only highly technical and inanimate figures. Throughout *De Visione, Voce, Auditu* (1600), *De Formato Foetu* (1600), *De Formatione Ovi et Pulli* (1621), and all the works in *Opera Omnia Anatomica & Physiologica* (1687) Fabricius uses figures barren of the animation, flourishing backgrounds, or artistic expression found in earlier authors' works. One obvious explanation is that Fabricius' subjects (e.g., the inner ear, the larynx, the muscles of the eye, the developing fetus, or the valves in the veins) require such detail that any background or other images would clutter the figure and distract the reader. A more philosophical explanation is that Fabricius' goal is to describe with words and images the 'true' form of an organ or structure, and therefore extraneous images would be unnecessary and inappropriate. In either – or both – cases Fabricius designs his figures contrary to previous traditions at Padua, but his figures serve as a precedent for the style that many later anatomists would follow.



From the *Epitome of Andreas Vesalius.* "Adam and Eve" from the *Epitome of Andreas Vesalius.*

Figure 1. The skeleton appears on a landscape, striking a clearly animated pose, although it is labeled as an anatomical figure. Standing in *contrapposto*, 'Adam and Eve' are unlabeled and are not necessarily meant to exemplify specific anatomical features. Instead, they seem to represent the classical ideal of the human forms.



Figures 63 and 64 from the *Tabulae Sex* of Andreas Vesalius.

Figure 2. These two figures depict the male and female urogenital systems. The bodies, however, more resemble statues than anatomical figures. The limbs resemble broken classical statues rather than amputated or dissected arms and legs.

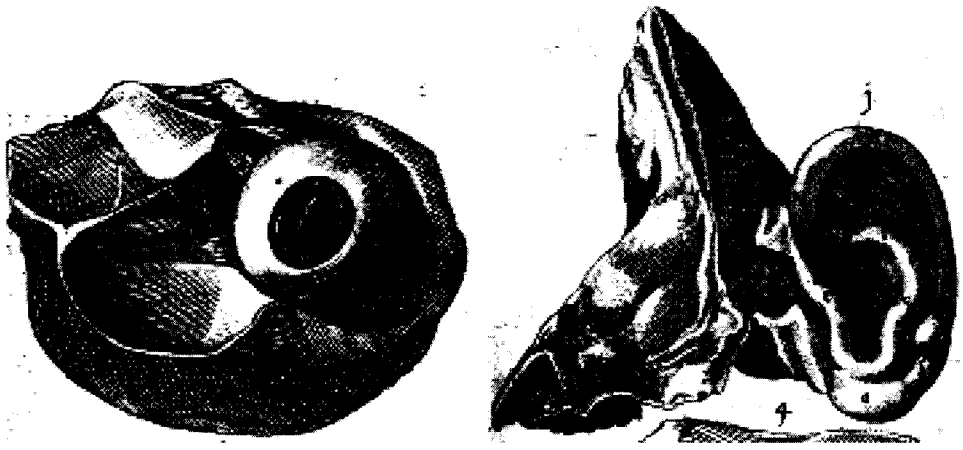


Figure 3. Fabricius' depictions of the eye and ear from *De Visione, Voce, Auditu* (1600). His figures depict structures separated from the body with little, if any, of the artistic flair found in Vesalius' works.

The Significance of De Auditu

Contemporaries of Fabricius and later anatomists refer to *De Visione, Voce, Auditu* (1600) as a seminal text on the anatomy and physiology of vision, voice, and hearing, but no one has translated and analyzed the entire work that began Fabricius' publishing career. Furthermore, the lack of scholarship devoted to this text is surprising since in the century that preceded its publication anatomists debated the supremacy of the senses, especially vision and hearing (See Appendix 1: Sound and Hearing in the Renaissance). It seems then that Fabricius chose contemporary and controversial issues as the subjects of his first treatise. Therefore, a complete translation of *De Visione, Voce, Auditu* or even of solely *De Auditu* will most likely provide new evidence in the sixteenth century debate regarding the senses.

Already in book one of *De Auditu* Fabricius establishes the precedent for the format in which all of his following treatises consider their subjects: a discussion of the dissection and *historia* of the organ; a discussion of the action of the organ; and finally a discussion of the function of the organ. This systematic method, wherein the parts are first considered independently and then interdependently, exemplifies Fabricius' Aristotelian approach. Fabricius' devotion to Aristotle and Galen is clearly evident throughout the first book of *De Auditu*. He repeatedly cites the work of both classical authors and writes: *cum Aristoteli tum Galeni gloriae faveam, simul desiderio flagrem Galeno & Aristoteli nihil occultum extitisse*, 'I favor the fame of both Aristotle and Galen and, likewise, burn with the desire that nothing was concealed to Galen or Aristotle.' Furthermore, throughout the text Fabricius deliberately mentions how he is using a systematic approach to the discussion and dissection of the ear. Although he does not equate his approach with Aristotle's, he certainly implies that the Greek philosopher would approve of his systematic technique. Each book in *De Visione, Voce, Auditu* follows this Aristotelian form, and so it seems that Fabricius deliberately set out at the beginning of his writing career to write about anatomical investigation in a very systematic fashion.

Entitled *De Dissectione et Historia Auris*, '*On the Dissection and History of the Ear*,' the first book of *De Auditu* seems to promise the reader an account of the history of the ear. Fabricius does discuss the historical etymologies of several anatomical terms and

frequently cites Aristotle and Galen, but he does not provide the reader with a historical account of the dissection of the ear or of how anatomists' thoughts on the ear changed over time. He all but ignores previous research in the Renaissance on the ear and takes credit for an anatomical feature that had been described forty years prior to his writing.[3] Given that Fabricius does not provide a history in a modern sense, it is useful to translate *historia* as 'description' or 'account' rather than simply 'history' in order to appreciate Fabricius' goals.

Finally, *De Dissectione et Historia Auris* provides the modern reader with insight into the relationships between anatomists in the sixteenth century. Throughout his work Fabricius cites the two Paduan physicians who preceded him (i.e., Vesalius and Fallopius), but he never once mentions the Roman anatomist Bartholomaeus Eustachius, who was a contemporary of Fallopius. Indeed, Fabricius not only credits but also praises his fellow Paduans while completely ignoring Eustachius. Furthermore, Fabricius takes credit for what is clearly a discovery of Eustachius' and does not credit Eustachius for the Roman anatomist's description of the tube that would eventually bear his name. Although Renaissance scholarship does not use the strict modern rules of citation, Fabricius' rejection of Eustachius suggests that the relationship between Eustachius and Fallopius was so competitive that, as Fallopius' student, Fabricius feels compelled to shun Eustachius.

Grammatical and Syntactic Considerations of De Auditu

Examining the original text of *De Auditu*, the reader will encounter a plethora of inconsistencies in punctuation, capitalization, spelling, and even grammar. Although the modern reader would consider the inconsistencies to be errata in a modern text, the modern reader must realize that in the early seventeenth century many such inconsistencies were common and accepted. Nonetheless, it may be helpful to divide the inconsistencies into two categories: those that were commonplace in the seventeenth century and do not detract from the content of the work, and those regarding grammar that significantly change the meaning of words and phrases.

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[3] See the commentary.

The first category of inconsistencies includes those that occur in the punctuation, capitalization, and spelling of *De Auditu.* Throughout the Synopsis and main text, Fabricius or his printers capitalize the same word or words in the same case and even in the same sentence differently, including *tympanum*, *auditorius*, and *auricula*, to name but a few. They use two different but equally recognized spellings of *tragus* (or *tragos*) throughout the text; they are inconsistent with their usage of the *e* caudata abbreviation for the *ae* diphthong; they have several typesetting errors; and they use the script *f* for 's' without any consistency. The inconsistent punctuation of the text renders it almost impossible to decipher in many cases, e.g., colons are often best read as periods; semicolons as colons, commas, or periods; commas as semicolons, etc. Although the modern reader has considerable difficulty with the punctuation, writers in the early seventeenth century had few systematic rules of punctuation, and so Fabricius' lack of consistent punctuation was the norm.[4]

Fabricius' rather questionable usage of Greek also causes several inconsistencies that, although frustrating to the modern reader, do not detract from the content of *De Auditu.* Throughout *De Auditu* and other works by Fabricius, printers wrote in the Greek by hand, and so they may share as much or more blame for inaccuracies. Accents on Greek characters are haphazard at best, and iota subscripts are nowhere to be found – even in the case where Fabricius deliberately declines the Greek term λοβός as a dative (i.e., λόβῳ) so that it fits into the Latin grammar of the sentence. Throughout the Synopsis and the index of the figures in *De Auditu*, Fabricius or his printers use terminal sigmas, but in the main text they use no terminal sigmas. These inconsistencies may aggravate the modern reader but do not detract from Fabricius' content.

Although many of the inconsistencies that the modern reader would perceive as errata do not affect Fabricius' content, Fabricius or his printers make several mistakes in the Latin grammar that do significantly affect the meaning of the text. For the most part, these include improper endings on nouns and relative pronouns that result in improper gender and number agreement and misspellings in both Latin and Greek terms that result

[4] A codification of punctuation occurred in the middle of the seventeenth century, and so it is no surprise that the punctuation in the 1687 printing of *De Auditu* in *Opera Omnia Anatomica & Physiologica* is more consistent than the original printing in 1600.

in non-attested words. For example, Fabricius or his printers misspell the Greek word κυψέλη, 'hollow of the ear,' as the non-attested Greek word ψέλη. If other authors had not used κυψέλη to describe the auricle of the ear, a reader of Fabricius would never know what Fabricius means. Such errata have, as thoroughly as possible, been addressed and corrected in the Emendations to the Original Latin Text.

The comparisons between the 1600 and 1687 versions of *De Auditu* are invaluable means to address and to correct errata. By comparing the original printing of *De Auditu* in 1600 with the version printed in the posthumous compilation *Opera Omnia Anatomica & Physiologica* (1687), one may begin to see what Fabricius envisioned when he wrote *De Auditu*. Although the content and format are almost identical in the two texts, the printer of *Opera Omnia Anatomica & Physiologica* makes changes to the punctuation of the text as well as to the spelling of several words. He also supplies several words that Fabricius or his original printer abbreviate in the original text. Although he does not correct all the grammatical and spelling errors found in the original text, he does make several helpful corrections (see Emendations to the Original Latin Text). Therefore, the 1687 version of *De Auditu* provides a precedent for many of the emendations to the original text.

Style of De Auditu

The modern reader will find the first book of *De Auditu* to be a highly technical anatomical text designed for medical students. The identity of Fabricius' audience is evident throughout, as he frequently addresses the reader with instructions regarding dissection techniques. In comparison with other contemporary texts, the first book of *De Auditu* stands out as a fairly modern attempt at an anatomical text. For example, Bartholomaeus Eustachius describes the ear in a rather informal style in *Epistola De Auditus Organis, 'A Letter on the Organs of Hearing'* (1562), which he writes as a letter to a friend. Helkiah Crooke, although somewhat more professional in *A Description of the Body of Man* (1616), does not provide the specific, textbook details of dissection that Fabricius does. Fabricius' technical style in book one is probably due to his Aristotelian examination of the ear, i.e., first considering the individual parts, then their relationships to each other, and finally their functions. That is, unlike Eustachius and Crooke who

examine the parts and discuss their functions simultaneously, Fabricius is able to provide a much more technical description of the parts in book one without having to incorporate a discussion of their functions. Indeed, it seems that through his descriptions and representations of anatomy, Fabricius is introducing a more technical and – from a modern perspective – a more scientific approach to anatomy than his predecessors used.

Finally, the modern reader ought not approach Fabricius' *De Auditu: De Dissectione et Historia Auris* expecting to learn a great deal about the anatomy of the ear. Fabricius' descriptions are fairly accurate, but the modern reader will do best to read a modern anatomy text for an accurate description of the ear. Although *De Auditu: De Dissectione et Historia Auris* provided the Renaissance medical student with a description of the anatomy of the ear that was accurate for its time, it provides the modern reader with insights into the history of paradigms in anatomy and how they were changing at Padua in the Renaissance.

SYNOPSIS OF THE BOOK *ON HEARING*, OR *ON THE EAR, THE ORGAN OF HEARING*

The Ten Chapters of the First Part:
On the Dissection and History of the Ear.

Proem	Contains an outline of the book.
Chapter I.	On the Auricle.
II.	On the Petrous bone, which is called the *λῐθοειδές*.
III.	On the Meatus of the Ear, which is called the *πὸρος ακουστικὸς* in Greek.
IV.	On the Membrane called the Tympanum.
V.	On the Three Ossicles: The Malleus, Incus, and Stapes.
VI.	On the Muscle for moving the Malleus to the Incus.
VII.	On the Cavities of the Petrous bone, and first about the first [sc., cavity], which is called the Conch.
IIX.	On the Congenital or, as they call it, Smooth air.
IX.	On the Duct or Meatus or Channel that extends from the first cavity or Conch to the edge of the palate or to the throat.
X.	On the Auditory Nerve.

Index.

This index is alphabetized in accordance with the English translation, not the Latin original, and therefore the order of the entries does not always correspond. Likewise, the page numbers refer to the English translation, not the Latin original. For more information, see the commentary (p. 37).

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HIERONYMUS FABRICIUS AB AQUAPENDENTE'S

BOOK

ON THE EAR

THE ORGAN OF HEARING.

ON DISSECTION AND HISTORY
THE FIRST PART.

An Outline of the Book.

In explaining the construction of the ears, I seem to be undertaking the study of an organ that because of its elegance and artistry is especially pleasing to see. But it is quite difficult to explain and to demonstrate; difficult (I say) since many things that are contained in this sense organ were completely unknown to those ancient authorities; yet those things that were known have been explained rather carelessly and uninterestingly. Although later authors used greater diligence, they nonetheless were either silent about or accounted insufficiently for the parts that they themselves discovered. Finally, some, moving away from the fundamentals of philosophy, explained things less correctly. We must therefore strive the more to render all things clear and intelligible in their allotted portion, to take up the starting point from the exterior parts as they first come to our attention, and from there gradually to arrive at those [sc., parts] that are interior and closely follow the previous ones. Thus, the first part will be the Auricle, and the second the *πὸρος ακουστικὸς*, i.e., the auditory meatus. The third part will be the membrane called the Tympanum, and the fourth the three ossicles: the Malleus, the Incus, and the Stapes. The fifth part will be the muscle, and the sixth the caves and all the small cavities: the Conch, Cochlea, labyrinth, and the hidden duct. The seventh part will be the congenital or (as they say) the smooth air. The eighth part will be the auditory nerve and the duct or passageway of the nerve, and the ninth will be that path – whether meatus or duct – from the ear to the

palate. The tenth chapter covers and contains nearly all these as well as one bone, which is called the λῐθοειδές from its hardness, i.e., the petrous bone.[1]

On the Auricle. *Chapter I.*

The ear then is the part of the head with which we hear, so named from the act of hearing voices, for its purpose is to comprehend voices and the differences between them. Thus in Greek they named them ὦτα [i.e., 'ears'] from the act of admitting sound, which they name ὄπα [i.e., 'sound']. For this reason the ears are also thought to have been named *audes*[2] as if from the act of hearing. These [sc., terms] are used for the entire organ of hearing.

On the History of Animals. C. XI.

Melet. Specific chapter.

The exterior part of the ear * is called the Auricle by Aristotle.* Its broader, superior cartilaginous part is supposed to be have been unnamed by Aristotle, although an intermediary [sc., scholar] has rather rendered it the Pinna, along with more recent scholars, either because its shape is similar to a *pinna*, which is a type of shell, or because it is on the outer surface of the ear and rises up as do the outer surfaces of walls, called *pinnae* or, colloquially, Merlons, that were used more in antiquity than now. Or, finally, the Pinna is so called from the dirtiness of the ears since πῐρός means filths.[3]

* First Figure

⁎ Figure 1

✣ The lower, fleshy part of the Auricle is called the *fibra* by us [sc., in Latin] but λοβός [i.e., 'lobe'] in Greek from [sc., the verb] λοβεῖν [i.e., 'to mutilate'], because you would say 'to disfigure' or 'to cut off,' since this [sc., part of the ear] is often amputated on account of crimes. Thus, the decorations of the

✣ Figure 1 a.

Melet. Ruffus.

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[1] At the base of the temporal bone in the skull, the Petrous or Petrosal bone encases the inner ear. Very hard and dense, this bone gets its name from the Latin word for rock, '*petrus*.' The Greek term for the Petrous bone, '*λῐθοειδές*,' also has an etymology related to the bone's rock-like properties: *λῐ́θος*, 'stone,' and *εἶδος*, 'form.'

[2] Fabricius proposes an etymological connection between the Latin word for ears, '*aures*,' and the non-attested Latin noun *audes* that resembles the word for hearing, '*auditus*.'

[3] *Πῐρός* is a non-attested Greek word that resembles the Greek word for filth, '*πῐναρός*.' Fabricius either misspells *πῐναρός* or purposefully spells *πῐναρός* as *πῐρός* so that it resembles *πῐνέ*, 'bivalve clam.' Nonetheless, Fabricius translates *πῐρός* as *sordes*, 'filths,' even though the former is singular and the latter plural.

ears, which are on the λόβῳ, i.e., on the pierced Lobe, are called ἀλλοβία by Pollux.[4] * The ἑλίξ, or the Helix – that whole thing which goes around the circumference of the Auricle – is so called because of its circular or twisted nature.

* Figure 1 b.

Ruffus.

* The Ἀνθάλιξ, or the Anthelix, is opposite to that [sc., the Helix] in the middle space behind the Helix, and refers to the parts swelling up near the cavity.

⁑ Figure 1 c.

✣ The cavity itself, the Conch, is called the <κυ>ψέλη because it is concave and shell-like.

✣ Figure 1 d.

* The projection opposite the Conch, near the edge of the temple, is called the Tragus, i.e., the goat,[5] either because this part in some becomes hairy like the little beard of a goat, or because the hairs that occasionally sprout out in it are dense and rigid and so emulate the beard of a goat. Or, lastly, [sc., it is so called] because these hairs – by which this part becomes hairy – are said to be luxuriant like goats.[6]

* Figure 1 d.

Ruffus.

* The part opposite from the rather thick Anthelix is named the Antitragus, for this also is a hairy part and imitates the beard of a goat.

⁑ Figure 1 f.

They call the edge of the Helix, which is somewhat short, the Ἀντιλοβίδα [i.e., 'Antilobe']. I suppose that this is the cavity placed in the Auricle or Pinna above and opposite the λόβῳ, i.e., the Lobe. Now all the listed parts (the one exception being the lobe, which is somewhat fleshy) are made out of skin and cartilage. They are of various shape but refer collectively to the cavities, circles, vortices, and bends. This is the Auricle.

Pollux.

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[4] Fabricius uses λοβός in the dative case (i.e., λόβῳ) so that it fits properly into the Latin grammar of the sentence. That is, if λόβῳ were in Latin (i.e., *fibra*), it would be *fibrae*.

[5] Fabricius transliterates the Greek word τράγος, 'male goat,' into the Latin *tragos*. The Latin word *tragos* (or *tragus*, as it often appears), however, refers to the body odor of a goat, whereas *hircus* refers to a goat itself.

[6] These hairs grow very quickly and randomly, and so Fabricius compares their growth to the wanton or luxuriant nature of goats.

On the Petrous bone, which is called the λἴθοειδές.

Chapter II.

Now let us describe the remaining auditory organ that is composed of bone. The entire organ of hearing appears to be partly cartilaginous and partly bony. The cartilaginous part is the Auricle,* which is so cartilaginous that it is by no means compatible with the nature of bone. * The remaining part is bony and is called petrous because it is so bony that cartilage has no place here. We discussed the cartilaginous part of the organ, and now we must discuss the bony part. First we must speak in general terms about the entire bony part, and then we must differentiate the little parts, which this entire bone contains in itself. Furthermore, it is behind the Auricle and, due to its hardness, is called λἴθοειδές: rocky or stony. In truth, it appears to be harder than the hardest bone whatsoever. The hardness in this bone, moreover, is especially pronounced on the exterior because it is covered by a most hard and dense outer surface, although the entire interior is cavernous and full of cavities, a fact which does not detract from the hardness of the bone since the extremely thin layers forming the small caverns are themselves also very hard. This bone is positioned at the base of the head at the part where nerves proceed from the cerebrum, where, through a foramen carved above and partly behind in the bone, the bone receives a nerve called the auditory. It is a bone tending to have a circular shape, but it is oblong and somewhat resembles a pyramidal shape,✣ whose base faces the Auricle and whose peak faces the cerebrum, and the whole thing protrudes out from within the skull. You will seem to see that the exterior bone is continuous and solid because of its outer surface, but with it [sc., the outer surface] having been removed, however, the entire interior is so cavernous, spongy, and full of cavities that we could indeed marvel at an infinity of little caverns, but we cannot count them in the same way. Therefore, it is the plan to describe now the caves of the bone as a whole and the parts which are contained in them, with the beginning starting from the exterior duct. But before all, it is proper (so that you may see all things exactly) to separate this entire bone from the rest of the skull by means of a saw, which is not

* First Figure

* Figure 1 g.

✣ Figures 6, 7 g.

difficult. If the Auricle has first been amputated to its base, and the entire brain has been extracted from the skull, and all the soft tissue that completely surrounds and covers the bone of the ear [sc., has been removed], you could grasp with your hands only this bone for the purpose of dissecting and use hard dissecting knives struck with a mallet. Thus, looking at the method of dissecting, you now could complete the entire task quickly and easily and make a start, as I said, from the exterior duct.

On the Meatus of the Ear, which is called the πὸρος ακουστικὸς in Greek.

Chapter III.

On the boundary of the Auricle is a small cavern* – one on both sides [sc., of the head] – which is called the *πὸρος ακουστικὸς*, i.e., the meatus pertaining to or designed for hearing through which we hear. This completely bony meatus, however, has been covered by hide-like skin and is an oblong tube that, inserting itself at an angle and having its end at the membrane, goes back inside [sc., the skull]. A knife having been applied and struck on one part, and particularly on the part which is opposite the mastoid process, you will see it [sc., the meatus] easily, provided that you turn it [sc., the one part of the skull] toward the mastoid process.[7] And so you will observe the laid-open membrane.

* Figure 4h.

On the Membrane called the Tympanum.

Chapter IV.

* This membrane is simply called by some the Myrinx and the Myringa by barbarians and by others the Tympanum because it resembles the membrane of a war drum. As a matter of fact, even a bony ring is not lacking to this membrane on its circumference, which extends a circle around the membrane, like the

* Figures 5. 1. 6. 11.

[7] The mastoid (sc., *μαστός* + *εἰδος*, 'breast-like') process. Located at the lateral base of the skull on the temporal bone and immediately posterior to the ear, it has a rounded, breast-like appearance.

circular ring on a drum.* The ring is conspicuous and easily separated in children, [sc., but] in adults it is united with the other bordering bone and ossifies.[8] With the aid of this ring encircling the membrane, this covering is a firm septum dividing and closing off the entire exterior ear and the meatus from the interior.[9] It [sc., the septum] is a complete circle, although not remaining flat in every part; in the middle and center somewhat on the inside it is curved and bulging out beyond the cave, just as if it were resembling a boat-like herb or navel. For this reason its position is slanted, and something like a little nerve or cord or thread seems to extend transversely along its exterior surface.[10] From what part this membrane is produced is not entirely clear to the senses, and therefore some say that its origin is from the *pia mater*,[11] some from a little nerve, and some from the covering of the bordering bone. Nevertheless, although this membrane is different from the others due to the particularity of its composition, it will not be discordant to reason to accredit its origin to a seed. Besides, the covering is very thin, very dense, and very dry, a fact which Hippocrates also expounded on with these words: the skin in the ear next to the hard bone is thin, like the webs of spiders, and of all the skins, it is the most dry.

* Figures 6. 7. 8. 9. 11. 12. 13. k

In the book *De Carnibus*.

This membrane is also similarly mentioned by Aristotle. I am thus more surprised in this matter by Galen, who made absolutely no mention of this membrane. He utterly denied that any covering stands in the auditory meatus because it would have blocked air movement, which is carried along with sound, from entering into the ear. Some, however, contend that this membrane was recognized by Galen because it is not apparent that Galen denied this entirely, but

In the text *De Anima* 2. 8 (3).

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[8] The petrous portion of the temporal bone does not completely fuse with the squamous portion until some time after birth. Until then, the two portions of the temporal bone may be separated to reveal the membrane and the bony ring at the juncture of the two portions (Morris 143).

[9] In Latin *membrana*, 'membrane,' and *tunica*, 'covering,' refer to the same structure, i.e., the tympanic membrane. Fabricius uses two words to describe the same things since one usage (i.e., *membrana*) is in relation to the ring, and the other (i.e., *tunica*) is in relation to the septum.

[10] Fabricius is most likely referring to the *chorda tympani* nerve.

[11] The *pia mater* is the innermost of three protective layers that cover the central nervous system, i.e., the *dura mater*, the arachnoid, and the *pia mater*.

he did not expound on this as he did on the eye. To them I by no means protest because I favor the fame of both Aristotle and Galen and, likewise, burn with the desire that nothing was concealed to Galen or Aristotle. But I cite the passages in Galen so that each person may judge in accordance with his own discretion. The first passage is [sc., in Book] 8, Chapter 6 of *On the Usefulness of the Parts* [sc., *of the Human Body*], and the second is [sc., in Book] 11, Chapter 12 of the same work. The third is [sc., in] Chapter 5 in the book *On the Instrument of the Sense of Smell.* Besides, it is sometimes the case (although it rarely happens) that a certain covering in front of the membrane comes to be thicker than natural and blocks [sc., the meatus], which I discovered twice in children. Mention is made of it by Paulus, who also proposed a way of treating it and removing it, since, while it is present, it causes the auditory meatus and hearing to be deaf; indeed, I reckon that sometimes deaf and consequently mute [sc., people] are often made that way from birth because from an early age this rather thick membrane obstructs the Tympanum on the outside.[12] Finally, anatomists note on the Tympanum a thread or cord that is as thin as possible and affixed to and transversely spread over the Myrinx on the outside.[13] It is thought by some to be an arteriole, by others a nerve, by others a ligament, and by others a tendon. If it is none of these, then it is necessary that it is a unique entity.

Book 3, Chapter 23.

On the Three Ossicles: the Malleus, Incus, and Stapes.

Chapter V.

Behind the membrane, which is in fact a septum separating the exterior from the inner ear, a certain large cavity appears in the interior called the Conch,* about which I have been speaking above. What bodies exist in this first cavity

Malleus.

* Figures 7, 8, 18 l.

[12] Fabricius uses a strange juxtaposition of *nonnumquam*, 'sometimes,' and *saepe*, 'often.' *Saepe* occurs between *a nativitate*, 'from birth,' and *fieri*, 'are made,' and so *saepe* logically modifies *fieri*, i.e., 'are often made that way from birth.' Nonetheless, *nonnumquam*, positioned after *surdos*, 'deaf,' logically modifies *surdos*, i.e., '...sometimes deaf [sc., people]...are often made...'

[13] Again, Fabricius is most likely referring to the *chorda tympani* nerve.

must be seen; there are these three ossicles and a muscle.* From its similarity to a mallet, the first ossicle is called the Malleus, the second the Incus, and the third the Stapes or the Stapeda.[14] At one edge the Malleus is a rather thin and pointed bone, but at the other it swells rather thickly with a rounded head, and for that reason it has been called a femur by some. Nonetheless, it is not perfectly rounded, but at the part where it is joined to the Incus it has an oblong and uneven cavity. Towards its middle, though, it has two small processes: the superior, which receives the insertion of the muscle, and the inferior. And inside, in the middle of its substance where the marrow is contained, it is hollow. This ossicle ✣ adheres to the membrane as tenaciously as possible and causes it to be bent downwards by somehow dragging it by that part in its center. At that part the exterior head of the little hammer actually protrudes out above the membrane.

= Figures 16, 11, 10, 14, 13, 15, 9 m

✣ Figure 11.

* Twice as large as the Malleus, the Incus, which indeed is even called a tooth by some, has at one end two separated slender shanks, as it were, that are usually sharp, and one of them is longer than the other. At the longer vertex the Incus is attached to the Stapes, and at the shorter vertex it rests upon the squamous [sc., portion] of the temporal bone. But at the other end the bone is rather thick like an anvil, although it differs from an anvil of craftsmen because the flatness of an anvil is lacking in this bone. But on the flat spot an uneven cavity is seen, such as commonly appears in the molar teeth. Hence Vesalius must be praised highly, since he compared this bone to a molar tooth having only two roots. The Malleus is connected to this quite uneven cavity and makes a jointed structure designed for motion.

✱ Figures 14, 15, 13, 11 n.

Incus.

* Finally, the Stapes is an ossicle even smaller than the others and having a cavity and oblong foramen in the middle, like the stirrup of a horseman, which is exactly to what it refers. It consists of three sides and angles as does a triangle. Contrary to the nature of other bones, these three ossicles are seen to be in no way

Stapes.

▪ Figures 14, 15, 10, 7, 8, 9, 18 o.

[14] The informal names for the Malleus, Incus, and Stapes are the hammer, anvil, and stirrup, respectively. Their names, as Fabricius points out, come from their shape.

hidden by a periosteum but are exposed. [15] Indeed, even in newborn infants they appear hard and complete, which happens in the same manner in no other bone. Furthermore, they are mutually joined and bound, and the bond is flexible, maintaining itself completely in this manner.* Only the thinner extremity of the Malleus is firmly bound to the inner surface of the membrane. Meanwhile the thicker [sc., extremity] is left as if it were hanging, except for the fact that it rests upon the Incus and is attached to it, sc., as in the manner of a dislocated joint, which is called a *γιγγλυμοειδης*,[16] * in which the bones support and are supported by each other. There is a cavity and head on the Malleus and, reciprocally, on the Incus. And the Malleus is moved above the Incus, and the motion is certainly not complex, but it is perceived by the sense through its companion [sc., the Incus] and the accompanying noise (about which later). The Incus, however, which partly supports the Malleus, contacts no other body. But at its other, shorter extremity or proximal shank it is strengthened by the temporal bone, whereas the longer [sc., extremity] is attached to the sharper part of the Stapes, which can be called a vertex, by a bond of a ligament, and somehow supports the Stapes. The remaining part of the Stapes, however, which can be named the base,[17] rests in a certain oval cavity,[18] as if balanced, just as the remaining ossicles, however they may be joined, sort of balance each other mutually and seem to be suspended. But only the Stapes is attached by a certain very thin ligament that extends transversely from the sides of the bone to its sharper part. Moreover, you will find the three ossicles if first you continue the dissection, as we said above, of the auditory meatus all the way to the Tympanum, then as you proceed inward the Malleus will be revealed, and, with the Tympanum elevated, the Incus and Stapes [sc., will be revealed].

These ossicles are different than others.

*Figures 11 m, l.

* Figures 11. 14.

[15] A *periosteum* is a membrane covering the exterior surface of a bone. In youths this membrane promotes the growth and calcification of new bone.

[16] *Γιγγλυμοειδης* is Greek for 'hinge-like.' It is related to the Greek noun *'ο γιγγλυμός*, 'hinge.'

[17] The modern term is 'base-plate.'

[18] The *foramen vestibuli* or oval window.

On the Muscle for moving the Malleus to the Incus.

Chapter VI.

✣ The small muscle – nay, the smallest of all [sc., muscles] that nonetheless elegantly resembles the form of a muscle – is attached by a small tendon to the superior process of the Malleus, which touches the membrane. Proceeding across at that point, having a fleshy source from the neighboring bone – and the fleshy part becoming thicker in the middle but rendered thinner on the superior and larger process of the Malleus – the muscle is attached to the membrane. Whoever wishes to find the muscle of this sort should begin a dissection of the bone, which is located in the part opposite of the mastoid process, by cutting the entire bone along the length of the auditory meatus. And so now the membrane will first appear to you, and then the head of the Malleus, and finally, if you proceed by cutting somewhat inside, the muscle itself will also emerge. The muscle appears out of the bone existing in the same region and, having become flesh, it arrives obliquely at the Malleus beneath the membrane and is inserted on its process. And in as much as it is a muscle, it necessarily exhibits motion, and it is not able to produce [sc., motion] other than toward the articulation of the Malleus and Incus; therefore it moves the Malleus to the Incus. But if the motion is made from the muscle and through the joint, then it is undoubtedly voluntary. It should not seem strange to anyone that motion in the ears is voluntary. For if we designate that motion as voluntary – which we are able to do when we wish and not able to do when we do not wish, which, in addition, we are able [sc., to do] more frequently or more rarely, more quickly or more slowly according to discretion – then it is very clear that this motion is produced in the ear. For I am able to do or not do it, frequently or rarely, quickly or slowly on purpose. And there is motion with some noise, like when someone extends three cords at a moderate interval, and strikes them with a plectrum, as is accustomed to happen even on strings; or like when someone scratches a table with a fingernail across the grain; or like when someone hears a spark thrown

✣ Figure 17 ✣

Method for finding the muscle for moving the Malleus to the Incus.

Demonstration of the voluntary motion in the ears.

from the logs of a fire; but it is especially felt when we begin to yawn. But at the outset, while this motion is on the way, a certain, rather obscure sound, which seems to be [sc., the sound] of air set in motion and similar to the sound which is made by a stick striking the air, precedes. Besides, this motion has this noteworthy [sc., feature], that it may be in each ear at the same time, and it is not able to happen separately in only one ear. Thus this motion seems to have a certain analogy with the motion of the eyes, i.e., one eye having been moved, the other also is moved. Therefore, this distinctive motion, which I perceive in my ears, is rather arbitrary, and I am otherwise unable either to show or to teach it to anyone because it happens inside the ears and is a slight but nonetheless evident movement. Just as I am not able to be deceived in shaking hands, so I am not deceived in this. I say this especially because there are some who, since they are unable to observe the aforementioned motion in themselves, dare to deny it. But nonetheless, I have found many, always in public theaters, who have examined and acknowledged that. But why this motion is not noticed in themselves will be discussed in the [sc., chapters regarding] functions.

Moreover, in this year 1599, I seem to have found the muscle in the auditory meatus, which is called the *πὸρος ακουστικὸς*.* It is beyond the membrane, small, fleshy, and devoid of a tendon; it is carried directly from the middle of the duct or meatus itself all the way to the membrane on the outside, into almost the center of which – that is, on that part where the Malleus is connected to the membrane on the inside – it is inserted. Together with the Malleus, it drags the membrane on the outside. You will find this new muscle if, in a recently deceased body, you cut into the cortex of the bone of the auditory meatus by hitting a knife with a hammer here or there or on the distinct part, and, with dexterity, you turn the bone of this sort to the sides. For thus the muscle will appear to you, which later I to be sure have not found in all cases, however much I consider that to be necessary. So these are the bodies, which rest beneath the membrane in the first large cavity.

* Figure 17 r.

On the Cavities of the Petrous bone; and first on the first, which is called the Conch.

Chapter VII

Let us now follow through to the cavities carved in the stony bone, taking our beginning from the first [sc., cavity] * which appears immediately beneath the membrane. This is not only the first among the others, but it is also the foremost, because, as we have seen, not only have more parts worthy of remark been positioned in it, but also because it is the greatest of all; and then finally because the seat and sense of hearing is located here, as will be clear below. It is called by some the cave, by others the Conch, by others the basin, and the drum by others, namely because the cavity resembles a complete drum along with a membrane. It is incorrect to name it the Cochlea, as will be clear below. This is indeed the first cavity carved out in the bone,* rounded, and by chance somewhat uneven, even rough, and in approximately the middle, [sc., there is] a protrusion near a hole in another perforated cavity.[19] At this point it is possible to observe that virtually endless little caverns go in every which way from this first cavity. The entire organ of hearing is so crowded with these [sc., little caverns] that it is not possible to understand or to list [sc., them all]. Nonetheless, in this first cavity * some holes are carved and bored inside, one of which is the Oval cavity, on which the Stapes rests, and which for the most part occupies and closes on the port itself. Accordingly Fallopius, in whom in abstruse matters I have the greatest faith, and whom I esteem as a teacher, maintains that it goes into the labyrinth.[20]

* Figures 8, 18, 9, 7 1.

* Figure 19 t.

* Figure 10

The second hole leads to the Cochlea, which itself many years ago, while preparing the organ for display, I by chance cut transversely through along the entire Cochlear duct. I kept the exhibits for a long time and for a fair number of years regularly displayed them to be inspected by my listeners; for how many

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[19] See Emendations to the Original Latin Text.

[20] The labyrinth of the inner ear refers to the Cochlea, vestibule, and semicircular canals.

years did I show them publicly in full theaters, until decay spoiled the cavity itself, which most elegantly resembles the spiral of a snail.

As is clear, the third hole leads into other cavities, which are so innumerable and, in turn, intricate that they are justly called a labyrinth. Indeed, it is possible to admire them; it is not, however, [sc., possible] to number or to render in any order or to define [sc., them] as someone is trying.[21] For all such labor, I think, will have been undertaken in vain. Nay, furthermore, each person easily (if I am not mistaken) believes that they have been constructed without any order and randomly rather than for the sake of some function, although, nonetheless, that divine and infinite wisdom, which it has not been given to man to understand, has devised all these things and has made [sc., them] for the sake of something even to the smallest degree. You will discover, however, all these things to be very true if you should cut the bony organ of that sort indiscriminately in just about any part. You will seem to see that (with one exception being the external surface, which is very hard, continuous, and smooth) the rest of the bone appears hollow, full of holes, perforated, and completely spongy. To the extent that it was possible to be done, we attempted to represent it by means of a diagram and picture because it was not possible to be expressed by language.

On the Congenital or (as they say) the Smooth air.

Chapter VIII.

But if it is clear to sense that the entire organ of hearing, and especially where hearing is located, consists of cavities and is completely hollow, and that all the cavities are formed out of the thinnest and hardest bones like layers, and since all the cavities appear empty, and since nature uniformly abhors a vacuum, then it is necessary to affirm that all the cavities of this sort are filled with air.

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[21] Fabricius is denouncing a fellow anatomist for attempting to define or to categorize the innumerable holes, but it is unclear to whom he is referring. Perhaps some or all of his contemporary readers knew who this anatomist was, but the modern reader is not so enlightened.

And this is that air which is called smooth, enclosed, and congenital by Aristotle and the ancients. Even though it is not permitted to see and to understand it with vision or sense, it is nonetheless expressly permitted to see and to understand it with the most evident demonstration. It is proper to suppose that it fills all locations and that it has been positioned in the ear from an early age as soon as empty spaces in the bone were hollowed out; and thus it was called congenital, enclosed, and smooth. For the purpose of hearing well, it ought to be completely pure, clear, immobile, and quiet in the ear, as will be described in the [sc., section on] functions.

On the Duct or Meatus or Channel that extends from the first cavity or Conch to the edge of the palate or to the throat.

Chapter IX.

In addition to the other mentioned holes, which appear in the Conch, sc., the first cavity, one, which extends from it [sc., the Conch] to the palate, remains to be described in the last place. It is a meatus which you would say is like an aqueduct, and therefore from the first cavity of the bone a hole is formed resembling a round, small canal or rather narrow reed-pen. [22] Proceeding down from here at an angle, it is bored through to the palate or to the sinuses[23] near the back of the throat,[24] and it is encased by cartilage through almost the entire duct of itself. Aristotle is witness that this meatus did not escape the notice of the ancients; in the first book, chapter 11 of *On the History of Animals* he maintained that a channel extends from the ears all the way to the palate of the mouth. He bore witness to the same [sc., channel] in *Problems*, although it is not certain whether it was known to Galen. You will find this duct with no difficulty if you [sc., examine] a fetal pig with a bare and drained skull or if you insert a very thin,

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[22] The otopharyngeal, auditory, or Eustachian tube that connects the middle ear cavity with the nasopharynx.

[23] *Narium amplitudinem* translates literally as the 'amplification of the noses.'

[24] *Radicem gargareonis* translates literally as 'the base of the gargling.' *Gargarizatio, gargarizationis* is Latin for the action of gargling, and γαργαρίζω is Greek for 'to gargle.'

silver-pointed instrument into the auditory meatus. For you will observe a little later that it goes out to the region of the palate or of the throat. In a fresh head, however, you will see the most wide rim and openings of this duct on either side of the palate, where it is ended.

On the Auditory Nerve. *Chapter X.*

The nerve pertaining to hearing is considered to be in the fifth pair [sc., of cranial nerves] by all because where it comes out from the cerebrum and inserts itself into an opening carved in the petrous bone for its purpose. Separated into several branches, it thus spreads out into most of the little caverns of the bone of greater importance, until it comes to the first principle cavity, called the Conch where the ossicles are, and is terminated. I would like this matter to be understood in this way: that it not be denied in any way that some branches of less importance cease in other caverns but, nonetheless, the more prominent ones lead to the more prominent and greater [sc., cavity], as has been said. You will examine all of these with no difficulty if, first with a fresh organ of hearing having been separated from the remaining skull with a saw, you should next strike with a hammer the very tip of a sharp knife through to the opening located where the nerve is and turn the morsel from the remaining bone. And from then on you repeat this, by following the nerve and keeping it unharmed, as many times until one has arrived to the last fibrils of the nerve.[25] Thus (if I am not mistaken) you will best see the extensions of the entire auditory nerve and those cavities that it enters privately, where it ends, or where it starts. At this point I shall readily abstain from the conflicting opinion amongst Anatomists regarding the two-fold auditory nerve, viz., the soft and the hard one: whether, as in the eyes, the soft one leads to the organ of sensation, and the hard one to the muscles of the organ; and

[25] Fabricius uses an awkward juxtaposition of the second person singular verb *repetas*, 'you repeat,' and the impersonal verb *ventum sit*, 'it has been come.' Although both verbs are grammatically correct, a literal English translation is confusing since the number of the first verb does not match that of the second.

so it is in the ear. Likewise, I shall abstain from recounting or describing the construction of various animals which traduce the reader to a great admiration of the sense organ, since we shall follow up precisely these and many others in an important work elsewhere.

An Explanation of the 19 Figures of the Ear.

The First Figure, exhibiting the entire intact Auricle.

a. The inferior part of the Auricle called the λοβός.

b. The circumference of the Auricle called the Helix.

c. The protrusion of the Auricle, which they call the Anthelix.

d. The Conch of the Auricle.

e. The goat or Tragus, viz., an additional projection of the Conch.

f. The Antitragus.

2. Depicts the anterior face of the Auricle without the hide.

3. The posterior face of the Auricle without the hide.

4. h. The auditory meatus carved in the squamous bone.

5. i. The membrane called the Tympanum.

6. g. The oblong bone exhibiting a pyramidal shape.

i. The Tympanum.

k. The bony ring.

7. g. The bone resembling a pyramidal shape.

k. The bony ring.

l. The cavity called the Conch.

o. The Stapes.

8. k. The bony ring.

l. The cavity called the Conch.

o. The Stapes.

9. m. The Malleus.

o. The Stapes.

10. m. The Malleus. n. The Incus. o. The Stapes.

11. i. The Tympanum. m. The Malleus. n. The Incus.

12. k. The bony ring.

13. k. The bony ring.

    m. The Malleus.

    n. The Incus.

14. m. The Malleus. n. The Incus. o. The Stapes.

15. m. The Malleus. n. The Incus. o. The Stapes.

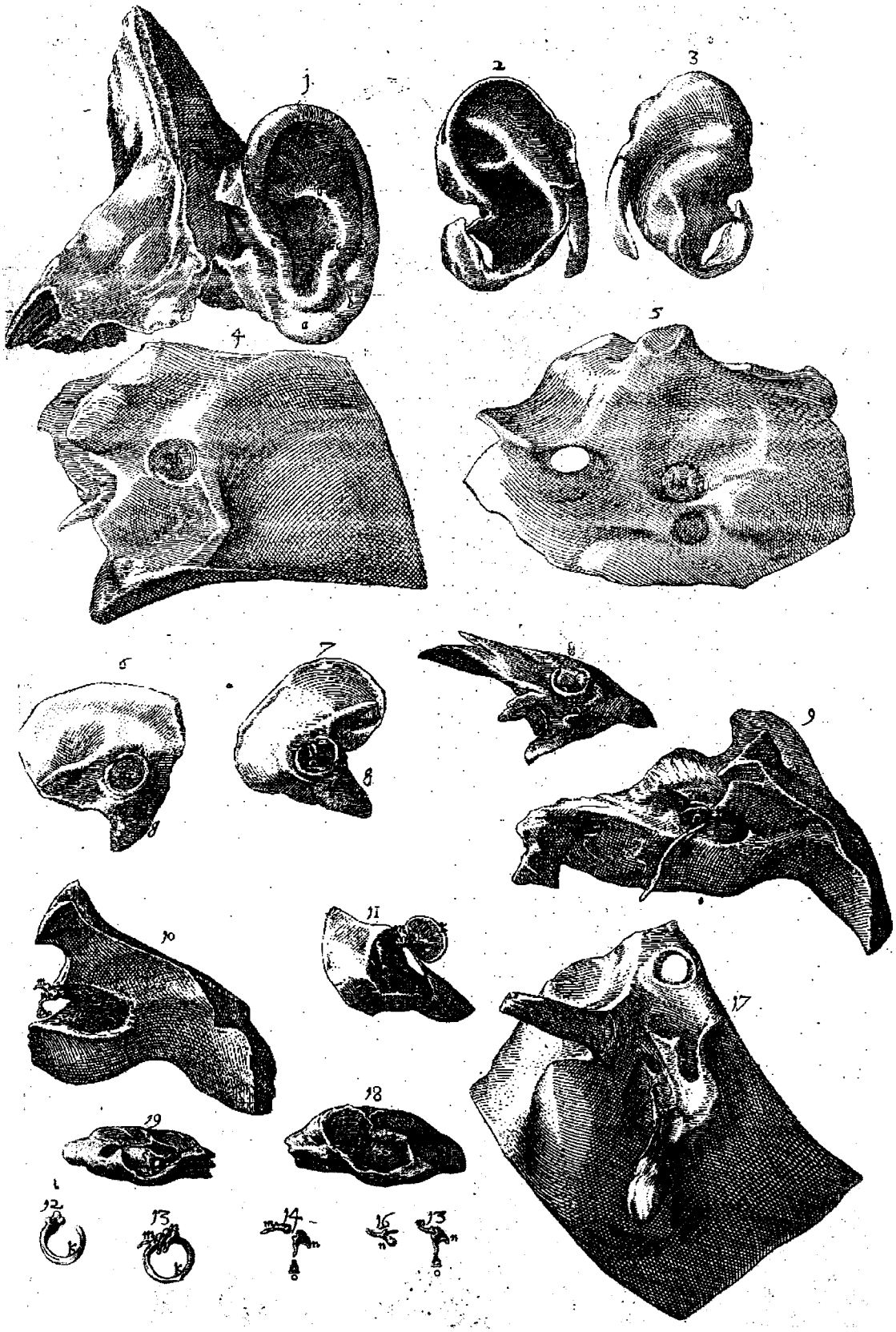
16. m. The Malleus.

17. r. The muscle that was recently discovered.

18. l. The Conch, a cavity.

    o. The Stapes.

19. s. A protrusion in the middle cavity [sc., the promontory].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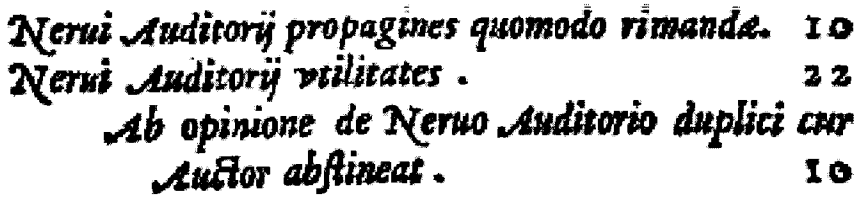
A Commentary on the Contents of *On the Dissection and History of the Ear.*

Index.

At the beginning of each of the three works of *De Visione, Voce, Auditu*, in between the Synopsis of the given book and the Proem, Fabricius provides an index of terms and concepts that the reader will encounter in the coming book. Since this translation concerns only the first part of *De Auditu*, the translated Index has been edited so as to include only those entries that concern the first part, i.e., pages 1 through 11 of the original text.

The index provides several examples of the inconsistencies found throughout *De Auditu*. Fabricius or his printer make several errors in the alphabetization of the entries; they use random capitalization patterns; and they haphazardly use *ae* diphthong abbreviations and scripted 's' characters, i.e., *f*. Because the majority of Latin words have significantly different spellings when translated into English, the English translations of many of the entries begin with different letters, and so English entries should be alphabetized differently than the corresponding Latin ones. Furthermore, since word order is variable in Latin, two entries regarding the same subject may start with different words and, therefore, be alphabetized separately in the English or even in the Latin. As if realizing that these sorts of changes would affect alphabetization in translation, Fabricius uses subheadings in order to group related entries together in the alphabetized list, even though they begin with different letters. For example, under N for the auditory nerve, Fabricius uses the following subheading structure:


Nerui Auditorij propagines quomodo rimandæ. 10
Nerui Auditorij vtilitates. 22
Ab opinione de Neruo Auditorio duplici cur Auctor abſtineat. 10

Since *Ab opinione de* had to precede *Nervo Auditorio*, Fabricius could not begin the entry with *Nervo*, which would have made the entry fit nicely under the heading of N. Fabricius obviously did not want to place this entry regarding the nerve under the heading of A for *Ab* since no reader looking for information on the nerve would look under A. He therefore indented the entry under N and therein neatly solved the problem.

Not surprisingly, Fabricius varies the word order of his sentences throughout *De Auditu* and its index, e.g., he may begin one sentence with an ablative absolute and another with a noun in the genitive case. In Index entries with very similar wording, however, Fabricius employs entirely different word order patterns. The following two entries share the same nominative subject (i.e., Hippocrates), the same verb (i.e., *describat*, 'describes'), the same adverb (i.e., *quomodo*, 'how'), and a similar accusative object (i.e., *tympanum auris*, 'Tympanum of the ear,' or *myringem auris*, 'Myrinx of the ear').

> *Hippocrates quomodo describat Tympanum auris.* 4
> 'How Hippocrates describes the Tympanum of the ear.'
>
> *Myringem auris quomodo describat Hippocrates* 4
> 'How Hippocrates describes the Myrinx of the ear.'

Nonetheless, Fabricius or the printer arranges the words of the two entries in different orders and alphabetizes the two entries differently based upon the first word in each entry. A reader consulting the index for information on Hippocrates or the tympanic membrane could very easily miss information categorized in slightly different entries. Regardless, the two entries are alphabetized separately in the translation.

Fabricius includes two entries in the index referring to the Tragus of the ear: one in which he uses the term *tragus*, and another in which he uses *hircus*. As noted in the translation (cf. 5), the Latin term *hircus* and the Greek term *τράγος* both refer to a goat, whereas the Latin term *tragus* refers to the body-odor of a goat. A semantic extension between the Greek *τράγος* and the Latin *hircus* has occurred, and so *tragus* means 'goat' to Fabricius and his readers. Although Fabricius is clearly referring to the same subject, he alphabetizes the entries separately. In the translation the two entries therefore remain separate and are alphabetized differently.

Finally, in the entry on the Pinna Fabricius refers to *Gaza*, but the reference is unclear. Fabricius does not refer to *Gaza* in the main text when he discusses the Pinna. *Gaza, gazae* translates into English as 'riches' or 'treasure,' but that is obviously not what he intends since the nominative *gaza* is the subject of *interpretetur*, 'interprets.' The Oxford Classical Dictionary provides no other entry for *Gaza* other than for the ancient city of the Philistines. In the main text Fabricius does claim that the superior part of the

Auricle, although unnamed by Aristotle, was termed the Pinna by some intermediary scholar. Perhaps this scholar was *Gaza*, although his identity is uncertain.

Proem.

Fabricius introduces the reader to the subject of the dissection and history of the ear, claiming that it is an elegant organ but difficult to examine. He tells the reader that many anatomists have tried but ultimately failed to provide an adequate description of the anatomy and workings of the ear. Having set the challenge before him, he promises his readers – in what seems to be have been his usually confident style – that he will provide such a description. Furthermore, he tells his readers that he will 'render all things clear and intelligible' in a systematic manner. He therein provides the first evidence that he is not only using an Aristotelian method but is also increasing the level of scientific rigor in the study of anatomy.

He outlines his proposed chapters and their contents, but it is immediately evident that his outline is not the actual arrangement of the chapters as they appear in the Synopsis or the main text.

Chapter	Proposed Outline in the Proem	Actual Outline
I	On the Auricle.	On the Auricle.
II	On the *πὸρος ακουστικὸς*.	On the Petrous Bone...
III	On the Membrane.	On the *πὸρος ακουστικὸς*.
IV	On the Three Ossicles.	On the Membrane...
V	On the Muscle.	On the Three Ossicles...
VI	On the Cavities.	On the Muscle...
VII	On the Congenital, Smooth Air.	On the Cavities...
VIII	On the Auditory Nerve.	On the Congenital Air...
IX	On the Duct [sc., Eustachian tube].	On the Duct ...
X	On the Petrous Bone.	On the Auditory Nerve.

Throughout the main text Fabricius reminds the reader how he is moving in his descriptions from the exterior portions of the ear to the interior ones. The proposed outline in the Proem has this general format, but the chapter on the petrous bone – an outer feature of the ear – seems out of place at the end. Fabricius clearly wrote the Proem prior to writing the main text, and as he wrote the main text, he moved the chapter on the petrous bone to the second position. Indeed, in dissecting the ear, the reader would

encounter the petrous bone immediately after examining the Auricle and removing the skin in an attempt to find the inner features. Likewise, Fabricius moves the chapter on the auditory nerve from before to after the chapter on the auditory tube since the reader would encounter the tube prior to the nerve when dissecting the ear in the manner that Fabricius suggests.

Chapter 1: On the Auricle.

Fabricius begins the main portion of his work with a reference to Aristotle. As Aristotle does in Book 1, Chapter 11 of *De Historia Animalium*, Fabricius begins his work by asserting that the ear is obviously the part of the head with which we hear. Unlike Aristotle, however, Fabricius goes on to describe the various parts of the outer ear and to provide etymologies for their names. He first suggests that the etymology of *auris*, 'ear,' is from *haurire*, 'to gather up,' since the ear is designed to gather up voices. The etymological equivalent in English would be that the ear is so called because it is designed for hearing. Fabricius also proposes an etymological connection between the Latin word for ears, '*aures*,' and the non-attested Latin noun *audes* that resembles the word for hearing, '*auditus*.'

In what seems to be an abbreviation Fabricius also cites a "Melet." and a *capite proprio*, 'specific chapter,' in the margin adjacent to his discussion of the etymologies of the terms for the ear. Fabricius may be referring to Meletius of Tiberiopolis, who was a Renaissance scientist and the author of *De Natura Hominis*, '*On the Nature of Man*' (1552). Fabricius likely would have known of this Meletius, but without a more exact reference, it is unclear as to whom and to what work Fabricius is referring.

When describing the features of the Auricle and why it is called the Pinna, Fabricius explains that the uppermost ridge of the Auricle resembles the defenses atop castle walls, i.e., *pinnae* in Latin, 'merlons' in English. Merlons were the tooth-like protrusions that lined castle walls, and so the structural similarities between them and the Auricle are unclear. Some merlons, however, protruded horizontally out from the plane of the wall, just as the top of the helix protrudes out from the plane of the Auricle.

Fabricius cites Ruffus in the margins throughout Chapter 1. Ruffus (or Rufus) of Ephesus was a physician in the latter half of the second century AD who was noted for

several anatomical treatises. His works were known primarily to the Arabic world until they were printed in the middle of the sixteenth century (Singer 42). Anatomists began reading Ruffus' works around the time when Fabricius was a student, and so it is no surprise that Fabricius would cite them. In Chapter 7 of *De Corporis Humani Partium Appellationibus*, '*On the Names of the Parts of the Human Body*,' (1567) Ruffus gives the names for the various parts of the ear. Fabricius credits Ruffus for only the terms λοβός, Anthelix, and Tragus, but Ruffus also coined or knew the terms πόρος ακουστικὸς, *fibra*, Helix, and Antitragus.

Twice in Chapter 1 Fabricius refers to Pollux. In the first instance he credits Pollux with the term 'αλλοβίαor 'ελλοβία, 'on' or 'to the λοβός,' which refers to the decorations of the ear-lobe, i.e., ear-rings. He also mentions Pollux in the margin adjacent to the description of the Antilobe. Fabricius is most likely referring to Julius Pollux of Naucratis, who was a contemporary of Galen in the second century AD. Pollux wrote *Onomasticon*, '*Dictionary [sc., of Greek terms]*' for the Roman Emperor Commodus, who was a patient of Galen and a friend of Pollux. Pollux dedicates this lexicon of Greek terms, ranging in subjects from science and medicine to arts and crafts and even cooking, to Commodus. Like the works of Ruffus, however, *Onomasticon* was not printed until the sixteenth century, and Fabricius probably read it as a student. Since Fabricius does not specifically cite *Onomasticon*, however, it is difficult to credit Pollux with the terms 'αλλοβία or Antilobe since the index of *Onomasticon* prepared by Bethe (1966) unfortunately does not include either 'αλλοβία or 'αντιλοβίδα.

Chapter 2: On the Petrous bone, which is called the λιθοειδές.

Fabricius describes the 'remaining auditory organ,' i.e., the bony part 'in which cartilage has no place.' He is referring to the petrous bone or petrosal portion of the temporal bone in the skull that encases the middle and inner ear cavities. The bone is especially dense and is so named the *petrous* bone (i.e., from the Latin *petrus*, 'rock') or the λιθοειδές (i.e., from the Greek λίθος, 'stone'). The interior of the bone, however, as Fabricius notes, is filled with small caverns. Aristotle and Galen believed that the porous nature of the bone allows incoming sound to resonate in the bone and, therefore, be

perceived as sound (See Appendix 1). Fabricius does not, of course, discuss the function of the petrous bone in this section of *De Auditu*.

At the close of this chapter Fabricius provides his first description of how to dissect the ear. He refers to techniques that he probably taught his students but did not discuss with lay people. His terminology suggests that he writes *De Auditu* from his lecture notes as a technical text intended for medical students rather than as a philosophical text intended to provide the general public with a better understanding of hearing, i.e., the sort of text previous and contemporary anatomists were writing. This further suggests that Fabricius' approach to anatomy, at least from a modern perspective, is more scientific than those of his predecessors.

Chapter 3: On the Meatus of the Ear, which is called the *πὸρος ακουστικὸς* in Greek.

In the shortest of his chapters Fabricius describes the auditory meatus and how to dissect it. Although Fabricius uses the Greek term for the meatus (i.e., *πὸρος ακουστικὸς*), he does not cite Ruffus of Ephesus as one of the first to use the term, as he does in Chapter 1 for several other terms.

As Fabricius describes it, the auditory meatus extends from the Auricle into the petrous bone and to the tympanic membrane. Fabricius claims that the entire meatus is bony, but the outer third of the meatus is encased solely in cartilage.

Chapter 4: On the Membrane called the Tympanum.

Fabricius describes the tympanic membrane in the auditory meatus, which is responsible for converting the energy of sound waves into mechanical energy in the ossicles. Perhaps ignorant of the membrane's specific function, Fabricius is more concerned with how the membrane resembles a drum and why it is called the Tympanum or Myrinx. The membrane certainly resembles and even functions in a similar fashion as

does the covering of a drum, and at a certain developmental stage a ring clearly encircles the tympanic membrane, like the ring around a drum.[1]

Fabricius mentions the umbo of the tympanic membrane, which is the depression near the center of the membrane caused by the manubrium of the Malleus as it pulls the membrane taut. He first describes the depression as observed from inside the middle ear, i.e., bulging into the cavity from the external auditory meatus. He also uses the term *herbam cymbalitidem*, which seems to refer to an herb with a boat-like depression in a leaf or flower. In this case the term describes the umbo as viewed from the external ear, i.e., it is a small cup or boat-like depression in the membrane. Fabricius also describes the umbo by comparing it to an *umbilicum veneris*, 'navel of Venus' (sc., belly-button) which can also have a cup or boat-like depression.

In two separate sections of this chapter Fabricius mentions a little nerve, cord, or thread which extends transversely across the membrane.[2] Fabricius seems to be referring to the *chorda tympani* nerve, which extends across the upper portion of the tympanic membrane inside the middle ear cavity. Although it would not be surprising for Fabricius to be ignorant of the specific nature of the *chorda tympani*, given its size and the limited magnification available at that time, it is surprising that Fabricius is not more familiar with the *chorda tympani* since his teacher discovered it. Fallopius was the first anatomist to give a full description of the *chorda tympani*, and so Fabricius probably heard of it as a student (Singer 143). The fact that Fabricius does not cite Fallopius demonstrates that the methods of scientific citations and references in the Renaissance were significantly different than modern methods.

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[1] At birth the petrous and squamous portions of the temporal bone have not yet ossified and fused together completely. Until they do, the two portions may be separated to reveal the membrane and a bony ring, which is also known as the tympanic portion of the temporal bone, at the juncture of the petrous and squamous portions (Morris 142).

[2] Fabricius clearly refers to it in the middle of the chapter and seems to refer to it again at the very end. In the latter reference, however, Fabricius describes the structure as being *exterius*, ' on the exterior,' of the membrane. The *chorda tympani* is inside the middle ear, and so it is perplexing why Fabricius uses the adverb *exterius*.

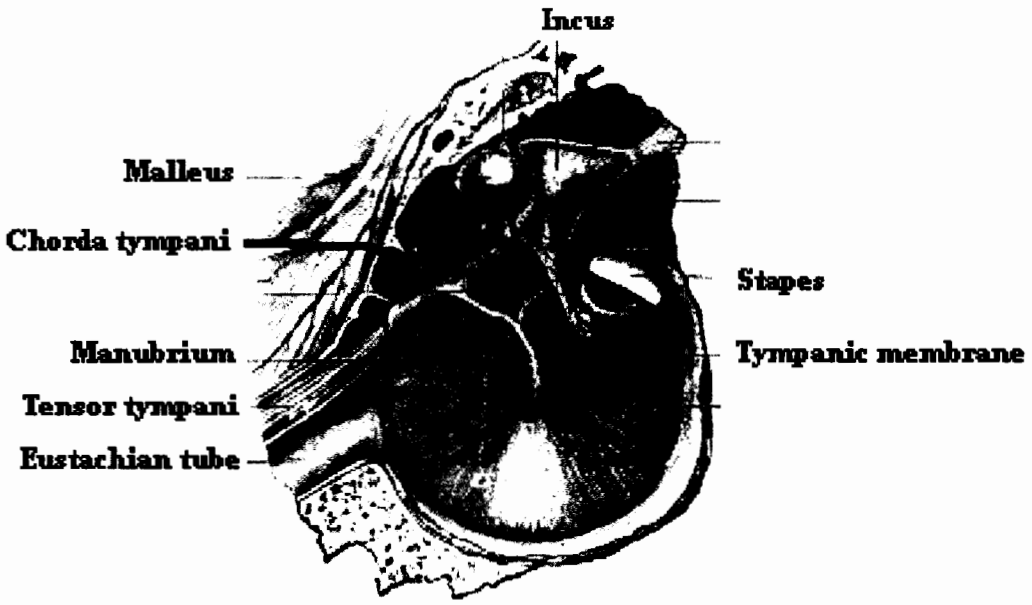

Figure 4. The Ossicles and Tympanic Membrane. The figure adapted from Morris (1230) depicts the view from within the tympanic cavity.

Fabricius reviews the proposed theories for the development of the membrane, but he does not support a particular view. Instead, he claims that attributing the origin of the membrane to a seed (i.e., the membrane could develop on its own as does a seed) would 'not be discordant to reason' since its origin is so obscure. Although its origin was obscure to Fabricius, the tympanic membrane is now known to develop from the ectoderm, mesoderm, and endoderm of the embryo. Specifically, the tissue that becomes the membrane originates near the first pharyngeal pouch in the embryo. In a sense, then, the membrane does develop on its own and independently of a nerve or the *pia mater*, for instance.

Fabricius quotes and translates Hippocrates' words from *De Carnibus, 'On the Fleshes,'*:

> *...τὸ δὲ δέρμα τὸ πρὸς τῇ ακοῇ πρὸς τῷ οστεῷ τῷ σκληρῷ*
> *λεπτόν εστὶν ὥσπερ ἀπάξνιον, ξηρότατον τοῦ ἄλλου δέρματος*
>
> ...the skin in the ear next to the hard bone is thin, like the web of spiders, and of all the skins, it is the most dry (*De Carnibus* 15, Loeb Classical Library).

Hippocrates uses *derma*, 'skin,' whereas in the Latin, Fabricius uses the diminutive, *pellicula*, 'little skin.' The tympanic membrane actually has a thin covering of mucous, and so it is perplexing why both Hippocrates and Fabricius perceive it to be the most dry of all skins.

In addition to the anatomy of the membrane, Fabricius reviews the historical references, i.e., the *historia*, of the membrane. In *De Anima, 'On Spirit'* (420), Aristotle mentions a membrane in the ear, but he does not explain how the membrane functions or what role it plays in sound conduction and air movement. Fabricius seems to understand the theory of simultaneous air movement and sound propagation as described by Aristotle (*De Anima*, 419-20), who explains that sound is created when two objects hit each other and then hit the air, which moves into the organ of hearing. In regard to the membrane in the ear, Fabricius also refers to Galen's *De Usu Partium Corporis Humani*, Book 8, Chapter 6 and Book 11, Chapter 12. In both sections Galen discusses the protection that

nature provides the auditory nerve and why it is important that the protection does not hinder the flow of air striking the nerve. Galen seems to be referring to the protection provided by the petrous bone since he does not explicitly mention a membrane. Fabricius is therefore correct in claiming that it is uncertain whether Galen is aware of the membrane.

Finally, Fabricius also refers to Paulus in his discussion of the membrane and how it can hinder hearing. He is most likely referring to Paulus of Aegineta, who was a noted surgeon and anatomist in the seventh century AD. Fabricius provides a specific reference (i.e., Book 2, Chapter 23), but it is unclear to which work of Paulus he is referring. Paulus of Aegineta is most noted for *The Seven Books of Paulus of Aegineta*, but in Book 2, Chapter 23 of this work Paulus discusses fevers. In Book 3, Chapter 23, however, Paulus discusses hearing and the diseases and conditions associated with it, and so Fabricius or his printer cites the incorrect book.[3] Paulus notes that deafness is difficult if not impossible to cure in many instances, but he does have several suggestions for treatments. If the deafness is caused by 'crude and thick humors,' then he suggests bleeding the patient. He also suggests, as he does for a variety of other hearing ailments, to inject the urine and gall of a goat, the juice of rue with honey, castor oil, or *oesypum* (i.e., grease from unwashed wool) into the auditory meatus. Unfortunately, he provides no rationale for any of these treatments.

Chapter 5: On the Three Ossicles: the Malleus, Incus, and Stapes.

In this chapter Fabricius provides fairly accurate descriptions of the ossicles in the middle ear cavity. So named because of their shapes, the Malleus, Incus, and Stapes provide the mechanical bridge between the vibrations of the tympanic membrane and the transmission of motion into the fluid of the Cochlea. The Malleus attaches to the tympanic membrane, and so vibrations in the membrane move the Malleus. The resulting motion is transmitted to the Incus, which in turn transmits it to the Stapes. As Fabricius accurately describes, the base-plate of the Stapes rests on the oval window of the Cochlea. Therefore, the motion transmitted through the ossicles results in the vibration

[3] The text is therefore emended.

of the base-plate on the oval window. The window allows the motion to be transmitted into the fluid (i.e., perilymph) inside the Cochlea. The Cochlear portion of the auditory nerve detects the movement of the perilymph, and hence the brain perceives the vibrations in the perilymph – which began as vibrations in the air – as sound.

Fabricius cites Vesalius for a description of the Incus, suggesting that he is comfortable citing his fellow Paduan physicians but perhaps not their rivals, e.g., Eustachius.

Finally, by including another description about the method for finding the ossicles through dissection, Fabricius provides further evidence that his text is meant for medical students and that he is striving to increase the scientific rigor of anatomy.

Chapter 6: On the Muscle for moving the Malleus to the Incus.

Fabricius claims to have discovered the smallest muscle of the body attached to the membrane and responsible for moving the Malleus. Fabricius is incorrect in claiming that it is the smallest muscle of the body and that it attaches to the membrane. Furthermore, he is incorrect in asserting that he is the first person to discover the muscle.

Fabricius is referring to the *tensor tympani* muscle, which arises from the auditory or Eustachian tube, proceeds laterally across the middle ear cavity, and attaches to the lower process (i.e., the manubrium) of the Malleus. By pulling on the Malleus, the *tensor tympani* draws the tympanic membrane taut, thereby allowing the membrane to vibrate in response to sound waves. Contrary to Fabricius' description, however, the *tensor tympani* itself does not attach to the membrane. Although it may have seemed to be the smallest of all muscles to Fabricius, the *stapedius* muscle – which attaches to the neck of the Stapes – is smaller than the *tensor tympani.* This muscle is only visible with magnification, however, and since Fabricius wrote 40 years prior to the invention of the microscope, he did not have the magnification necessary to view the *stapedius.*

After his preliminary discussion of the *tensor tympani*, Fabricius claims to have discovered the muscle in the auditory meatus. His descriptions are vague, sometimes suggesting that the muscle is *exterius*, 'on the outside,' of the tympanic membrane, but at other times suggesting that it functions with the Malleus to pull on the membrane. No muscle exists in the external auditory meatus, and so Fabricius is either describing a

fictional muscle or simply providing a poor description of the *tensor tympani*. He is most likely doing the latter since the title of the chapter indicates the he is describing only one muscle, i.e., the muscle that attaches to the Malleus. Although he claims that the muscle is in the auditory meatus, suggesting that it is outside of the membrane, he also claims that the ossicles are in the auditory meatus. Therefore, he seems to recognize that the muscle and the ossicles are in the same location, i.e., in the middle ear. Furthermore, he ends the chapter by saying that *haec sunt, quae sub membrana in magna primaque cavitate consistunt, corpora*, 'these are the bodies, which rest beneath the membrane in the first large cavity,' and so suggesting that the muscle in question is in the middle ear.

Assuming that Fabricius does claim to have discovered the *tensor tympani* in 1599, he is in conflict with the Roman anatomist Bartholomaeus Eustachius, who discovered and described the *tensor tympani* a generation prior to Fabricius. In *Tabula* 41 of *Tabulae Anatomicae* (1714) Eustachius clearly depicts the *tensor tympani* muscle. Moreover, in his diagram Eustachius clearly depicts the muscle attaching only to the manubrium of the Malleus and not to the membrane. One may hesitate to criticize Fabricius for not crediting Eustachius with the discovery since *Tabulae Anatomicae* – like several of Eustachius' works – was not published until the eighteenth century. Nevertheless, anatomical scholars contemporary with Fabricius such as Helkiah Crooke knew of Eustachius' discovery. Indeed, in Book 2, Chapter 19 of *A Description of the Body of Man* (1616) Crooke gives Eustachius credit for describing the *tensor tympani*, albeit he does not use that name for it.[4] The fact that scholars contemporary with Fabricius recognize Eustachius' discovery suggests that Fabricius chooses to omit any references to Eustachius since the Roman anatomist was a contemporary and possible competitor with Fabricius' mentor, Fallopius.

[4] Some confusion exists as to whether Crooke realizes that the muscle Fabricius describes in *De Auditu* is the same one described by Eustachius. In Book 8, Chapter 19 of *A Description of the Body of Man* Crooke discusses the muscle that he credits Fabricius with discovering in 1599, which he seems to suggest is separate from the *tensor tympani*. Crooke may believe that Fabricius describes a muscle in the external auditory meatus.

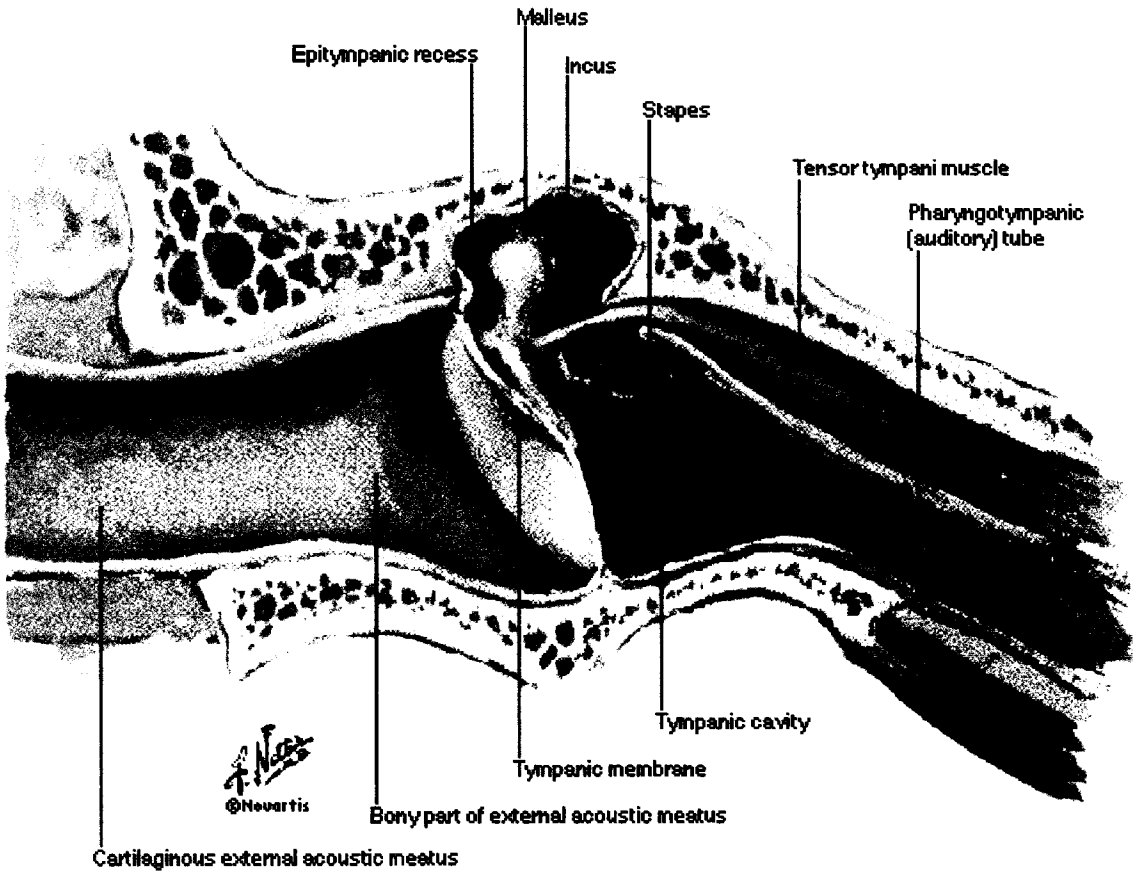

Figure 5: A Frontal or Longitudinal Section of the Middle Ear Cavity. The *tensor tympani* muscle arises parallel to the auditory or Eustachian tube and inserts on the manubrium of the Malleus. If Fabricius is not claiming to have discovered the *tensor tympani*, then he claims to discover a fictional muscle since clearly no muscle exists in the external acoustic meatus.

Fabricius also discusses the voluntary nature of the *tensor tympani*. Certain muscles in the body (e.g., the *biceps brachii*) are voluntary, i.e., they can be contracted on command from the brain. Other muscles (e.g., the heart), however, are not controlled in the same fashion by the nervous system, and so their contractions are not governed by conscious thought. The *tensor tympani* is not a muscle controlled by conscious thought, but Fabricius argues otherwise. Fabricius claims that since the *tensor tympani* is a muscle, then it must govern motion, and since he believes that all motion 'through joints' is voluntary, then the *tensor tympani* must govern voluntary motion. His errors, of course, are in assuming that all motion is voluntary and that the *tensor tympani* induces motion 'through' the joint between the Malleus and the Incus. The muscle is responsible for maintaining tension in the membrane, whereas the motion 'through the joint' is caused by vibrations in the membrane due to sound waves. Given that a muscle attaches to the Malleus, Fabricius wants to associate sound perception with movement in the ear. His argument at best is confusing and indicates that Fabricius clearly does not understand the function of the *tensor tympani*. Nonetheless, he realizes that his argument for voluntary motion is rather arbitrary and weak, i.e., he admits that anatomists can argue at will for or against the voluntary nature of the motion in the ear.

Attempting to prove his erroneous claim that the *tensor tympani* is a voluntary muscle, Fabricius provides a brief but clearly Aristotelian description of sound waves. Fabricius asserts that motion must exist in the ear since sound is produced by air being set in motion. Aristotle recognized that sound arises when an object – or two colliding objects – strikes the air (*De Anima* 420a) . Although Aristotle did not have the thorough modern understanding of sound waves, he certainly recognized that the movement of air into the ear must be the source of sound. Fabricius surprisingly does not cite Aristotle, but he clearly believes that sound is a result of air movement. Given this Aristotelian view, it is surprising that Fabricius would assert that the motion associated with hearing arises within the ear and is caused by a voluntary muscle. It is equally surprising that Fabricius seems to suggest that before the motion of the air reaches the ear, a certain

sound can be heard in the ear. He seems to attribute the preceding sound to the contraction of the muscle, but if so, he is completely incorrect.

Finally, in the last sentence of the chapter Fabricius mentions how he is not able to replicate his finding in all cases, i.e., he is not able to find the *tensor tympani* in each dissection. Fabricius recognizes the importance of the replication of results as a scientific principle, further suggesting that Fabricius' *De Visione, Voce, Auditu* (1600) introduces deliberate and calculated scientific methods to the study of anatomy.

Chapter 7: On the Cavities of the Petrous bone...

Fabricius discusses the innumerable caverns and holes found in petrous bone. He begins with the primary cavity or Conch, which is known as the middle ear to a modern anatomist. He describes the middle ear as rounded and a bit uneven and seems to refer to a specific protrusion. In the original text Fabricius uses the nominative singular participle *protuberans*, 'protruding' or 'growing out,' in a clause that refers to the cavity itself, but it seems illogical for a cavity to be '*protruding* near a hole in another perforated cavity.' In the index of figures, however, Fabricius refers to a *protuberantia in media cavitate*, 'a protrusion in the middle cavity.'[5] The protrusion in question is the promontory in the middle ear, which is a bulge in the middle ear caused by the rounded Cochlea pushing against the bone separating the middle ear from the inner ear. The term promontory is derived from the Latin *promontorium*, which was used in the classical period to refer to an outgrowth or outcropping of a mountain. When anatomists first used *promontorium*, 'promontory,' to describe the bulge in the middle ear is uncertain, but since Fabricius does not use the term, it is likely that anatomists did not adopt the term *promontorium* until sometime after 1600.

Fabricius identifies two holes that lead into the Cochlea: the oval and round windows. The Stapes rests on the oval window, and the motion caused by sound waves is transmitted through the oval window and into the perilymph. As its name implies, the Cochlea resembles a spiral-shaped snail. The tube in which the perilymph is contained coils around two and a half times before terminating at the round window. This window

[5] See Emendations to the Original Text. Fabricius considers *protuberantia* to be feminine singular.

is a small hole in the Cochlea that allows the pressure of the perilymph to equalize with the atmospheric pressure inside the middle ear. Fabricius discusses at some length how he found this 'second' hole and how he would display it for his audiences. When Fabricius notes that the promontory is adjacent to a hole leading to another cavity, he is most likely referring to the round window, since the promontory is immediately above the round window.

Throughout this chapter Fabricius refers to the labyrinth of the ear. In modern anatomy the labyrinth is a term applied to the structures of the inner ear, including the Cochlea, vestibule, and semicircular canals. Fallopius is the first anatomist to describe these structures (Singer 143), and although Fabricius refers to Fallopius in this section, Fabricius only briefly mentions the labyrinth. Furthermore, Fabricius uses the term *labyrinthus*, 'labyrinth,' both for the structure into which the oval window leads and for the innumerable series of cavities.

Fabricius refers to a third hole that leads to the many little cavities of the petrous bone. The identity of this hole is unclear since Fabricius has already accounted for the two major holes – not including the opening to the Eustachian tube – that lead out of the middle ear, i.e., the oval and round windows. There is a space above the ossicles that, in a sense, is separated from the main part of the cavity by the ossicles, and so perhaps Fabricius believes that this space leads to the many holes of the petrous bone.

Finally, as with previous chapters, Fabricius discusses the methods for dissecting the petrous bone, again demonstrating that *De Dissectione et Historia Auris* is a highly technical text.

Chapter 8: On the Congenital or, as they call it, Smooth air.

Fabricius devotes an entire chapter to the air enclosed in the middle ear. As Aristotle does in *De Anima* (2.8), Fabricius refers to the air as congenital, implying that the air is encased in the ear from birth. The classical perception of hearing involved the transfer of sound in the external air to the hollow internal caverns of the ear, which were filled with still and congenital air.[6] The fact that Fabricius devotes an entire chapter to the congenital air indicates that he was not only familiar with classical perceptions of

[6] See Appendix 1.

hearing but that he was also still including them to a certain extent in his Renaissance work. In the last line he provides evidence that he believes that the air is involved with the action of hearing: 'For the purpose of hearing well, it ought to be completely pure, clear, immobile, and quiet in the ear, as will be described in [sc., the section on] functions.' Regardless, without translating the later sections, one cannot definitively address Fabricius' thoughts on the function of the air in the ear.

Chapter 9: On the Duct or Meatus or Channel ...

After seeming to claim that the air in the middle ear is separated from the atmosphere, Fabricius describes the passage that connects the middle ear with the throat. The auditory or otopharyngeal tube is a two to three inch channel that extends from the middle ear to the nasal pharynx. It is often referred to as the Eustachian tube since Eustachius describes it in his work *Epistola De Auditus Organis*, '*A Letter on the Organs of Hearing*' (1562). Eustachius was not the first to describe the tube since Aristotle mentions a passage from the ear to the roof of the mouth in Book 1, Chapter 11, of *De Historia Animalium*. Aristotle credits Alcmaeon, presumably of Croton, who in the fifth century BC discovered this passage in goats. Alcmaeon claimed that this passage allows goats to breathe through their ears, a theory which Aristotle disputes in *De Historia Animalium* (1.11). In Book 32, Chapters 6 and 13 of *Problemata*, '*Problems*,' Aristotle implies that a passage extends from the ears to the throat, although he does not explicitly mention the passage itself.[7]

Fabricius refers to Aristotle when describing the tube, but he omits any reference to Eustachius, as he did in regard to the *tensor tympani*. Unlike his description of the *tensor tympani*, Eustachius' description of the tube was published during his lifetime and a generation before Fabricius wrote *De Auditu*. Fabricius may not be familiar with the works of Eustachius, but more likely, this is further evidence that Fabricius is not comfortable crediting his mentor's rival.

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[7] In Book 32, Chapter 6, Aristotle explains why it was thought that rubbing or scratching (i.e., *σκάλευοντες*) an ear induces coughing, i.e., that the heat generated by the rubbing produces moisture that flows down to the windpipe and induces a cough. In Chapter 13 of the same book Aristotle explains why he believes that yawning hinders hearing, i.e., the air entering through the mouth pushes on the tympanic membrane.

Chapter 10: On the Auditory Nerve.

When Fabricius uses the phrase *in quinto pari*, 'in the fifth pair,' he is referring to the classical numbering of the cranial nerves. Galen numbers the pairs of nerves emanating from the base of the brain in Book 14, Chapter 4 of *On Anatomical Procedures*. Galen numbers the nerve extending from the base of the brain to the inner ear as the fifth, and since a nerve extends to each ear, Galen refers to the auditory nerves as the fifth pair of cranial nerves. The modern anatomist recognizes that twelve pairs of cranial nerves exit the base of the brain and that the auditory nerve is properly labeled as the eighth.

Fabricius refers to controversy amongst anatomists regarding the two-fold auditory nerve. He is referring to a debate that began with Galen, who in his *De Usu Partium Corporis Humani* (Book 8, Chapter 5) describes two types of nerves: hard ones that innervate muscles, and soft ones that carry stimuli to the brain from sensory organs. Galen notes that some organs must have both types of nerves since the organs not only receive sensory information but are also capable of movement, e.g., the eyes (Book 16, Chapter 2). Galen claims that the ears must also have both types of nerves since they certainly receive sensory information and, in some people, are able to move. In other words, he recognizes the fact that some people have control over the vertical movement of their outer ears. The muscles governing the movement of the auricle are innervated by a branch of the facial nerve, which is the seventh cranial nerve immediately adjacent to the auditory nerve, and both nerves exit the cranium through the same foramen. Galen does not separate the facial and auditory nerves but rather claims that they are two branches of the same nerve. He therefore claims that one branch (i.e., the auditory nerve) is responsible for receiving sound and the other (i.e., the facial nerve) is responsible for moving the ear. Fabricius continues this misconception but abstains from discussing it in detail. His willingness to abstain may perhaps be due to the fact that he recognizes that the two nerves are separate but does not want to disagree with Galen. Perhaps Fabricius feels that previous Paduan physicians (e.g., Vesalius) have sufficiently criticized Galen,

or perhaps he feels that he should not address this issue in a book devoted strictly to the structures rather than to the functions of the parts of the ear.

Figures of the Ear.

Figures 1, 2, and 3 depict the Auricle or Pinna attached to the temporal bone of the skull. The labels on Figure 1 indicate the Helix, Anthelix, Conch, Tragus, Antitragus, and lobe of the Auricle. The temporal bone is unlabeled by Fabricius, but he clearly depicts the two portions, i.e., the squamous and petrous portions. Figures 2 and 3 depict the anterior and posterior views, respectively, of the cartilaginous portions of the outer ear.

Figure 4, which depicts the auditory meatus in the temporal bone, is fairly straightforward once the proper perspective is achieved. Fabricius' original figure should be rotated 90° so that the styloid process, which is at the base of the skull, is depicted on the bottom of the figure. The styloid process – to which three neck muscles attach – is curved towards the ventral face of the body.

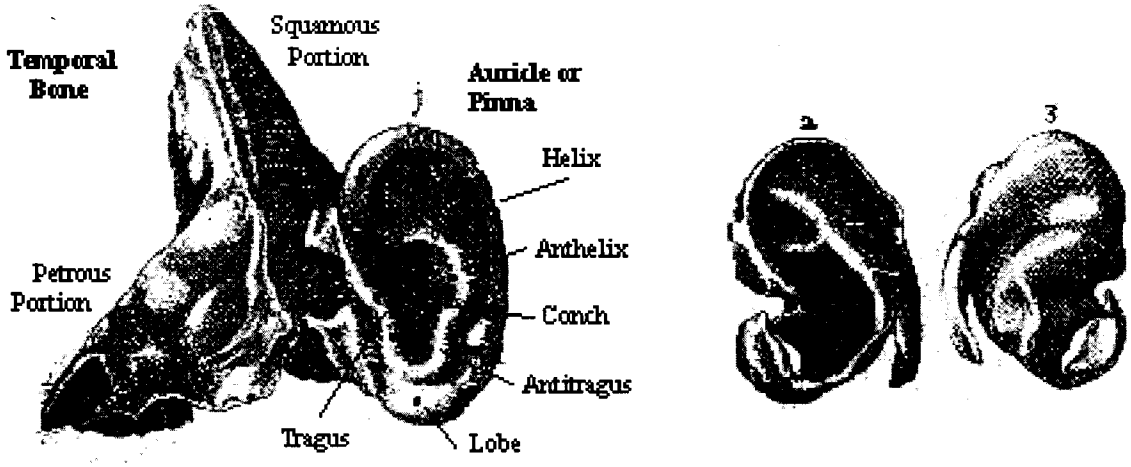

Figure 6: Figures 1, 2, and 3 Adapted from the Original Text.

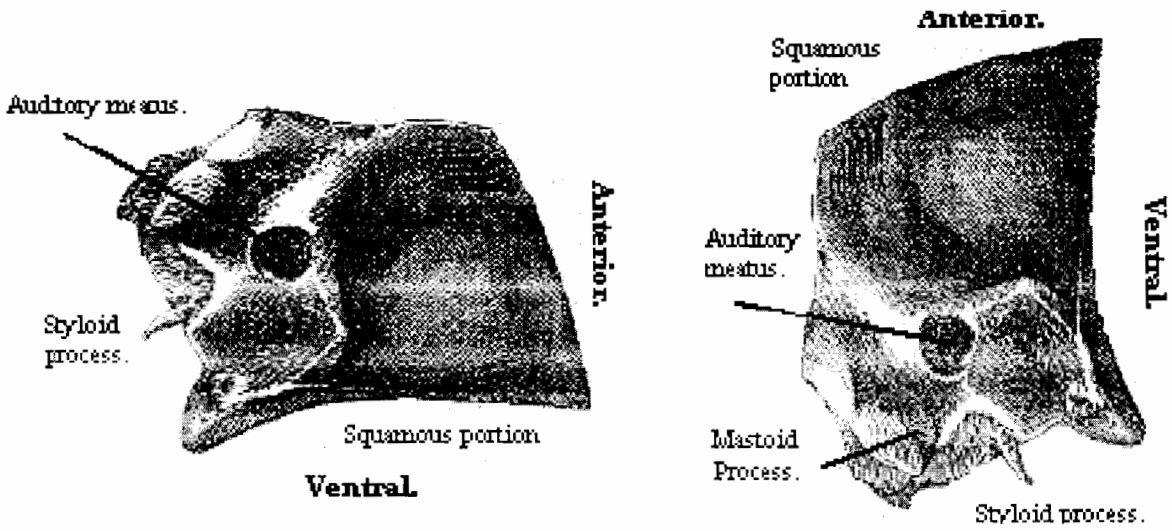

Figure 7: Figure 4 Adapted from the Original Text.

Figure 5 depicts some view of the petrous portion of the temporal bone with the tympanic membrane, but the specific angle is difficult to determine. The darker circular area is clearly the tympanic membrane but the empty circular area to the left of the tympanic membrane is perplexing. The carotid artery does flow through the petrous portion of the temporal bone, and so perhaps Fabricius is depicting that foramen.

Figures 6 and 7 represent the outer view of the petrous portion of the temporal bone as seen on the left and right sides of the head, respectively. The petrous portion of the temporal bone does not readily separate from the squamous portion in adults, but Fabricius seems to be depicting the junction between the two portions, perhaps as seen in a dissection from a young skull. In Figure 6 the tympanic membrane is intact, but in Figure 7 the membrane has been removed to reveal the ossicles.

Figures 8, 9, 10, and 11 depict various sections of the petrous portion of the temporal bone. The bony ring without the tympanic membrane seems to be facing up in Figure 8, but in an intact skull the ring would be facing out, parallel to the vertical axis of the body. In Figures 9, 10, and 11 the Conch or middle ear cavity is visible in the petrous bone along with the ossicles.

The small figures on the lower left portion of the page depict the bony ring and the ossicles. The figures are mislabeled since two Figure 13's appear: the left one depicts the ossicles attached to the bony ring, and the right one depicts the separated ossicles.

The figure on the right is most likely supposed to be Figure 15, which, according to the index, depicts the ossicles.

According to the index of figures, Figure 17 depicts the newly-discovered muscle, which is presumably the *tensor tympani* described in Chapter 6. As with Figure 4, Figure 17 was printed in a rather obscure position. If Figure 17 is rotated 90° to the left, however, a better perspective is achieved. The most evident structure in the figure is the mastoid process, which provides the proper orientation of the figure. The *tensor tympani* muscle seems to be visible extending across the open area of the middle ear. The Malleus is not visible, and it seems that the *tensor tympani* is attaching directly to the membrane. In the intact ear the *tensor tympani* arises from the Eustachian tube, but in the figure, it is unclear from what mass of tissue or bone the muscle is arising. Therefore, this figure may be a representation of the outer portion of the ear, suggesting that Fabricius does claim to have found a muscle in the external auditory meatus. Again, such a muscle is fictional, and the structure depicted in Figure 17 would therefore be non-attested.

The identity of the thick vertical structure to the left of the mastoid process in the rotated figure is unclear. The styloid process is in this region, but compared to the styloid process depicted in Figure 4, this structure is too thick and lacks the proper curvature. The structure may be a muscle attached either to the styloid process (e.g., a facial muscle) or to the area near the mastoid process (e.g., the sternocleidomastoid muscle). The structure may also be meant to represent the zygomatic bone, but if so, the juxtaposition of the bone with the mastoid process is improper. The identity of the open circular structure is also unclear. Although it may again be the foramen for the carotid artery, the positioning of the bone and foramen are improper.

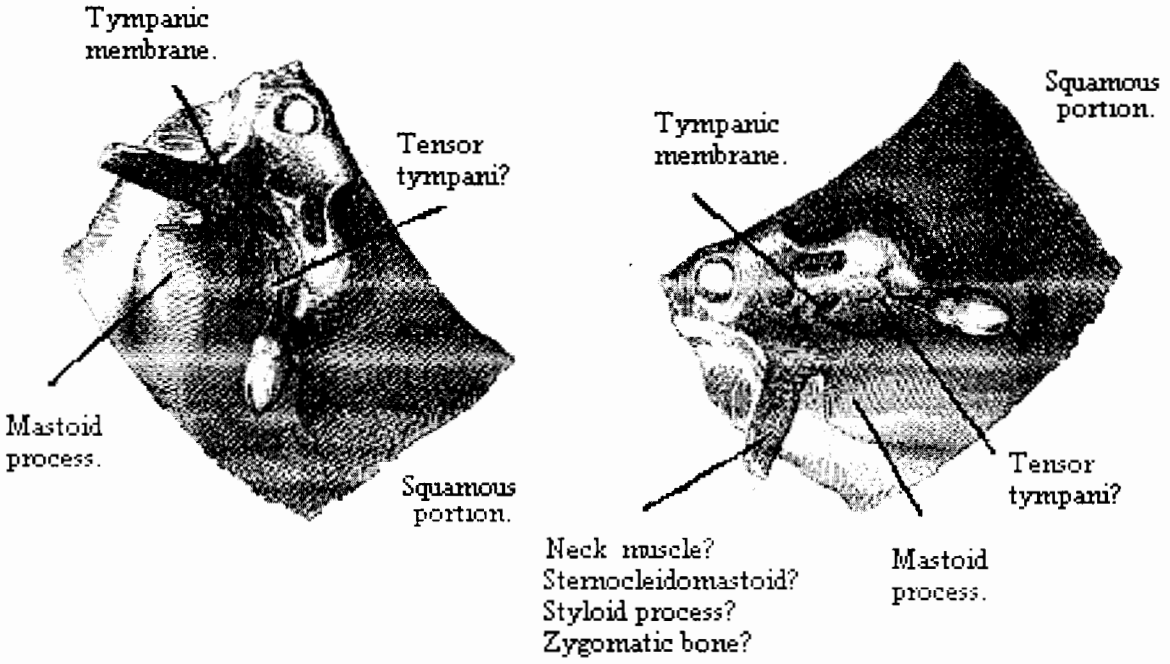

Figure 8. Figure 17 Adapted from the Original Text.

Figures 18 and 19 represent cross-sections of the middle ear in the petrous portion of the temporal bone. The promontory is supposedly depicted in Figure 19, but the specific feature that is supposed to be labeled is unclear.

The Original Latin Text

The following pages are scanned from the original copy of

De Visione, Voce, Auditu (1600)

available in the Rare Books Collection at the University of Iowa Medical Library.

SYNOPSIS LIBRI DE AVDITV, SIVE DE AVRE AVDITVS ORGANO.

PARTIS PRIMAE DE DISSECTIONE ET HISTORIA AVRIS

Capita Decem.

PROOEMIVM, Propositum libri continet.

PARTIS SECVNDAE, DE ACTIONE AVRIS HOC EST DE AVDITV

Caput Vnum.

PARTIS TERTIAE DE VTILITATIBVS, TVM TOTIVS AVRIS, TVM PARTIVM ILLIVS.

Capita Vndecim.

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HIERONYMI FABRICII
AB
AQVAPENDENTE

DE AVRE
AVDITVS ORGANO
LIBER.
DE DISSECTIONE ET HISTORIA
PARS PRIMA.

Propoſitum Libri.

IN aurium fabrica explicanda, videor mihi aggreſſurus organum elegantia & artificio viſu apprimè iucundum, ſed explicatu & oſtenſu admodum difficile: difficile (inquam) quoniam multa quæ in hoc ſenſorio continentur, priſcis illis auctoribus penitus ignota fuere: quæ verò cognita ſunt negligenter potiùs & oſcitanter fuere explicata. Poſteriores aũt quanquam maiori diligentia vſi ſunt, quas tamen & ipſi adinuenerunt partes, cuius gratia factæ eſſent vel tacuerunt, vel diminutè retulerunt; nonnulli demum a philoſophiæ fundamentis recedentes, minus rectè explicarunt: quo magis enitendum nobis erit, cuncta pro virili clara & aperta reddere, atq; ab exterioribus partibus tanquàm quæ primo nobis occurrunt exordium ſumere; inde ſenſim ad eas, quæ interius ſunt & proximè prioribus ſuccedunt, deuenire. Vnde prima pars erit Auricula: Secunda πόρος ἀκουστικὸς, ideſt meatus auditorius: Tertia membrana Tympanum appellata: Quarta oſſicula tria Malleus, Incus, Stapes: Quinta muſculus: Sexta, antra & cauernulæ omnes, concha, cochlea, labyrinthus, cæcus ductus; Septima aer congenitus ſeu (vt dicunt) complantatus: Octaua neruus auditorius & nerui ductus ſeu iter: Nona ſemita quædam ſeu meatus ſeu ductus ab aure in palatum: Quæ omnia ferè cõprehendit & continet tanq̃ decimũ corpus os vnum, quod a duritia λιθῶδες, hoc eſt petroſum dicitur.

A De

De Auricula. CAPVT I.

De hist. ani.c.xi. Melet. cap. proprio. AVRIS igitur pars capitis est, qua audimus ab hauriendis vocibus ita appellata. Nam eius officium est voces & earum discrimina comprahendere, Vnde græcè ὦτα a voce accipienda nominarunt, quam illi ὦτα nuncupant: ob id quoque aures velut audes ab auditu dictæ existimantur: & pro toto organo auditus sumuntur.

Auris pars exterior * Auricula ab Arist. dicitur: * cuius pars superior latior cartilaginea ab Arist. innominata censetur: quamuis interpres Pinnam potiùs cum recentioribus appellarit: vel quòd figura pinnæ, quæ conchæ genus est, similis sit, vel quòd in summitate auris sit, & assurgat vt murorum summitates pinnæ dictæ quæ antiquitus magis quàm nunc vsurpabantur: vulgo Merli. vel tandem a sorditie aurium pinna dicitur πῖνος enim sordes significat. * prima. * I.

* Inferior auriculæ carnosa pars fibra nostris græcè λόβος dicitur παρὰ τὸ λοβᾶν, quod deturpare vel abscindere diceres: nam hæc ob scelera truncari solet. Vnde a Polluce ἐλλόβια aurium ornatus, qui in λόβῳ, idest fibra perforata imponuntur * ἕλιξ seu Helice totum illud, quod auriculæ circumferentiam ambit, à gyro seu tortuositate sic dicitur. * I. 4. Melet. * I. iii. Ruffus.

* Ἀνθέλιξ seu Anthelice verò illi opposita, in medio post helicem extumescentes propè cauitatem particulas significat. * I. 2. Ruffus.

* Cauitas verò ipsa, Concha dicitur κόγχη quod concaua conchyliataque sit. * I. 5.

* Conchę opposita eminentia iuxta temporis fines Tragos idest hircus dicitur: vel quia hirta hæc pars ceu hirci barbula in nonnullis fiat: vel quia pili, qui interdum in ea repullulat densi & rigidiq; sunt vt hirci barbam ęmulentur: vel demum quia quibus hirta hęc pars sit, ij luxuriosi, vt hirci, dicantur. * I. 6. Ruffus.

* Huic opposita ex crassiore Anthelice Antitragos appellatur. Nam & hæc quoq; pars pilosa fit & hirci barbulam imitatur. * I. 7.

Helicis finem, qui subbreuis est Ἀντιλοβίδα vocant: hanc puto esse cauitatem in articula seu pinnà positam supernè, & λόβῳ idest fibræ oppositam. Omnes iam enumeratæ partes (vna excepta fibra, quæ carnosa tantummodo est) ex cute cartilagineq; constant: figuraq; varia sunt: sed communiter cauitates, gyros, vortices atq; anfractus referunt: hæc de Auricula. Pollux.

De osse Petroso, quod λιθοειδὲς dicitur. CAPVT II.

NVNC ad reliquum auditorium organum ex osse constatum accedamus. Andiendi organum vniuersum partim cartilagineum

gineum partim oſſeum viſitur: cartilagineum * auricula eſt, quæ ita
cartilaginea eſt, vt oſſis naturam nullo modo admittat: * oſſeum eſt re
liquum, & petroſum appellatur, quod ita oſſeum eſt vt cartilago hic
locum non habeat. Diximus de parte organi cartilaginea; nunc de
oſſea dicendum; priuſq; de tota oſſea parte generaliter loquendum,
inde de particulis, quas in ſe totum hoc os compræhendit diſſeren-
dum. Hoc aũt auriculã ſequitur & à ſua duritia λιθοειδὲς: petroſũ ſeu
lapidoſum dicitur: & reuera quocunq; duriſſimo oſſe durius apparet:
durities aũt potiſſimum in hoc oſſe exterius viget: quòd cruſta dũ-
riſſima denſiſſimaq; obducatur: quamuis interius totum cauerno-
ſum foraminulentumq; ſit: id quod de hoc oſſe duritiem non detrahit,
cum laminæ cauernulas efformantes quantumuis tenuiſſimæ, & ipſæ
quoq; duriſſimæ ſint. Hoc os in baſi capitis ponitur, qua parte nerui
à cerebro prodeunt; vnde neruum auditorium appellatum è ſuperna
ſui parte, poſterioreq;, per foramen in oſſe inſculptum excipit: eſtq;
os ad rotundum vergens ſed oblongum, & non nihil * pyramidalem
imitans figurã; cuius baſis auriculam vertex, autem cerebrum ſpectat:
totumq; intra caluariam protuberat: videreq; videberis os exterius
continuum & ſolidum, idq; propter cruſtam, cum tamen ea ablata
intus totum ita cauernoſum, ſpongioſum & foraminulentum ſit, vt
mirari quidem poſſimus cauernularum infinitatem, enumerare autẽ
non item. Vniuerſi igitur oſſis antra & quæ in ijs continentur partes
nunc memorare conſilium eſt ſumpto ab exteriore ductu exordio.
Sed ante omnia oportet, (vt cuncta exactè videas) ſerra totum eiuſ-
modi os a reliqua caluaria ſeparare; quod difficile non eſt: ſi prius am
putata ad eius rãdicem auricula & extracto è caluaria vniuerſo cere-
bro, ac tota molli ſubſtantia, quæ vniuerſum hoc aurium os circum-
ambit ac tegit, tantum hoc os manibus ad diſſecandum appræhendas,
& duris diſſecantibus cultris malleo percuſſis vtaris: ita. n. totum ne-
gocium ad rationem diſſecandi ſpectans citò ac facilè perages: & ini-
tium ab exteriori ductu, vt dixi, facias.

*prima.
* 1.g.
* 6.7.g.

De auris meatu, qui πόρος ἀκουστικὸς græcè dicitur.

CAPVT III.

AVRICVLAE finitima eſt cauernula quæ vtrinq; vna * πόρος
ἀκουστικὸς, ideſt meatus ad auditum pertinens, ſeu auditui
accommodatus, ſeu auditorius vocatur, per quem audimus.
Hic meatus totus oſſeus eſt cute tamen coriacea opertus: tubulumq;
oblongum refert obliquè ſeſe intus inſinuantem, atq; ad membranam
terminum habentem. Quem facilè ex vna parte cultro adhibito atq;
percuſſo eaq; maximè, quæ mammillari proceſſui oppoſita eſt, conſpi-

* 4.b.

cies, si modo eam versus processum mammillarem inuentas, ita enim membranam patefactam intueberis.

De Membrana, Tympanum appellata.

CAPVT IV.

*HAEC nonnullis membrana simpliciter ac myrinx, barbaris myringa nonnullis et tympanu est appellata: quod tympani bellici membranæ similis sit: etenim non deest etiam huic membranæ in circuitu * annulus osseus, qui circum circa membranam tendit, vt in tympano circularis annulus: qui in pueris conspicuus est, facilèq; separatur, in adultis cætero subiecto ossi vnitur & occallescit: cuius annuli membranam tendentis ope tunica hæc septu fit firmum totam exteriorem aurem ac meatum ab interiore dirimens ac cludens, circulumq; perfectum referens non tamen ex omni parte planum, sed in medio centroque quodammodo interius incuruatum & gibbum extra cauum, ita vt concinnè herbam cymbalitidem seu vmbilicum veneris præ se ferat: cuius situs propterea obliquus est: & per eius exteriorem superficiem quasi neruulus vel corda vel filum excurrere transuersè videtur. A quanam autem parte producatur hæc membrana sensibus omnino conspicuum non est: ideoque eius generationem nonnulli a pia matre, nonnulli à nerulo, quidam a periostio subiecti ossis faciunt: quæ tamen cum substatię proprietate a cęteris sit diuersa, rationi minimè dissentaneum erit eius originem semini acceptam referre: tunica præterea est tenuissima densissima siccissimaq; id quod Hip. quoq; protulit his verbis. Pellicula in aure iuxta os durum tenuis est veluti aranearum tela, & omnium pellicularum siccissima.

De hac similiter membrana ab Arist. quoq; mentio facta est: quo magis hoc loco demiror Galenum qui nullam prorsus mentionem de hac ipsa fecit: quinimmo negauit omnino tegmen aliquod consistere ad meatum auditorium, quòd aerem motum, qui cum sono fertur, ingredi in aurem impediuisset: quamuis nonnulli contendunt, a Galeno hanc membranam cognitam fuisse: quòd Galenum hanc absolutè negasse non patet, sed non vt in oculis adesse protulerit: quibus nequequam reclamo quòd cùm Arist. tùm Galeni gloriæ faueam, simul desiderio flagrem Galeno & Aristoteli nihil occultum extitisse: sed loca Galeni propono vt quisq; pro suo arbitratu iudicet. Primus locus est 8. de vsu part. cap. 6. secundus, 11. eiusdē operis cap. 12. Tertius in libro de instrumento odorat. cap. 5. solet præterea interdum (rarò tamen accidit) exterius ante membranam tunica quædam crassior præter naturam adnasci opponiq; quam ego in pueris bis deprehendi: de qua a Paulo mentio fit, qui modum quoq; eam curandi atq; eximendi proponit, quando dum adest, surdum meatum auditorium auditusq; efficit,

* 5.1.6. 11. 11.

* 6.7.8. 9.11.12. 13.K.

in lib. de carnib^s.

2. de anima tex. 83.

libr. 2. cap. 23.

ficit, etenim ſurdos nonnunquam & conſequenter mutos a natiuitate ſæpè fieri autumo, quia à primordijs crassior hęc mẽbrana exterius tympanum obuelat. Notant vltimò Anatomici in tympano filum ſeu cordulam quam tenuisſimam transuersè myringi exterius obtẽtã & annexam: quæ alijs arteriola, alijs neruulus, alijs ligamentum alijs tẽdo cẽſetur: quod ſi nullũ horũ eſt, corpus ſui generis eſſe neceſſe eſt.

De tribus oſſiculis Malleo, Incude, et Stapeda.

CAPVT V.

POST membranam, quæ reuera ſeptum eſt exteriorem ab interiori aure dirimẽs, interius * ampla quædam cauitas apparet cõcha dicta: de qua antequam dico, videnda ſunt, quæ in hac prima cauitate corpora conſiſtunt: ſunt autem hæc tria oſſicula & muſculus. * Primum oſſiculum à mallei ſimilitudine malleus appellatur: Malleus
secundum incus: tertium ſtapes ſeu ſtapeda. Malleus altero extremo tenuius & acutum eſt os: altero verò crasſius extuberans ac rotundo capite ideoque femur nonnullis fuit appellatum: attamen perfectè rotundum non eſt, ſed qua parte incudi nectitur cauitatem obtinet oblongam inæqualemq; : ad ſui verò medium duos habet exiguos proceſſus, ſuperiorem, qui muſculi in ſertionem excipit, & inferiorem: cauatumq; intus in ſuæ ſubſtãtiæ medio eſt, vbi medulla continetur: hoc oſſiculum * membranæ inhæret quàm pertinacisſimè facitq; eam deorſum quodammodo trahendo ea parte in centro .ſ. incuruari: qua etiam parte malleoli caput exterius ſupra membranam protuberat.

* Incus verò qui nonnullis etiam dens dicitur, malleo eſt duplo Incus.
maior ex altero extremo duo habet veluti crura inuicem diſtantia, tenuia, ferèq; acuta: quorum alterum altero longius eſt: longiori vertice ſtapedæ applicatur: breuiore oſſi temporum ſquamoſo innititur: ex altera verò extremitate crasſius eſt os uti incus: eo verò differt a fabrorum incude, quòd planities incudis in hoc oſſe deficit: ſed loco plani cauitas inæqualis viſitur, qualis in molaribus denibus ferè appareret. Quocirca non parum laudandus Veſalius eſt, qui hoc os etiam molari denti duas tantum radices habenti comparauit: cui ſanè inæquali cauitati malleus nectitur, & articulationem facit ad motum cõmparatam.

* Stapes deniq; oſſiculum eſt cæteris adhuc minus in medio cauatũ Stapes.
& foramen oblongum habens, vt ſtapes equeſtris, quam exactisſimè refert: tribuſq; lateribus atq; angulis vt triangulus cõſtat. Tria hæc oſſicula præter cæterarum oſſium naturam perioſtio nequaquam operta ſed nuda viſuntur: tum verò dura perfectaq; oſſa etiam in naſcẽtibus infantibus apparent: quod pariter nulli accidit oſſi: præterea mutuò iuncta innexaq; ſunt, nexuſq; varius eſt hoc planè modo ſe habens. Oſſicula hæc a cæteris diuerſa.

habens. * Membranæ internæ faciei, mallei tenuior tantum extremitas validè alligatur, crassiore interim quasi pendula remanente: nisi quod incudi incumbit, eiq; articulatur, ea scilicet dearticulationis specie, quæ * γιγγλυμοειδὴς appellatur, in qua ossa mutuò tum susc ipiunt tum susc ipiuntur: etenim tum in malleo & cauitas est & caput, tum vicissim in incude: moueturq; supra incudem malleus: ac motus non quidem difficilis est, sed sensu percipitur propter ei comitem & adiunctum strepitum de quo posterius. Incus autem qua parte malleum susc ipit, nullum aliud contingit corpus: cæterum altero sui breuiore extremo seu crure proximo firmatur ossi temporum: longiore vero stapedis acutiori parti, quæ vertex dici potest, ligamentali nexu alligatur, stapedemq; quoddammodo sustinet. Reliqua asit stapedis pars, quæ basis nuncupari potest in ouali quadam cauitate consistit, quasi librata, sicuti & reliqua ossicula vtcunq; inuicem iuncta sint, sese quasi librant, suspensaq; videntur: nisi quod stapes ligamento quodam tenuissimo ad acutiorem sua partem pertingente trãsuersè a lateribus ossi alligatur. Inuenies autem tria ossicula si sectionem sequaris vti supra diximus primum meatus auditorij vsq; ad tympanum, inde interius procedenti malleus detegetur, & eleuato tympano incus & stapes. * II. 1. * II. 14.

De Musculo Malleum ad incudem mouente.

CAPVT VI.

* MVSCVLVS quoq; exiguus immo omnium minimus sed tamen eleganter musculi formam referens ad supernum mallei processum, quæ membranam attingit exiguo tendine inseritur, transuersè illuc procedens, & a propinquo osse exortum carnosum sumens, carnosusq; incedens & in medio crassior, tandem tenuior redditus in superiorem maioremq; mallei processum ad membranam inseritur. Qui vult huiusmodi musculum inuenire, incipiat dissectionem ossis, quod ab opposita parte processus mammillaris cõsistit, incidendo totum os per longitudinem meatus auditorij: ita.n. primò tibi occurret membrana, inde caput mallei, deniq; sectione interius aliquantulum si procedas musculus quoq; se se exeret: qui ex osse in eadem regione consistente oritur, & carnosus factus obliquè ad malleum subtus membranam peruenit, atq; in eius processum inseritur: & quatenus musculus est, necessariò motum præbet: neque alium præstare potest quàm ad mallei & incudis dearticulationẽ: malleum igitur ad incudem mouet. Quod si motus est a musculo, & per dearticulationem factus, dubio procul voluntarius est. Neq; cuiq; mirum videatur in auribus motum voluntarium adesse. Nam si motum voluntarium eum appellamus, quem efficere possumus cum volumus, * 17.

Ratio inueniẽdi musculi malleũ ad incudem mouentis.

Motus in auribus voluntarij demonstratio.

lumus, & non efficere cum nolumus; præterea crebriorem ac rariorem, velociorem ac tardiorem pro arbitrio possumus, clarissimum est in aure hunc effici motum. Nam ego & facere ac non facere, & crebrius rariusq; & velocius ac tardius facere consultò possum: ac motus cum strepitu quodam est, perinde ac si quis tria fila modico interuallo distantia tendat, & plectro percutiat, vt in fidibus etiam fieri consueuit: vt si quis vngue tabulam per transuersum linearum scalpat: vel scintillam ignis a lignis excussam audiat: præcipuè autem percipitur cum ciscitare incipimus. Verum in principio hoc est dum in via est hic motus, sonus quidam obscurior, qui videtur aeris commoti, & similis sono, qui fit à baculo aerem percutiente, præcedit. Illud præterea habet notatu dignum hic motus, quod in vtraque aure eodem tẽpore fit, neq; vllo modo separatim in altera tantum aure fieri potest: vt videatur hic motus quandam habere analogiam cum oculorum motu: siquidem vno moto oculo, alter quoq; mouetur. Hic igitur motus ille est arbitrarius, quem in auribus meis percipio, & alteri ostendere aut docere aliter non possum, quia intus in auribus fit, & exiguus, sed tamen euidens est motus: & sicuti in constringenda manu decipi non possum sic neq; in hoc decipior: hoc dico propterea quod aliqui sunt, qui cum obseruare in se ipsis non possint prædictum motum, illum negare audent: sed tamen multos semper in publicis theatris reperi, qui illum explorati & confessi sunt. Cur verò ab omnibus hic motus in semetipsis non animaduertatur in vsibus dicetur.

Præterea hoc anno 1599. musculum inuenire visus sum in meatu
* 17.7. auditorio, qui πρῶτος ἀκουστικὸς dicitur: * qui extra membranam est, exiguus, carneus, non expers tendinis, qui a medietate ipsius ductus seu meatus rectà fertur vsquequo in membranam exterius ad eius fermè centrum inseratur, ea scilicet parte, qua malleus intus membranæ annectitur; quàm exterius vnà cum malleo trahit. Inuenies hunc nouum musculum si in recenti cadauere corticem ossis meatus auditorij hinc inde aut exima parte malleo cultrũ pertundente incidas, & dextere huiusmodi os ad latera reuoluas: sic enim tibi apparebit musculus, quem sanè in omnibus postea non reperi, quamuis existimem ipsum esse necessarium: atque hæc sunt, quæ sub membrana in magna primaq; cauitate consistunt corpora.

De cauitatibus ossis petrosi: ac primum de prima, quæ concha dicitur.

CAPVT VII.

NVNC cauitates in osse lapidoso insculptas persequamur, a pri
3. 18. 7.7. ma exordiũ sumentes, * quæ statim sub mẽbrana apparet. Hæc inter cæteras nõ modo prima, sed præcipua quoq; est, tũ quia

quia in ea plures partes effatu dignæ, vti vidimus, positæ sunt; tum quia amplissima omnium est; tum deniq; quòd sedes sensusq; audien di hic celebratur, vti infra patebit. Quæ alijs antrum, alijs concha, alijs peluis, alijs, tympanum dicitur: quod .s. cauitas vnà cum myrin ga tympanum integrum præseferat: cochleam nominare error est, vt infra patebit: est hæc omnino prima cauitas in osse exculpta, rotunda, at non nihil inæqualis fortè etiam aspera, * in medioq; ferè protu- * 192
berans propter foramen in aliam pertusum cauitatem. Quo loco ad-
notare licet ab hac prima cauitate in alias aliasq; iri propemodum in-
finitas cauernulas: quibus auditorium organum vniuersum ita refer-
tum est, vt assequi ac denumerare possibile non sit; tamen in hac pri-
ma cauitate * quædam foramina insculpuntur interiusq; pertudun- * 19.
tur: quorum vnum Qualis cauitas est, cui stapes incumbit, ipsumq;
ostium magna ex parte occupat cluditq;: a quo Fallopius cui in rebus
abstrusis maximam fidem adhibeo, vteq; Præceptorem colo, vult in la-
byrinthum iri.

Secundum foramen ducit in cochleam: quam ego multos iam an-
nos organum ad ostensionem parans, transuersè ipsam per totum co-
chlearem ductum fortè incidi, diuq; seruaui, & solenni complurium an
norum spectacula auditoribus meis inspectandam proposui, quot an-
nis publicè plenis theatris ostendi; donec caries ipsam cauitatem,
quæ elegantissimè cochleæ gyrum imitabatur, consumpserit.

Tertium foramen vt patet in alias ducit cauitates, quæ tam innu-
meræ sunt, inuicemq; intrincatæ, vt meritò labyrinthus dicantur, &
admirari quidem eas licet, dinumerare autem seu ad ordinem quen-
dam redigere aut dirrigere non est vt quispiam tentet. Vanus enim vt
puto omnis erit susceptus labor: quinimmo facilè (ni fallor) quisq;
crederet eas sine vllo ordine, & fortuito potiùs quàm vllius vsus gratia
conditas esse: cum tamen diuina atq; infinita sapientia, quam assequi
homini datum non est, hæc omnia construxerit, & alicuius gratia ad
minimum vsq; fecerit. Deprehendes autem hæc omnia verissima es
se si sinè vllo delectu ex omni fermè parte huiusmodi ossium organũ
incidas: videre enim videberis (vna excepta externa crusta) quæ du-
rissima, continua, perpolitaq; est, reliquum ossis cauernosum, fora-
minulentum, pertusum, & spongiosum totum apparere; vti quo fieri
potuit, delineatione ac pictura repræsentare, quod lingua exprimi
non potuit, studuimus.

De aere congenito aut (vti vocant) complantato.

CAPVT VIII.

QVOD si sensu patet vniuersum auditorium organum, maxi-
mèq; vbi auditus celebratur, è cauitatibus constare, & ca-
uernosum

uernoſum totum eſſe, atq; è tenuiſſimis duriſſimiſq; oſſibus quaſi laminis cunctas cauernulas efformari; cumq; cauernulæ omnes vacuæ appareant, neq; ex altera parte vacuum in natura detur: eſt omnino neceſſarium aſſeuerare omnes eiuſmodi cauitates aere plenas eſſe: atq; hic ille aer eſt, qui ab Ariſt. & priſcis complantatus, inædificatus, & congenitus appellatur: quem etſi viſu ac ſenſu non licet, tamen euidentiſſima demonſtratione deprehendere & videre omnino licet: quem exiſtimare oportet omnia loca replere, atq; a primordijs in aure poſitum eſſe, ſimulatq; vacua ſpatia in oſſe excauata fuere: indeq; congenitum inędificatum & complantatum fuiſſe appellatum. Qui omni nò tenuis, clarus & immobilis, quietuſq; eſſe in aure ad bene audiendum debet, vti in vſibus dicetur.

De ductu, ſeu meatu, ſiue ſemita, quæ a prima cauitate, ſeu concha in palati fines ſeu fauces protenditur.

CAPVT IX.

PRAETER alia memorata foramina, quæ in concha, prima ſcilicet cauitate apparent, vnum adhuc reſtat poſtremo loco deſcribendum, quod ab ea ad palatum protenditur: meatuſq; eſt quem veluti aquæductum dixeris: ideoq; a prima oſſis cauitate foramen efformatur rotundo canaliculo ſeu tenuiori calamo perſimile: hinc obliquè deorſum procedens in palatum ſiue narium amplitudinē propè radicem gargareonis pertunditur, atq; cartilagine per totū fermè ipſius ductum incruſtatur. Hunc meatum priſcos non latuiſſe teſtis eſt Ariſt., qui primo de hiſt. an. cap. 11. voluit ex auribus in oris palatum vſq; ſemitam pertendi: idem in problem. teſtatus eſt: quamuis an Galeno fuerit cognitus non conſtet. Hunc ductum non difficulter inuenies, ſi in nudis exiccatiſq; caluarijs ſetam porcinam, aut tenuiſſimum argenteum ſtylum in meatum auditorium immittas: ipſum enim exire paulo poſt ad palati ſeu faucium regionem conſpicies. In recenti autem capite huius ductus ora foraminaq; ex vtraq; palati parte qua finitur videbis amplisſima.

De Neruo Auditorio. CAPVT X.

NERVVS ad auditum pertinēs in quinto pari ab omnibus cenſetur, quod vbi à cerebro prodit, in foramen in oſſe petroſo eius cauſa, inſculpuum ſeſe inſinuat, atq; in nonnullas diductum propagines ſic in pleraſquè oſſis cauernulas maioris momenti diſcurrit, donec ad primam præcipuamq; cauitatem, conchā appellatam vbi oſſicula conſiſtunt, perueniat, terminetúrquè. Quam rem ita accipi velim, vt negandum haud quaquàm ſit, nonnullas minoris

momenti propagines in alijs cauernulis ceſſare, ſed tamen potiores, ad potiorem & maiorem, vti dictum eſt, accedere. Quæ omnia non difficulter rimaberis, ſi ſerra prius organo auditus quod recens ſit, & reliqua caluaria ſeparato, mox extremum acuti cultri mucronem ad foramen poſitum vbi neruus eſt, malleo pertundas, atque fruſtulum a reliquo oſſe reſoluas; idq; ſubinde toties repetas neruum tum ſequendo, tum illæſum ſeruando, donec ad vltimas nerui fibras ventum ſit, ſic (ni fallor) totius auditorij nerui propagationē, atq; priuatim quas cauernulas adeat, vbi finiatur, vbiuè procedat optimè conſpicies. Hoc loco lubens abſtinebo ab aduerſa inter Anatomicos opinione de nerue auditorio duplici, molli videlicet & duro, an ſicuti in oculis mollis ad ſenſorium, durus ad ſenſorij muſculos, ita in aure eat. Abſtinebo pariter a fabrica nonnullorum animalium recenſenda ac deſcribenda, quæ ad magnam ſenſorij admirationem lectorem traducunt, quando hęc & alia pleraq; in magno opere aliàs exactiùs proſequemur.

XIX Figurarum auris explanatio.

Prima Figura auriculam totam integram exhibens.

a. Inferior auriculę pars lobus dicta.
b. Auriculę circumferentia helix dicta.
c. Protuberantia auricula, quam anthelicen dicunt.
d. Concha auricula.
e. Hircus ſiue tragus, concha videlicet adnata eminentia,
f. Antitragus.

2. Anteriorem auriculę faciem excoriatam pingit.
3. Poſterior auriculę facies excoriata.
4. h. Meatus auditorius in oſſe ſquamoſo exſculptus.
5. i. Membrana Tympanum dicta.
6. g. Os oblongum pyramidalem figuram exhibens.
i. Tympanum.
K. Annulus oſſeus.
7. g. Os Pyramidalem figuram referens.
K. Annulus oſſeus.
l. Cauitas concha dicta.
o. Stapes.
8. K. Annulus oſſeus.
l. Cauitas concha dicta.
o. Stapes.
9. m. Malleus.
o. Stapes.
10. m. Malleus. n. Incus. o. Stapes.
11. i. Tympanum. m. Malleus. n. Incus.
12. K. Annulus oſſeus.
13. K. Annulus oſſeus.
m. Malleus.
n. Incus.
14. m. Malleus. n. Incus. o. Stapes.
15. m. Malleus. n. Incus. o. Stapes.
16. m. Malleus.
17. r. Muſculus nuper inuentus.
18. l. Concha, cauitas,
o. Stapes.
19. c. Protuberantia in ampla eminentia.

Emended Latin Text

The following is an edited version of the original *De Dissectione et Historia Auris* (1600). In order to provide the reader with a clear and grammatically correct text, the following text has been emended. Words or letters in square brackets (i.e., [x]) indicate that the words or letters appear in the original text but should be removed. Words or letters in angle brackets (i.e., <x>), however, indicate that the words or letters do not appear in the original text but should. Explanations of the emendations are provided in footnotes. Professor Daniel J. Taylor was invaluable with his suggestions regarding many of these emendations, and his own emendations are noted.

Fabricius refers to figures in the margin throughout his original text, but these references have been placed in the footnotes of the emended text. The emended text has also been re-punctuated to reflect more accurately the proper structure of the Latin sentences.

SYNOPSIS LIBRI DE AUDITU, SIUE DE AURE AUDITUS ORGANO.

PARTIS PRIMAE DE DISSECTIONE ET HISTORIA AURIS.

Capita Decem.

PROOEMIUM, Propositum libri continet.

[1] In the original text Fabricius uses the Greek term for the auditory meatus, *πὸρος ακουστικὸς*, but misspells *ακουστικὸς* without the τ, which is included here.

Index.

A.

C.

[1] Taylor. Fabricius uses the non-attested Latin word *pertrudi* in the entry regarding Aristotle's discussion of the channel extending from the ears to the palate. In the main text Fabricius uses the verb *protenditur* from *protendo*, *protendere*, 'to extend.' The text is therefore emended to read *protendi*.

Index.

[2] Fabricius misspells his mentor's name as *Fallapio* rather than *Fallopio*.

[3] Fabricius does not include the first two letters of κυψελη (i.e., kupsele) throughout the text.

Index.

[4] Fabricius does not include the 't' in the word *utrum*, 'whether.'

[5] Fabricius misspells *quinto* as *quincto*.

HIERONYMI FABRICII AB AQUAPENDENTE

DE AURE

AUDITUS ORGANO LIBER.

DE DISSECTIONE ET HISTORIA
PARS PRIMA.

Propositum Libri.

IN aurium fabrica explicanda, videor mihi aggressurus organum elegantia & artificio visu apprime iucundum. Sed explicatu & ostensu admodum difficile; difficile (inquam) quoniam multa quae in hoc sensorio continentur, priscis illis auctoribus penitus ignota fuere; quae vero cognita sunt negligenter potius & oscitanter fuere explicata. Posteriores aut quanquam maiori diligentia usi sunt, quas tamen & ipsi adinvenerunt partes, cuius gratia factae essent vel tacuerunt, vel diminute retulerunt. Nonnulli demum a philosophiae fundamentis recendentes, minus recte explicarunt. Quo magis enitendum nobis erit, cuncta pro virili clara & aperta reddere, atque ab exterioribus partibus tanquam quae primo nobis occurrunt exordium sumere, inde sensim ad eas, quae interius sunt & proxime prioribus succedunt, devenire. Unde prima pars erit Auricula, Secunda πὸρος ακουστικὸς, idest meatus auditorius. Tertia membrana Tymapnum appellata, quarta ossicula tria Malleus, Incus, Stapes. Quinta musculus, sexta, antra & cavernulae omnes, concha, cochlea, labyrinthus, caecus ductus. Septima aer congenitus seu (ut dicunt) complantatus. Octava nervus auditorius & nervi ductus seu iter, nona

semita quaedam seu meatus seu ductus ab aure in palatum. Quae omnia fere compraehendit & continet tanque decim[um]<a>[1] corpus os unum, quod a duritia λῐθοειδές, hoc est petrosum dicitur.

De Auricula. CAPUT I.

AUris igitus pars capitis est, qua audimus ab hauriendis vocibus ita appellata. Nam eius officium est voces & earum discrimina compraehendere. Unde graece ὦτα a voce accipienda nominarunt, quam illi ὄπα nuncupant. Ob id quoque aures velut audes ab auditu dictae existimantur; & pro toto organo auditus sumuntur. De historia animalium. c. xi. Melet. cap. proprio.

Auris pars exterior[2] Auricula ab Aristotele dicitur.[3] Cuius pars superior latior cartilaginea ab Aristotele innominata censetur, quamuis interpres Pinnam potius cum recentioribus appellarit, vel quod figura pinnae, quae conchae genus est, similis sit, vel quod in summitate auris sit & assurgat ut murorum summitates pinnae dictae quae antiquitus magis quam nunc usurpabantur, vulgo Merli, vel tandem a sorditie aurium pinna dicitur πῐρός enim sordes significat.

[4]Inferior auriculae carnosa pars fibra nostris, graece λοβός , dicitur παρά τὸ λοβεῖν, quod deturpare vel abscindere diceres, nam haec ob scelera truncari solet. Unde a Polluce ἀλλοβια aurium ornatus, qui in λόβῳ, idest fibra perforata imponuntur.[5] Melet. Ruffus.

'ελιξ seu Helice totum illud, quod auriculae circumferentiam ambit, a gyro seu tortuositate sic dicitur.

[6]A[μ]<ν>θαλῐξ seu Anthelice vero illi opposita, in medio post helicem extumescentes prope cavitatem particulas significat. Ruffus.

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[1] When Fabricius describes the putative contents of the tenth *pars*, 'part,' he uses *decimum*, 'tenth.' *Decimum* is neuter, whereas *pars* is feminine. Fabricius does use the correct gender for the other numbers (e.g., *prima*, *secunda*, *tertia*, etc.), and so *decimum* should clearly be *decima*.

[2] Prima.

[3] I.

[4] I. a.

[5] I. bb.

[6] I. cc.

[7]Cavitas vero ipsa, Concha dicitur <κυ>ψέλη[8] quod concava conchyliataque sit. Ruffus

[9]Conchae opposita eminentia iuxta temporis fines Tragos idest hircus dicitur, vel quia hirta haec pars ceu hirci barbula in nonnullis fiat, vel quia pili, qui interdum in ea repullula<n>t[10] densi & rigidique sunt ut hirci barbam emulentur, vel demum quia quibus hirta haec pars sit, ii luxuriosi, ut hirci, dicantur.

[11]Huic opposita ex crassiore Anthelice Antitragos appellatur, nam & haec quoque pars pilosa sit & hirci barbulam imitatur.

Helicis finem, qui subbrevis est A[μ]<ν>τιλοβίδα[12] vocant. Hanc puto esse cavitatem in a<u>r[t]icula[13] seu pinna positam supernem & λόβω idest fibrae oppositam. Omnes iam enumeratae partes (una excepta fibra, quae carnosa tantummodo est) ex cute cartilagineque constant, figuraque varia sunt, sed communiter cavitates, gyros, vortices atque anfractus referunt. Haec de Auricula. Pollux

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[7] I. d.

[8] While explaining the etymology of the term *concha*, 'Conch,' Fabricius claims that the Greek term for *concha* is ψέλ_. The final character is smudged in the original text, but in the *Opera Omnia Anatomica & Physiologica* (1687) text, the final character is clearly η, i.e.,ψέλη. In *A Description of the Body of Man* (Book 8, Chapter 11) Crooke uses the Greek term κυψέλη, 'hollow of the ear,' to describe the *concha*. Fabricius or his printers omit the initial syllable, which is restored in the emended text.

[9] I. d.

[10] Taylor. Fabricius uses the third person singular *repullulat* with the plural subject *pili*, and so the text is emended to the plural *repullulant*.

[11] I. f.

[12] Taylor and Smith. Fabricius uses the terms ἀνθαλίξ and ἀντιλοβίδα for the Anthelix and Antilobe, respectively. Fabricius or the printer, however, misspells both terms with a μ (mu) instead of a ν (nu), i.e., ἀμθαλίξ and ἀμτιλοβίδα. These mistakes have been corrected in the prepared text, as they were in *Opera Omnia Anatomica & Physiologica* (1687).

[13] In both the 1600 and the 1687 texts Fabricius uses the term *articula*, 'little joint,' synonymously with the term *pinna*. It seems illogical that Fabricius would describe a joint in the outer ear. Therefore, if the text is emended so that *articula* reads *auricula*, 'auricle,' then the association with *pinna* is logical.

De Osse Petroso, quod λῐθοειδές dicitur.

CAPUT II.

Nunc ad reliquum auditorium organum ex osse cons[l]<t>atum[14] accedamus. Audiendi organum universum partim cartilgagineum partim osseum visitur. Cartilagineum [15] auricula est, quae ita cartilaginea est, ut ossis naturam nullo modo admittat.[16] Osseum est reliquum & petrosum appellatur, quod ita osseum est ut cartilago hic locum non habeat. Diximus de parte organi cartilaginea, nunc de ossea dicendum. Priusque de tota ossea parte generaliter loquendum, inde de particulis, quas in se totum hoc os compraehendit differendum. Hoc aut auriculam sequitur & a sua duritia λῐθοειδές: petrosum seu lapidosum dicitur, & revera quocunque durissimo osse durius apparet. Durities aut potissimum in hoc osse exterius viget quod crusta durissima densissimaque obducatur, quamuis interius totum cavernosum foraminulentumque sit, id quod de hoc osse duritiem non detrahit, cum laminae cavernulas efformantes quantumuis tenuissimae, & ipsae quoque durissimae sint. Hoc os in basi capitis ponitur, qua parte nervi ab cerebro prodeunt, unde nervum auditorium appellatum ex superna sui parte, posteriorque, per foramen in osse insculptum excipit. Estque os ad rotundum vergens sed oblongum, & non nihil[17] pyramidalem imitans figuram, cuius basis auriculam, vertex autem cerebrum spectat, totumque intra calvariam protuberat. Videreque videberis os exterius continuum & solidum, idque propter crustam, cum tamen ea ablata intus totum ita cavernosum, spongiosum & foraminulentum sit, ut mirari quidem possimus cavernularum infinitatem, enumerare autem non item. Universi igitur ossis antra & quae in iis continentur partes nunc memorare consilium est sumpto ab exteriore ductu exordio. Sed ante omnia oportet, (ut cuncta exacte videas) serra totum

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[14] Taylor. Fabricius uses the non-attested Latin word *conslatum* when it is clear that he means to use *constatum*, 'composed.' The *Opera Omnia Anatomica & Physiologica* (1687) text includes the same mistake, but the emended Latin text corrects the misspelling.

[15] Prima.

[16] I. g.

[17] 6. 7. g.

eiusmodi os a reliqua calvaria separare, quod difficile non est. Si prius amputata ad eius radicem auricula & extracto ex calvaria universo cerebro, ac tota molli substantia, quae universum hoc aurium os circumambit ac tegit, tantum hoc os manibus ad dissecandum appraehendas, & duris dissecantibus cultris malleo percussis utaris. Ita nunc totum negocium ad rationem dissecandi spectans cito ac facile perages, & initium ab exteriori ductu, ut dixi, facias.

De Auris Meatu, qui πὸρος ακουστικὸς graece dicitur.

CAPUT III.

AUriculae finitima est cavernula quae utrinque una [18] πὸρος ακουστικὸς, idest meatus ad auditum pertinens seu auditui accommodatus, seu auditorius vocatur, per quem audimus. Hic meatus totus osseus est cute tamen coriacea opertus: tubulumque oblongum refert oblique sese intus insinuantem, atque ad membranam terminum habentem. Quem facile ex una parte cultro adhibito atque percusso eaque maxime, quae mammillari processui opposita est, conspicies, si modo eam versus processum mammillarem invertas. Ita enim membranam patefactam intueberis.

De Membrana, Tympan[um]<o>[19] appellata.

CAPUT IV.

[20] HAec nonnullis membrana simpliciter [ac] myrinx, <ac>[21] barbaris myringa, nonnullis et tympanum est appellata, quod tympani bellici membranae similis sit. Etenim non deest etiam huic membranae in circuitu [22] a[n]nulus[23] osseus, qui circum circa membranam tendit, ut in tympano circularis

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[18] 4. h.

[19] Since Fabricius equates *Tympanum* with *Membrana*, which is, of course, ablative in relation to *De*, *Tympanum* should also be ablative, i.e., *Tympano*.

[20] 5. 1. 6. 11.

[21] Taylor. In both texts Fabricius or the printers seem to have made a metathesis error, i.e., the words *ac* and *myrinx* should be reversed. Since *ac* is a conjunction, *ac* should not precede *myrinx*.

[22] 6. 7. 8. 9. 11. 12. 13. k.

[23] In both texts Fabricius consistently uses the term *annulus*, 'little year,' where he means to write *anulus*, 'ring.'

a[n]nulus. Qui in pueris conspicuus est, facileque separatur, in adultis caetero subiecto ossi unitur & occallescit. Cuius a[n]nuli membranam tendentis ope tunica haec septum sit firmum totam exteriorem aurem ac meatum ab interiore dirimens ac cludens. Circulumque perfectum referens non tamen ex omni parte planum, sed in medio centroque quodammodo interius incurvatum & gibbum extra cavum, ita ut concinne herbam cymbalitidem seu umbilicum veneris praeseferat.[24] Cuius situs propterea obliquus est, & per eius exteriorem superficiem quasi nervulus verl corda vel filum excurrere transverse videtur. A quanam autem parte producatur haec membrana sensibus omnino conspicuum non est, ideoque eius generationem nonnulli a pia matre, nonnulli ab nervulo, quidam a periostio subiecti ossis faciunt. Quae tamen cum substantiae proprietate a caeteris sit diversa, rationi minime dissentaneum erit eius originem semini acceptam referre. Tunica praeterea est tenuissima densissima siccissimaque, id quod Hippocates quoque protulit his verbis: pellicula in aure iuxta os durum tenuis est veluti aranearum tela, & omnium pellicularum siccissima.

in libro de carnibus.

De hac similiter membrana ab Aristoteles quoque mentio facta est. Quo magis hoc loco demiror Galenum qui nullam prorsus mentionem de hac ipsa fecit. Quinimmo negavit omnino tegmen aliquod consistere ad meatum auditorium, quod aerem motum, qui cum sono fertur, ingredi in aurem impedivisset. Quamuis nonnulli contendunt, a Galeno hanc membranam cognitam fuisse, quod Galenum hanc absolute negasse non patet, sed non ut in oculis adesse protulerit. Quibus nequequam reclamo quod cum Aristoteli tum Galeni gloriae faveam, simul desiderio flagrem Galeno & Aristoteli nihil occultum extitisse. Sed loc[a]<os>[25] Galeni propono ut quisque pro suo arbitratu iudicet. Primus locus est 8 de usu

2. de anima textus 83

[24] *Praeseferat* is best translated as three words, i.e., *prae se ferat*, 'it presents itself.'

[25] Taylor. In both texts Fabricius cites several passages from Galen and uses the term *loca* for 'passages.' Although this is not an entirely inappropriate usage of the neuter accusative plural *loca*, Fabricius should use the masculine accusative plural *locos*. Furthermore, Fabricius uses *locus* in the following line, suggesting that he meant to use the masculine in the first place.

partium <corporis humani> caput 6 < , > secundus [,][26] 11 eiusdem operis caput 12. Tertius in libro instrumento odorat<us>[27] caput 5. Solet praeterea interdum (raro tamen accidit) exterius ante membranam tunica quaedam crassior praeter naturam adnasci opponique quam ego in pueris bis depraehendi. De qua a Paulo[28] mentio sit, qui modum quoque eam curandi atque eximendi proponit, quando dum adest, surdum meatum auditorium auditumque efficit, etenim surdos nonnunquam & consequenter mutos a nativitate saepe fieri autumo, quia a primordiis crassior haec membrana exterius tympanum obvelat. Notant ultimo Anatomici in tympano filum seu cordulam quam tenuissimam transverse myringi exterius obtentam & annexam. Quae aliis arteriola, aliis nervulus, aliis ligamentum, aliis tendo censetur. Quod si nullum horum est, corpus sui generis esse necesse est.

libro [2] <3> caput 23.

De Tribus Ossiculis Malleo, Incude, et Stapeda.

CAPUT V.

Post membranam, quae revera septum est exteriorem ab interiori aure dirimens, interius [29] ampla quaedam cavitas apparet concha dicta, de qua antequam dico. Videnda sunt, quae in hac prima cavitate corpora consistunt; sunt autem haec tria ossicula & musculus.[30] Primum ossiculum a mallei similitudine malleus appellatur, secundum incus, tertium stapes seu stapeda. Malleus altero extremo tenuius & acutum est os, altero vero crassius

Malleus.

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[26] In reference to the tympanic membrane, Fabricius cites *De Usu Partium Corporis Humani* by Galen. In both the original and the *Opera Omnia Anatomica & Physiologica* (1687) texts, however, the title is abbreviated as *de usu part.* The full title is included in the emended text. Fabricius cites two passages in *De Usu Partium Corporis Humani* and uses a comma to separate the two citations. In both Latin texts the comma comes after *secundus*, 'the second,' but it is more appropriately positioned at the end of the first citation and before *secundus* so that it separates the two citations.

[27] In both the 1600 and 1687 printings Fabricius refers to another work of Galen and again abbreviates the title: '*in libro instrumento odorat.*' The full title, *De Instrumento Odoratus*, '*On the Instrument of the Sense of Smell*,' is included here.

[28] In both the 1600 and 1697 printings Fabricius cites Book 2, Chapter 23 of Paulus Aegineta, but he means to cite the same chapter in Book 3.

[29] 7. 8. 18. l.

[30] 16. 11. 10. 14. 13. 15. 9. m.

extuberans ac rotundo capite ideoque femur nonnullis fuit appellatum. Attamen perfectem rotundum non est, sed qua parte incudi nectitur cavitatem obtinet oblongam inaequalemque. Ad sui vero medium duos habet exiguos processus: superiorem, qui musculi insertionem excipit, & inferiorem. Cavatumque intus in suae substantiae medio est, ubi medulla continetur. Hoc ossiculum [31] membranae inhaeret quam pertinacissime facitque eam deorsum quodammodo trahendo ea parte in centro s<uo>[32] incurvari. Qua etiam parte malleoli caput exterius supra membranam protuberat.

[33] Incus vero qui nonnullis etiam dens dicitur, malleo est duplo maior ex altero extremo duo habet veluti crura invicem distantia, tenuia, fereque acuta, quorum alterum altero longius est. Longiori vertice stapedae applicatur, breviore ossi temporum squamoso innititur. Ex altera vero extremitate crassius est os uti incus, eo vero differt a fabrorum incude quod planities incudis in hoc osse deficit. Sed loco plani cavitas inaequalis visitur, qualis in molaribus dentibus fere apparet. Quocirca non parum laudandus Vesalius est, qui hoc os etiam molari denti duas tantum radices habenti comparavit. Cui sane inaequali cavitati malleus nectitur & articulationem facit ad motum comparatam. Incus.

[34] Stapes denique ossiculum est caeteris adhuc minus in medio cavatum & foramen oblongum habens, ut stapes equestris, quam exactissime refert. Tribusque lateribus atque angulis ut triangulus constat. Tria haec ossicula praeter caeterarum ossium naturam periostio nequaquam operta sed nuda visuntur. Tum vero dura perfectaque ossa etiam in nascentibus infantibus apparent: quod pariter nulli accidit ossi. Praeterea mutuo iuncta innexaque sunt, nexusque varius est hoc Stapes. Ossiculae haec a caeteris diversa.

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[31] 11.

[32] Fabricius uses the abbreviation *.s.* in the phrase: *quodammodo trahendo ea parte in centro .s. incurvari*, 'somehow dragging it by that part in its center.' The abbreviation *.s.* is often read *sunt*, but the third person plural form of the verb 'to be' does not fit grammatically or logically into the phrase. The printer of the *Opera Omnia Anatomica & Physiologica* (1687) inserts the term *siue*, 'or,' for the abbreviation. *Siue*, however, does not seem any more grammatical or logical than *sunt*, and so the abbreviation in the emended text is expanded to read *suo*, 'its,' as a modifier of *centro*.

[33] 14. 15. 13. 11. n.

[34] 14. 15. 10. 7. 8. 9. 18. o.

plane modo se habens.[35] Membranae internae faciei, mallei tenuior tantum extremitas valide alligatur, crassiore interim quasi pendula remanente, nisi quod incudi incumbit, eique articulatur, ea scilicet dearticulationis specie, quae [36] γιγγλυμοειδης appellatur, in qua ossa mutuo tum suscipiunt tum suscipiuntur. Etenim tum in malleo & cavitas est & caput, tum vicissim in incude. Moveturque supra incudem malleus, ac motus non quidem difficilis est, sed sensu percipitur propter ei comitem & adiunctum strepitum de quo posterius. Incus autem qua parte malleum suscipit, nullum aliud contingit corpus. Caeterum altero sui breviore extremo seu crure proximo firmatur ossi temporum, longiore vero stapedis acutiori parti, quae vertex dici potest, ligamentali nexu alligatur, stapedemque quoddammodo sustinet. Reliqua aut stapedis pars, quae basis nuncupari potest in ovali quadam cavitate consistit, quasi librata, sicuti & reliqua ossicula utcunque invicem iuncta sint, sese quasi librant, suspensaque videntur, nisi quod stapes ligamento quodam tenuissimo ad acutiorem sua<m>[37] partem pertingente transverse a lateribus ossi alligatur. Invenies autem tria ossicula si sectionem sequaris, uti supra diximus, primum meatus auditorii usque ad tympanum, inde interius procedenti malleus detegetur, & elevato tympano incus & stapes.

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[35] 11. m. 1.

[36] 11. 14.

[37] Taylor. *Sua*, 'its,' in the original Latin as well as in the *Opera Omnia Anatomica & Physiologica* (1687) text must be emended to read *suam* since it modifies the accusative noun phrase *acutiorem partem*, 'sharper part.'

De Musculo Malleum ad Incudem movente.

CAPUT VI.

[38] Musculus quoque exiguus immo omnium minimus sed tamen eleganter musculi formam referens ad supernum mallei processum, qu[ae]<i>[39] membranam attingit, exiguo tendine inseritur. Transverse illuc procedens, & a propinquo osse exortum carnosum sumens, carnosusque incedens & in medio crassior, tandem tenuior redditus in superiorem maioremque mallei processum ad membranam inseritur. Qui vult huiusmodi musculum invenire, incipiat dissectionem ossis, quod ab opposita parte processus mammillaris consistit, incidendo totum os per longitudinem meatus auditorii. Ita n<unc>[40] primo tibi occurret membrana, inde caput mallei, denique sectione interius aliquantulum si procedas musculus quoque se se exeret. Qui ex osse in eadem regione consistente oritur, & carnosus factus oblique ad malleum subtus membranam pervenit, atque in eius processum inseritur, & quatenus musculus est, necessario motum praebet, neque alium praestare potest quam ad mallei & incudis dearticulationem, malleum igitur ad incudem movet. Quod si motus est a musculo, & per dearticulationem factus, dubio procul voluntarius est. Neque cuique mirum videatur in auribus motum voluntarium adesse. Nam si motum voluntarium eum appellamus, quem efficere possumus cum volumus, & non efficere cum nolumus, praeterea crebriorem ac rariorem, velociorem ac tardiorem pro arbitrio possumus, clarissimum est in aure hunc effici motum. Nam ego &

Ratio inveniendi musculi malleum ad incudem moventis

Motus in auribus voluntarii demonstratio

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[38] 17. r.

[39] Taylor. In both the original and the *Opera Omnia Anatomica & Physiologica* (1687) texts the relative pronoun *quae*, 'which,' is not the proper gender to refer to the masculine *processum*, 'process.' *Quae* can be feminine or neuter, but since *processum* is masculine, *quae* must be emended to the masculine form, i.e., *qui.*

[40] Fabricius uses the abbreviation *.n.* while describing his suggested method for dissecting the auditory meatus and tympanic membrane. The abbreviation may stand for *non*, 'not,' but Fabricius clearly does not mean to negate the verb of the phrase, i.e., *occurret*, 'it will occur' or 'it will appear.' The printer of the *Opera Omnia Anatomica & Physiologica* (1687) text expands the abbreviation to *enim*, 'for.' The abbreviation may perhaps also stand for *nunc*, 'now.' *Nunc* is more logical in the context of the passage since Fabricius is describing a step-by-step dissection, and so a word such as *nunc* that conveys a temporal aspect fits nicely into the sentence.

facere ac non facere, & crebrius rariusque & velocius ac tardius facere consulto possum. Ac motus cum strepitu quodam est, perinde ac siquis tria fila modico intervallo distantia tendat, & plectro percutiat, ut in fidibus etiam fieri consueuit, ut siquis ungue tabulam per transversum linearum scalpat, vel scintillam ignis a lignis excussam audiat, praecipue autem percipitur cum oscitare incipimus. Verum in principio hoc est dum in via est hic motus, sonus quidam obscurior, qui videtur aeris commoti, & similis sono, qui sit a baculo aerem percutiente, praecedit. Illud praeterea habet notatu dignum hic motus, quod in utraque aure eodem tempore sit, neque ullo modo separatim in altera tantum aure fieri potest, ut videatur hic motus quandam habere analogiam c[n]<u>in[41] oculorum motu, siquidem uno moto oculo, alter quoque movetur. Hic igitur motus ille est arbitrarius, quem in auribus meis percipio, & alteri ostendere aut docere aliter non possum, quia intus in auribus sit, & exiguus, sed tamen euidens est motus; & sicuti in constringenda manu decipi non possum sic neque in hoc decipior. Hoc dico propterea quod aliqui sunt, qui cum observare in se ipsis non possint praedictum motum, illum negare audent. Sed tamen m[n]<u>ltos[42] semper in publicis theatris reperi, qui illum explorati & confessi sunt. Cur vero ab omnibus hic motus in semetipsis non animadvertatur in usibus dicetur.

Praeterea hoc anno 1599 musculum invenire visus sum in meatu auditorio, qui πὸρος ακουστικὸς dicitur,[43] qui extra membranam est, exiguus, carneus, non expers tendinis, qui a medietate ipsius ductus seu meatus recta fertur usquequo in membranam exterius ad [e]<cu>ius[44] ferme centrum inseratur, ea scilicet parte, qua malleus intus membranae annectitur, quam exterius una cum malleo trahit.

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[41] The printer either inserted an *n* for a *u* or, more likely, simply placed the *u* upside-down in the typesetting for the words *cum*, 'with,' and *multos*, 'many,' which therefore read *cnm* and *mnltos* in the original Latin. The editor of the *Opera Omnia Anatomica & Physiologica* (1687) text corrects these mistakes, and, therefore, the Latin is emended to read *cum* and *multos*. The *Opera Omnia Anatomica & Physiologica* (1687) text, however, is not devoid of the same error in other places.

[42] *Ibid.*

[43] 17. r.

[44] Taylor. Fabricius uses the pronoun *eius*, 'its,' but since a relative pronoun is clearly necessary, the text is emended to *cuius*, 'of which.'

Invenies hunc novum musculum si in recenti cadavere corticem ossis meatus auditorii hinc inde aut exima parte malleo cultrum pertundente incidas, & dextere huiusmodi os ad latera revolvas. Sic enim tibi apparebit musculus, quem sane in omnibus postea non reperi, quamuis existimem ipsum esse necessarium. Atque haec sunt, quae sub membrana in magna primaque cavitate consistunt, corpora.

De Cavitatibus Ossis Petrosi: ac primum de prima, quae Concha dicitur.

CAPUT VII.

Nunc cavitates in osse lapidoso insculptas persequamur, a prima exordium sumentes,[45] quae statim sub membrana apparet. Haec inter caeteras non modo prima, sed praecipua quoque est, tum quia in ea plures partes effatu dignae, uti vidimus, positae sunt, tum quia amplissima omnium est, tum denique quod sedes sensusque audiendi hic celebratur, uti infra patebit. Quae aliis antrum, aliis concha, aliis pelvis, aliis[,][46] tympanum dicitur, quod s<cilicet>[47] cavitas una cum myringa tympanum integrum praeseferat.[48] Cochleam nominare error est, ut infra patebit. Est haec omnino prima cavitas in osse exculpta, rotunda, ac non nihil inaequalis forte etiam aspera,[49] in medioque

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[45] 8. 18. 9. 7. l.

[46] When describing the different terms for the Conch in the middle ear, Fabricius uses a string of *aliis ... aliis*, 'some ... others.' He uses commas betweens terms (e.g., *...aliis antrum, aliis concha, aliis pelvis...*), but for the last term, he or the printer inserts a comma between *aliis* and *tympanum*. The editor of the *Opera Omnia Anatomica & Physiologica* (1687) corrected this obvious mistake, and the emended Latin also omits the comma.

[47] Fabricius uses the abbreviation *.s.* in the phrase describing how the cavity of the middle ear resembles a drum: *...quod s. cavitas una cum myringa tympanum integrum.* Again, this abbreviation is often read *sunt*, 'they are,' but Fabricius does not supply a plural subject for *sunt*. The printer of the *Opera Omnia Anatomica & Physiologica* (1687) again inserts the term *siue*, 'or,' for the abbreviation. *Siue*, again, does not seem any more logical than *sunt*. Therefore, Fabricius is most likely abbreviating *scilicet,* 'namely,' 'that is,' or, literally, 'it is permitted to know.'

[48] Again, *praeseferat* is best translated as three words, i.e., *prae se ferat.*

[49] 19. t.

fere protuberan[s]<tia>[50] propter foramen in aliam pertus[um]<am>[51] cavitatem. Quo loco adnotare licet ab hac prima cavitate in alias aliasque iri propemodum infinitas cavernulas. Quibus auditorium organum universum ita refertum est, ut assequi ac denumerare possibile non sit. Tamen in hac prima cavitate [52] quaedam foramina insculpuntur interiusque pertu<n>duntur,[53] quorum unum Ovalis cavitas est, cui stapes incumbit, ipsumque ostium magna ex parte occupat cluditque, a quo Fallopius cui in rebus abstrusis maximam fidem adhibeo, utque Praeceptorem colo, vult in labyrinthum iri.

Secundum foramen ducit in cochleam, quam ego multos iam annos organum ad ostensionem parans, transverse ipsam per totum cochlearum ductum forte incidi. Diuque servavi, & solenni complurium annorum spectacula auditoribus meis inspectanda[m][54] proposui; quot annis publice plenis theatris

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[50] In both printings of *De Auditu* Fabricius uses the nominative participle *protuberans*, 'growing out,' in a clause describing the primary cavity of the petrous bone, i.e., the middle ear. Although the grammar of the sentence implies that he is describing the cavity, he is rather referring to the promontory of the middle ear, which is a protrusion in the cavity caused by the Cochlea. Since Fabricius refers to a *protuberantia in media cavitate*, 'a protuberance in the middle cavity,' in the index of figures, he is obviously using the term *protuberantia* for the promontory. *Protuberantia* seems to be neuter plural, but Fabricius clearly uses it as a feminine singular: *protuberantia...quam...* (Index of Figures, 1c). The Latin term *promontorium*, 'promontory,' must have entered the medical vocabulary after 1600. The Latin therefore has been emended so that *protuberantia* replaces *protuberans*. The clause is now independent of the first, and the reader must supply the third person form of the verb 'to be,' i.e., *est*.

[51] Taylor. Fabricius is clearly referring to the promontory of the ear, but the Latin grammar is vague. *Pertusum*, 'perforated,' is a neuter adjective, but *cavitatem*, 'cavity,' is feminine, and so *pertusum* is not modifying *cavitatem*. *Foramen*, 'hole,' is neuter and so could be modified by *pertusum*, but it seems illogical that Fabricius should refer to a 'perforated hole in another cavity.' Therefore, although the 1687 printer makes the same mistake, *pertusum* is emended to *pertusam* so that it may modify *cavitatem*.

[52] 19.

[53] Taylor. Fabricius or the printer misspells *pertunduntur*, 'they are perforated,' without the first *n*, i.e., *pertuduntur*. The editor of the *Opera Omnia Anatomica & Physiologica* (1687) corrects this mistake, and, likewise, the emended Latin includes the 'n.'

[54] Taylor. Fabricius describes how he kept specimens, '*spectacula*,' of the Cochlea so that they could be inspected, '*inspectanda*,' by his listeners. In both

ostendi, donec caries ipsam cavitatem, quae elegantissime cochleae gyrum imitabatur, consumpserit.

Tertium foramen ut patet in alias ducit cavitates, quae tam innumerae sunt, invicemque intrincatae, ut merito labyrinthus dicantur, & admirari quidem eas licet, dinumerare autem seu ad ordinem quendam redigere aut dirrigere non est ut quispiam tentet. Vanus enim ut puto omnis erit susceptus labor. Quinimmo facile (ni fallor) quisque credet eas sine ullo ordine, & fortuito potius quam ullius usus gratia conditas esse, cum tamen divina atque infinita sapientia, quam assequi homini datum non est, haec omnia construxerit, & alicuius gratia ad minimum usque fecerit. Deprehendes autem haec omnia verissima esse si fine ullo deleeta ex omni ferme parte huiusmodi osseum organum incidas. Videre enim videberis (una excepta externa crusta [)] quae durissima, continua, perpolitaque est <)>[55] reliquum ossis cavernosum, foraminulentum, pertusum, & spongiosum totum apparere. Uti quo fieri potuit, delineatione ac pictura repraesentare, quod lingua exprimi non potuit, studuimus.

De Aere Congenito aut (uti vocant) Complantato.

CAPUT VIII.

QVod si sensu patet universum auditorium organum, maximeque ubi auditus celebratur, ex cavitatibus constare, & cavernosum totum esse, atque ex tenuissimis durissimisque ossibus quasi laminis cunctas cavernulas efformari, cumque cavernulae omnes vacuae appareant, neque ex altera parte vacuum in natura detur, est omnino necessarium asseverare omnes eiusmodi cavitates aere plenas esse. Atque hic ille aer est, qui ab Aristotele &

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the original and the *Opera Omnia Anatomica & Physiologica* (1687) texts Fabricius or his printers incorrectly use the feminine singular *inspectandam*, which does not agree with the gender and number of the neuter plural *spectacula*. The emended Latin text omits the *m* in *inspectandam* so that it is neuter plural, *inspectanda*.

[55] Taylor. Fabricius uses parentheses around the phrase *una excepta externa crusta*, 'with one exception being the outer surface,' but follows the parentheses with a relative pronoun (i.e., *quae*, 'which') for which no subject exists outside the parentheses. The parentheses are therefore extended in the emended text so that the relative clause modifies *crusta*.

priscis complantatus, inaedificatus, & congenitus appellatur. Quem etsi visu ac sensu non licet, tamen euidentissima demonstratione depraehendere & videre omnino licet. Quem existimare oportet omnia loca replere atque a primordiis in aure positum esse, simulatque vacua spatia in osse excavata fuere, indeque congenitum inaedificatum & complantatum fuisse appellatum. Qui omnino tenuis, clarus & immobilis, quietusque esse in aure ad bene audiendum debet, uti in usibus dicetur.

De Ductu, seu Meatu, siue Semita, quae a prima cavitate, seu concha in palati fines seu fauces protenditur.

CAPUT IX.

Praeter alia memorata foramina, quae in concha, prima scilicet cavitate apparent, unum adhuc restat postremo loco describendum, quod ab ea ad palatum protenditur. Meatusque est quem veluti aquaeductum dixeris, ideoque a prima ossis cavitate foramen efformatur rotundo canaliculo seu tenuiori calamo persimile. Hinc oblique deorsum procedens in palatum siue narium amplitudinem prope radicem gargareonis pertunditur, atque cartilagine per totum ferme ipsius ductum incrustatur. Hunc meatum priscos non latuisse testis est Aristoteles, qui primo de historia animalium caput 11 voluit ex auribus in oris palatum usque semitam pertendi. Idem in problemata testatus est, quamuis an Galeno fuerit cognitus non constet. Hunc ductum non difficulter invenies, si in nud[is]<a> exiccat[is]<a>que calvari[is]<a>[56] fetam porcinam, aut tenuissimum argenteum stylum in meatum auditorium immittas. Ipsum enim exire paulo post ad palati seu faucium regionem conspicies. In recenti autem capite huius ductus ora foraminaque ex utraque palati parte qua finitur videbis amplissima.

[56] In both the 1600 and 1687 texts Fabricius describes a single *fetam porcinam*, 'fetal pig,' that has multiple skulls: *nudis exiccatisque calvariis*, 'with bare and drained skulls.' In order to make the numbers agree, the text is emended such that the pig has only one skull.

De Nervo Auditorio.

CAPUT X.

Nervus ad auditum pertinens in quinto pari ab omnibus censetur, quod ubi a cerebro prodit, in foramen in osse petroso eius causa, insculptum sese insinuat, atque in nonnullas diductum propagines sic in plerasque ossis cavernulas maioris momenti discurrit, donec ad primam praecipuamque cavitatem, concham appellatam ubi ossicula consistunt, perveniat, termineturque. Quam rem ita accipi velim, ut negandum haud quaquam sit, nonnullas minoris momenti propagines in aliis cavernulis cessare, sed tamen potiores, ad potiorem & maiorem, uti dictum est, accedere. Quae omnia non difficulter rimaberis, si serra prius organo auditus quod recens sit, a reliqua calvariua separato, mox extremum acuti cultri mucronem ad foramen positum ubi nervus est, malleo pertundas, atque frustulum a reliquo osse resolvas; idque subinde toties repetas nervum tum sequendo, tum illaesum servando, donec ad ultimas nervi fibras ventum sit, sic (ni fallor) totius auditorii nervi propagatines, atque privatim quas cavernulas adeat, ubi finiatur, ubiue procedat optime conspicies. Hoc loco lubens abstinebo ab adversa inter Anatomicos opinione de nervo auditorio duplici, molli videlicet & duro, an sicuti oculis mollis ad sensorium, durus ad sensorii musculos, ita in aure eat. Abstinebo pariter a fabrica nonullorum animalium recensenda ac describenda, quae ad magnam sensorii admirationem lectorem traducunt, quando haec & alia pleraque in magno opere alias exactius persequemur.

XIX Figurarum Auris explanatio.

Prima Figura auriculam totam integram exhibens.

a. Inferior auriculae pars λοβός dicta.
b. Auriculae circumferentia helice dicta.
c. Protuberantia auriculae, quam anthelicem dicunt.
d. Concha auriculae.
e. Hircus siue tragos, conchae videlicet adnata eminentia.
f. Antitragos.

2. Anteriorem auriculae faciem excoriatam pingit.
3. Posterior auriculae facies excoriata.
4. h. Meatus auditorius in osse squammoso exculptus.

5. i. Membrana Tympanum dictum.
6. g. Os oblongum pyramidalem figuram exhibens.
   i. Tympanum.
   k. An[n]ulus osseus.
7. g. Os pyramidalem figuram referens.
   k. An[n]ulus osseus.
   l. Cavitas concha dicta.
   o. Stapes.
8. k. An[n]ulus osseus.
   l. Cavitas concha dicta.
   o. Stapes.
9. m. Malleus.
   o. Stapes.
10. m. Malleus. n. Incus. o. Stapes.
11. i. Tympanum. m. Malleus. n. Incus.
12. k. An[n]ulus osseus.[57]
13. k. An[n]ulus osseus.
   m. Malleus.
   n. Incus.
14. m. Malleus. n. Incus. o. Stapes.
15. m. Malleus. n. Incus. o. Stapes.
16. m. Malleus.
17. r. Musculus nuper inventus.
18. l. Concha, cavitas.
   o. Stapes.
19. s. Protuberantia in media cavitate.

[57] As before, Fabricius uses the term *annulus*, 'little year,' instead of *anulus*, 'little ring.'

Appendix 1: Sound and Hearing in the Renaissance

From the classical period and through the Renaissance, anatomists debated the respective importance of vision and hearing and, specifically, which sense was more important to both human survival and epistemology. In the century preceding *De Visione, Voce, Auditu* (1600), Charles de Bovelles (1479 – 1567) and Giovanni Battista Benedetti (1530 – 90) wrote extensively on this debate, and they both, of course, relied heavily upon Aristotle (Frangenberg 74). In *De Sensu*, '*On Sense*,' (437a) and *De Anima*, '*On Spirit*,' (424) Aristotle presents equally compelling cases for the two senses that, since they transfer information through a medium, are the most important, i.e., vision and hearing. Although vision is more necessary for daily life and can be equally useful in gathering information, Aristotle argues that hearing is more important since speakers transfer knowledge through dialogue, and hearing is responsible for detecting dialogue. Furthermore, according to Aristotle, images can deceive viewers more readily than sounds deceive listeners. Bovelles and Benedetti take opposing sides in this debate: Bovelles favors hearing in *Liber De Sensibus*, '*A Book on Senses*' (1509), whereas in 1585 Benedetti argues for the supremacy of vision in *Comparatio Visus et Auditus*, '*A Comparison of Vision and Hearing*' (Frangenberg 72). Having been educated during the middle of the sixteenth century, Fabricius undoubtedly was aware of both authors' arguments. The fervor with which Bovelles, Benedetti, *et al.* debate their viewpoints suggests that Fabricius chooses very popular and controversial issues as the subjects of his first work.[1]

Although Renaissance anatomists debated the supremacy of the senses, they seemed to be fairly unified regarding their understanding of sound production and the physiology of hearing. Aristotle suggests that one object striking another and then the air – or simply striking the air without any other object – produces movements in the air that travel to the ear and are perceived as sound (*De Anima* 419). Aristotle claims that by moving the air, the *μέγεθος [βοης]*, 'loudness of sound,' affects the air in a manner that can be perceived, '*αἰσθάνεσθαι*,' by the ear (*De Anima* 424). Perception inside the ear,

[1] Nonetheless, without a complete translation of *De Visione, Voce, Auditu* (1600), it is impossible to determine whether Fabricius means for his first publication to address or even to answer the questions regarding the relative values of vision and hearing.

explains Aristotle (*De Anima* 420), is dependent upon the transfer of the motion in the external air into the air encased in the middle ear. Aristotle believes that once in the internal air, the motion can be properly perceived as the *μεγεθος* of the sound.[2] Renaissance anatomists whole-heartedly subscribe to this Aristotelian theory of sound production and reception. Furthermore, anatomists in the Renaissance interpret their findings from human dissections and write their texts in the framework provided by Aristotle.

The first book of *De Auditu* on the anatomy of the ear does not readily provide insight into Fabricius' treatment of sound production and reception. Nonetheless, an analysis of a contemporary English text by Helkiah Crooke that relies heavily upon *De Auditu* does provide some insight into Fabricius' thoughts on sound reception. Crooke's *A Description of the Body of Man* (1616) frequently refers to Fabricius and *De Auditu* in its description of hearing. Crooke writes his passage on hearing in much the same style as Fabricius, but Crooke does not separate his discussion of the anatomy of the ear from his discussion of its functions, as Fabricius does in his systematic Aristotelian manner. Crooke recognizes and describes the same parts as Fabricius, and Crooke cites and credits many of the same authors, including, of course, Aristotle and Galen. So dependent upon Aristotle is Crooke that he incorrectly interprets the Renaissance discoveries in anatomy so that they fit into the Aristotelian paradigm. Specifically, after Italian anatomists had described the ossicles in the middle ear, Crooke describes the ossicles not as the mechanical bridge between the tympanic membrane and the Cochlea but as supports for the membrane:

> Forward or inward according to the motion of the membrane whereto it is annexed ... the outward air is driven inward and upward, remaining so long ... on the

[2] In *De Anima* (424) Aristotle says that sensory perception, '*αἰσθησις*,' is the perception, '*δέκτικος*,' of the form, '*εἶδος*,' of a sensible object, '*αἰσθητος*,' without the material of the object. In *De Sensu* (437) he further explains that a sensible object, '*αἰσθετος*,' has a magnitude, '*μέγεθος*.' In the case of hearing, the *μέγεθος* is the magnitude or loudness of a sound. Aristotle is not clear as to how the perception of *μέγεθος* translates into an understanding of the *εἶδος* of an object. Although he does not refer to the Greek terms, Francis Bacon in *Sylva Sylvarum* (1652) provides an interpretation of Aristotle by suggesting that sound transmits the 'spirit' of an object.

> inside [un]til the Inbred air is affected with the sound, which air wandering through the circles, convolutions, and boroughs of the ear, maketh the representations of the sounds to be received by the branches or tendrils of the fifth pair of Synewes [sc., the auditory nerve], by which they are connected in a moment of time...But that membrane should not be driven too far inward, the Hammer opposeth it...The Hammer determineth at the small cavity of the Anvil whereinto the head of the Hammer is articulated, wherefore the Anvil being a firm and stable bone, stayeth the inclination of the membrane...And as the Anvil is assistant unto the Hammer by laying a law upon his motion ... so also the stirrup standing upon the cavity of the stony bone near the circles as it were upon a stable basis, doth elegantly sustain ... (Crooke 595).

Aristotle's paradigm on auditory perception is highly dependent upon the movement of the internal or, as Crooke says, 'inbred' air by the tympanic membrane. That is, according to Aristotle, the vibrations of the membrane move the inner air, and the brain somehow perceives sound as it resonates in the air-filled cavities of the inner ear. Therefore, Aristotle makes no mention of the ossicles in his paradigm on hearing. The membrane, however, moves the ossicles, which mechanically transmit the motion into the Cochlea. Crooke does not perceive the ossicles as a bridge but rather as a means of support. Interestingly, Crooke can use Aristotle's work as evidence for the existence of such support since Aristotle claims that if the 'excitement of the sense organ is too strong,' then the organ cannot properly perceive the sense (*De Anima* 424).

Although the analysis of Crooke does not prove that Fabricius interprets auditory perception in strict Aristotelian terms, Crooke's dependence upon Fabricius' work suggests that the Paduan anatomist had similar views. In the first book of *De Auditu* Fabricius devotes an entire chapter to the internal or, as he says, 'congenital' air. Furthermore, although his teacher discovered it, Fabricius does not discuss in detail the Cochlea, which Aristotle does not include in his paradigm on auditory perception. In addition to Fabricius' devotion to Aristotle, the fact that Fabricius highlights the air and virtually ignores the Cochlea in his discussion of the anatomy of the ear suggests that Fabricius understands auditory perception in an Aristotelian manner. Nonetheless, this indirect interpretation of Fabricius' views cannot be conclusive, especially as it does not

address Fabricius' thoughts on the functions of the ossicles, which he discusses in the later books of *De Auditu*.

By organizing *De Auditu* as he does, Fabricius does not discuss the action and functions of the ear in *De Dissectione et Historia Auris*. As such, Fabricius addresses only the anatomy and not the physiology of the ear in this first book. A translation of the final two books of *De Auditu* will provide evidence regarding Fabricius' understanding of the functions of the ear and how his understandings relate to the classical and Renaissance understandings.

Appendix 2: Modern Images of the Anatomy of the Ear

In order for the reader to understand some of the anatomical structures of the ear, the following images have been adapted from drawings by Frank H. Netter, M.D. Many of the same structures described by Fabricius are labeled in Netter's figures.

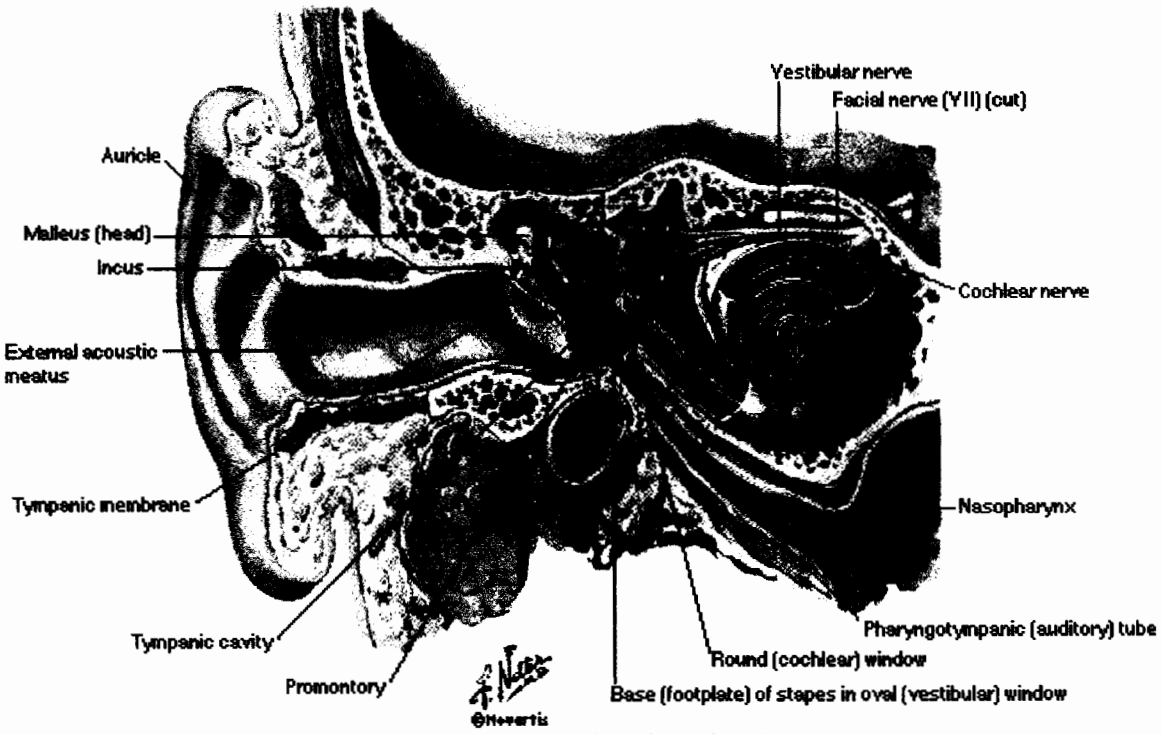

Figure 9: A Frontal or Longitudinal Section of the Ear.

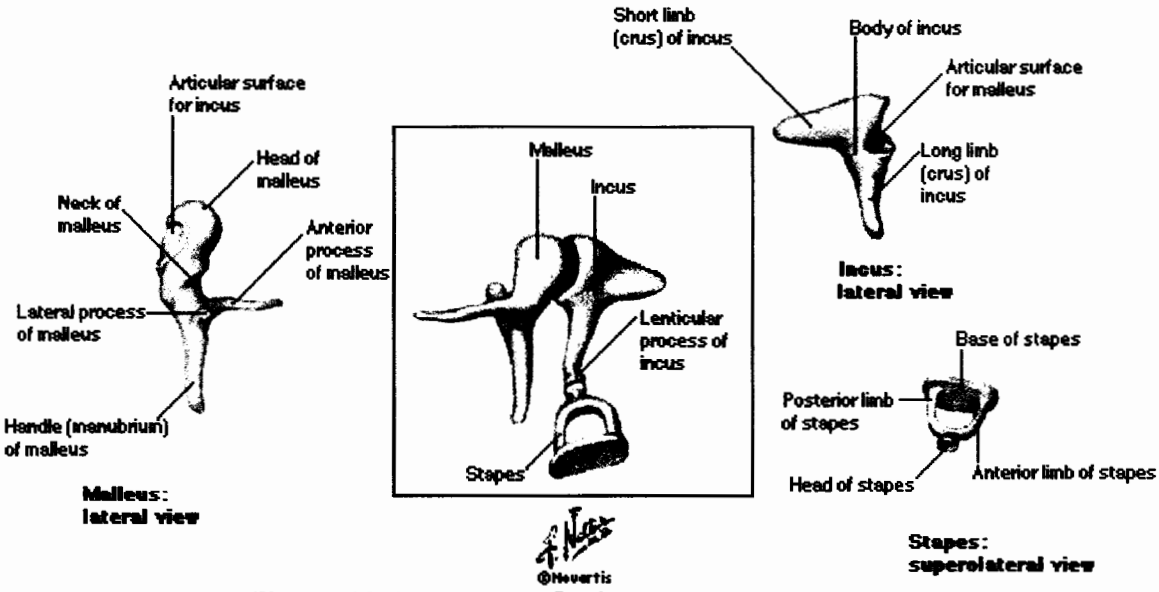

Figure 10: The Three Ossicles of the Middle Ear.

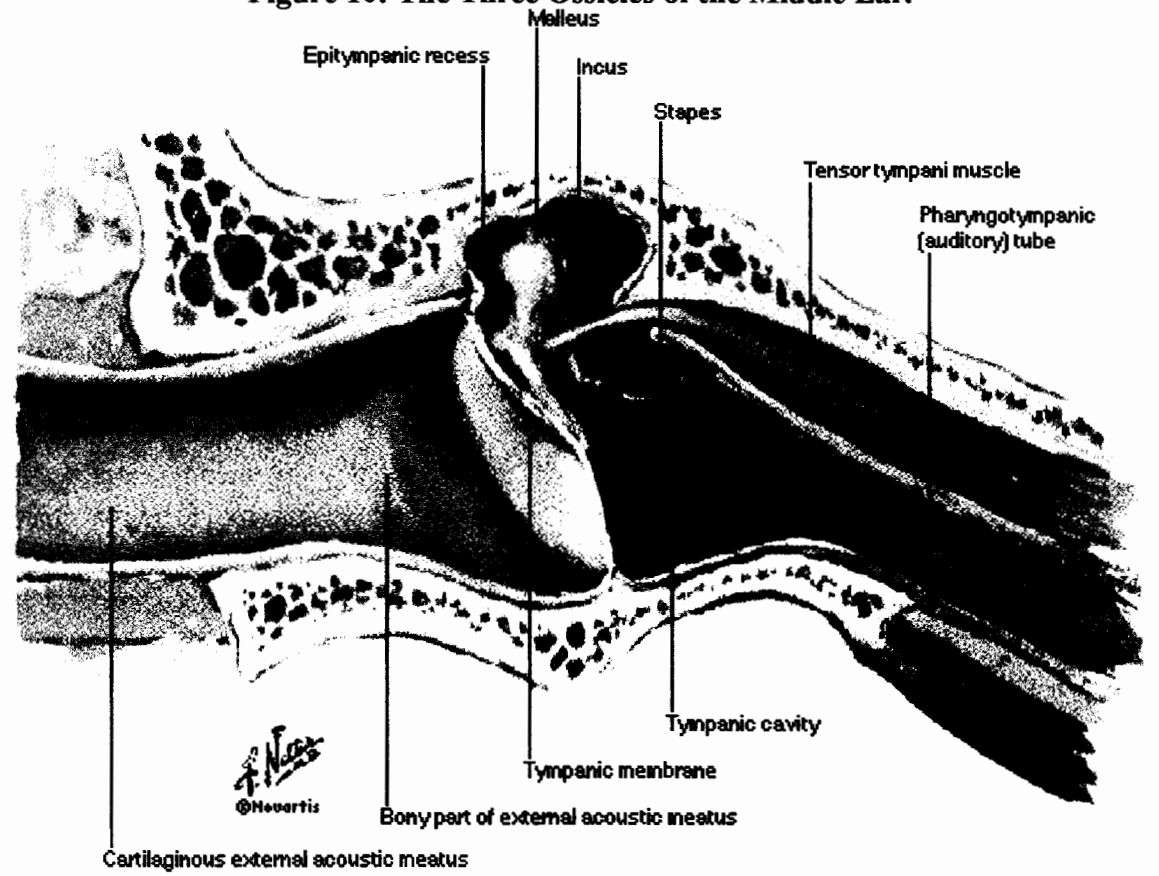

Figure 11: A Frontal or Longitudinal Section of the Middle Ear Cavity. The *tensor tympani* muscle arises parallel to the auditory or Eustachian tube and inserts on the manubrium of the Malleus. If Fabricius is not claiming to have discovered the *tensor tympani*, then he claims to discover a fictional muscle since clearly no muscle exists in the external acoustic meatus.

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