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*October* 1, 1839.

THE

# British and Foreign Medical Review.

EDITED BY JOHN FORBES, M.D., F.R.S., AND JOHN CONOLLY, M.D.

*Editors of the "Cyclopædia of Practical Medicine."*

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# BRITISH AND FOREIGN MEDICAL REVIEW.

*Edited by* JOHN FORBES, M.D. F.R.S.

## Principal Contents of No. XVI. October, 1839.



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### CRITICAL NOTICES.

"The accession of The British and Foreign Medical Review to our list, it seems imperative on me to notice. The wide circulation of its first Numbers is a guarantee of the high estimation in which it is held; and every reader of this work must have felt satisfied of its being conducted with a strict reference to those gentlemanly and elevated feelings which should ever characterise a scientific journal: discarding the froth and scum of ephemeral publications, it collects and intermixes the ingenious speculations of the day with the most solid practical materials, and exhibits a degree of erudition hitherto unknown among us."—*Retrospective Address, delivered at the Manchester Meeting of the Provincial Association*, July 21, 1836, by J. G. Crosse, Esq. F.R.S

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# TREATISE ON THE EAR;

INCLUDING ITS

## ANATOMY, PHYSIOLOGY, AND PATHOLOGY;

FOR WHICH THE AUTHOR OBTAINED A GOLD MEDAL IN THE UNIVERSITY OF EDINBURGH.

BY

JOSEPH WILLIAMS, M.D.

MEMBER OF THE ROYAL COLLEGE OF SURGEONS.




LONDON:

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MDCCCXL.

LONDON:
PRINTED BY IBOTSON AND PALMER,
SAVOY STREET.

The following Essay obtained, as an Inaugural Dissertation, the recommendation of the Medical Faculty of Edinburgh to the Senatus Academicus, by whom a gold medal was awarded to the author: it has been printed in conformity with the College Rules of the University of Edinburgh, and is now submitted to the medical profession.

The form of an Essay necessarily excludes any length of detail; the ensuing pages present, therefore, a general outline, rather than a complete investigation, of a subject at once comprehensive and difficult, in the prosecution of which the author has little more than glanced at the following topics:—The special Anatomy of the Human Ear—a brief description of Different Portions of the Ear in various Animals—the Theory and Laws of Sound—the Physiology of the Ear, and the Difficulties connected with that branch of the subject—the Pathology of the Ear, and

some interesting Cases in illustration—Suggestions as to the mode of treating Diseases of the Ear—Instances of Morbid Alteration in Structure, and Congenital Malformations—their presence or absence in the congenitally Deaf and Dumb—and some observations respecting Medico-Legal facts connected with the Deaf and Dumb.

The author cannot refrain from acknowledging his obligations to the labours of M. Itard, whose valuable suggestions respecting the treatment of the Deaf and Dumb claim the attention of all those who have the superintendence, professional or otherwise, of that interesting class of the community.

8, *Tavistock Square*,
25*th Nov.* 1839.

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ON THE

# ANATOMY, PHYSIOLOGY, AND PATHOLOGY

# OF THE EAR.

In surditate quidnam est mali?—*Cicero.*

A knowledge of the structure of the ear is by no means general in the profession, and still less are its diseases understood.—*Sir A. Cooper. Phil. Trans.* p. 448. 1801.

Tantôt excité par l'espoir d'arracher au domaine de l'empirisme, et d'élever à la hauteur des autres parties de la médecine, cette branche négligée et presque dédaigneé de l'art de guérir.—*Itard.*

ON THE

# ANATOMY, PHYSIOLOGY, AND PATHOLOGY OF THE EAR.

---

Empedocles appears to have been the first to have given any description of the ear, and this seems to have been merely confined to the external portion.

It is impossible to say how far Galen's knowledge extended; but from his time to the commencement of the fourteenth century, anatomy seems to have made no progress; but in the year 1315, Mundini de Luzzi, having instituted public dissections, the anatomy of the internal ear became gradually known. The anatomy of Mundini seems to have been the text-book in the European universities, until the middle of the sixteenth century; when the discoveries of Achillini, Berengar of Carpi, Serveto, Sylvius, Eustachius, Fallopius, and Vesalius, afforded more certain and exact information, and doubtful points were now no longer referred to Galen. It was at this time that the organ of hearing, which had completely escaped the notice of the ancients, first became investigated.

It would be tedious to mention the successive discoveries, investigations, or excellent descriptions of

Alexander, Vesalius, Ingrassias, Fallopius, Eustachius, Aranzi, Spigel, Morgagni, Duverney, Valsalva, Cassebohm, Cotugno, Meckel, Scarpa, Camper, Comparetti, Bichat, and Cuvier, or those of our own countrymen, Hunter, Monro, Home, Astley Cooper, Carlisle, and Charles Bell.[1]

The organ of hearing is contained in the temporal bone, which is found on either side, and at the inferior part of the cranium.

Each temporal bone is arbitrarily divided into two portions, the *squamous and petrous;* the latter *alone* containing the organ of hearing.

At the inferior and posterior part of this bone is found the *mastoid process*,[2] externally hard, and composed internally of a cancellated structure, which communicates with the cavity of the tympanum. Three or four of these cells are always of remarkable size.

The *auditory process*[3] reaches from the root of the zygomatic to the mastoid process, and forms the inferior edge of the meatus auditivus externus, and gives attachment to the cartilages of the ear.

The *meatus auditivus externus* is found between the zygomatic and mastoid processes, and immediately above the auditory process, extending from the exter-

[1] For history of the anatomical discoveries of the ear, *see Medical and Physical Journal*, p. 160, vol. ii. Consult also the historical preface of J. M. G. Itard, 1821. *Paris.—Traité des Maladies de l'Oreille et de l'Audition.*

[2] The mastoid process is wanting in very early infancy.

[3] The auditory process is in a child a distinct ring, which is laid upon the rest of the bone. In brutes, indeed, it is a process standing out. In the adult the process is united to the bone, the cartilaginous tube is fixed to it, and the membrana tympani is stretched upon it.—*Bell's Anatomy*. 1816.

nal ear to the cavity of the tympanum, being about one inch in length, and resembling an Italian *f*.[4]

A second foramen is found between the mastoid and styloid processes, and is appropriately named the *stylo-mastoid foramen;* it is the termination of the canal of Fallopius, and through it passes the portio dura.

The *external* opening of the carotid canal is found anterior and internal to the styloid process. The internal carotid artery passes through this canal to enter the skull, in its passage giving off several small branches which penetrate the cavity of the tympanum, through the foramina found in this canal.[5] It also admits filaments of connexion between the sympathetic and the fifth pair of nerves.

On the anterior edge of the petrous portion, immediately where it joins the squamous portion, and above the inner opening of the carotid canal, is found the bony part of the *Eustachian tube*, above which, and only separated by a thin lamina of bone, is a small foramen, through which passes the tendon of the tensor tympani muscle.

At the superior part of the fissura glasseri, are found two foramina,[6] through one of which passes the chorda tympani, and through the other the tendon of the laxator tympani muscle.

[4] In the fœtus the meatus is very long, is wide within, contracted in its centre, and large without. There is a space between its fibro-cartilages; the osseous part of the canal does not exist, but its place is supplied by membrane.

[5] Valsalva.

[6] In some very perfect temporal bones now before me, I distinctly observe two foramina, which are separated from each other by a very thin, although a very distinct, lamina of bone.

The *petrous portion*,[7] called sometimes os lapidosum, is of a triangular shape, having a direction forwards and inwards, where its apex joins the basilar processes of the occipital and sphenoid bones. It has an *anterior*, a *posterior*, and an *inferior* surface.[8]

On the *anterior* face are found depressions for the middle lobes of the brain, and for the semi-lunar ganglion; and on its inner and anterior surface is found the *internal* opening of the *carotid canal*, and a little external and superior, the Eustachian tube; between these two, and superior to both, we trace a groove leading to the foramen innominatum, which gives transmission to the reflected branch of the fifth, and which usually is divided into two or more foramina, and very frequently a complete sulcus or depression is found in the immediate neighbourhood, around which are several minute openings.

On the *posterior face* we find the *meatus auditivus internus*, allowing the transmission of the portio dura and portio mollis; the former passing through the canal of Fallopius, the latter going to the labyrinth, being the special nerve of hearing. Behind this foramen is found the *aquæductus vestibuli*.[9]

The *aquæductus cochleæ* is situate at the *inferior* face, between the jugular fossa and the carotid canal.

The *auricle*[1] is situated on either side of the head, in front of the mastoid process of the temporal bone.

[7] The petrous portion is very soft during the fœtal and very early life.

[8] The anterior and posterior semi-circular canals are protuberant upon its surfaces.—*Bell's Anatomy*. 1816.

[9] See Cotunnius de Aquæductibus auris humanæ.—*Neap*. 1761. 4to.

[1] In the fœtus the auricle is very soft.

It is of an irregular oval figure, larger above than below, is free throughout its circumference, except on its anterior surface, where it is connected with the cheek. Upon its external surface are found numerous fossæ and prominences, forming a number of parabolic curves; these, although irregular, lead into each other, and terminate in the concha, and to all these parts names have been given.

The *helix*, being the outer margin, commences the opening of the meatus, forms the circumference of the auricle, and terminates in the lobe.

The *anti-helix* commences by two crura, behind the helix, which unite and form one prominence, at first thick, but gradually becoming thinner as it passes down to terminate above the anti-tragus.

The *tragus* is the small triangular projection, whose apex overhangs the meatus externus.

The *anti-tragus* is found behind the tragus, and below the anti-helix.

The *fossa innominata* is the depression commencing in the concha, between the helix and the other part of the auricle.

The *fossa navicularis* is the groove between the two crura of the anti-helix, before described.

The *concha* is the largest cavity, and is divided into two parts by the commencement of the helix; it is bounded above by the anti-helix, and below by the tragus and anti-tragus, and on the inferior part of the internal surface is the meatus externus.

The auricle terminates inferiorly in the *lobe*,[2] which

[2] There is a preparation at the London College of Surgeons, No. 1621, of the ear of an Ethiopian. The auricle is large, but the *lobe* is wanting.

is principally composed of fat, and possesses no elasticity. The auricle is made up of a thin skin, connected to fibro-cartilage by cellular structure, never containing any fat, and of ligaments and muscles.

The fibro-cartilage does not extend through the whole auricle, being deficient between the helix, tragus, and anti-tragus; these cartilages are, however, firmly held together by fibrous tissue.

There are three ligaments to fix the auricle to the side of the head, a *superior*, *anterior*, and *posterior*.

The muscles of the auricle may be divided into those which move the whole external ear, three in number; and those which move the individual parts of the auricle, being five in number.

Muscles which move the whole external ear.

1. *Attollens aurem*, arises from the temporal aponeurosis, and passes down to be inserted into the superior part of the concha.

*Use.*—It elevates and draws forward the auricle, enlarging the concha and meatus auditivus externus.

2. *Auricularis anterior*, arises from the temporal aponeurosis at the base of the zygomatic process, and passes backwards to be inserted into the inner surface of the helix.

*Use.*—It assists the former muscle.

3. *Auricularis posterior*, has three or four origins from the mastoid process, and is inserted into the lower part of the inner surface of the concha.

*Use.*—It draws the auricle backwards, and is said to contract the meatus. (?)

When these three muscles act together, they enlarge the meatus externus.

The muscles proper to the auricle, and moving its individual parts, are five in number.

1. *Tragicus*, arising from the base of the tragus, passes forwards and is inserted into the apex of the tragus.

*Use.*—To draw the apex outwards and forwards.

2. *Anti-tragicus*, is connected with the cartilages of the anti-tragus and the anti-helix.

3. *Helicis major*, passes from the helix major, to be attached to the cartilage of the helix minor.

4. *Helicis minor*, situate within the concha, has a similar direction to the helicis major.

All these muscles assist in making the auricle tense and concave.

5. *Transversus auriculæ*, arises from the inner and upper part of the dorsum of the auricle, and passes outwards to be inserted upon the convexity of the concha.[3]

*Use.*—To antagonize the helix major and minor, thereby diminishing the concavity of the auricle.

A great many small muscular fibres may be traced over different parts of the auricle, which are called *vestigia*; very minute glands resembling millet seeds are found between these muscular fibres.

The auricle is well supplied with blood-vessels and nerves, which will be hereafter described. The nerves are much more distinct on the dorsum of the auricle, than they are on its concave surface.

Although, so far as I am aware, absorbents have not been demonstrated, yet the fact of ulceration taking place, is quite sufficient to justify one in inferring that they actually do exist.

The glands are placed upon the outer surface of

[3] Mr. Tod has described two other muscles, an obliquus auris and contractor meatus.—*See Tod on the Organ of Hearing*, p. 5.

the sterno-cleido mastoideus, where the absorbents terminate.

The *meatus auditivus externus*, very variable in its diameter, extends from the external ear to the tympanum, from which it is separated by the membrana tympani; it has an inclination forwards, and its inferior surface is longer than the superior, in consequence of its inner extremity terminating obliquely. It is formed of skin, fibro-cartilage, ceruminous glands, and bone.[4] The meatus externus is entirely composed of cartilage in the fœtus; it is filled by a peculiarly viscid secretion, varying in colour, sometimes white and sometimes yellow, and is supposed to be for the purpose of protecting the internal ear, from the liquor amnii.

The skin is a continuation of the common integuments, and passing into the meatus gradually becomes attenuated, completely lines the meatus, and forms the external layer of the membrana tympani.[5]

This mucous membrane is perforated by several small *excretory ducts*, in addition to the ceruminous glands, and at its commencement are found numerous small and short hairs, called *pili auriculares*.

The *fibro-cartilages* are a continuation of the tragus and inferior part of the concha; they do not form a perfect tube, neither do they unite, but are connected together by fibrous tissue; and it is more particularly between these fissures, called the *fissures* of *Santorini*, that we find the *glandulæ ceruminosæ*;[6] each gland having an excretory duct to convey the cerumen to the meatus.

[4] See page 4.

[5] This cul de sac may be separated by the putrefactive process.

[6] First described by Warthon in 1656.—*See also Valsalva de Aure Humanâ.*

The *tympanum* is placed between the meatus auditivus externus and labyrinth, and forms the middle portion of the ear; it is irregular in form.[7]

It has an *external* wall occupied by the membrana tympani; an *internal* wall separating the cavity of the tympanum from the labyrinth; an *anterior* wall, pierced by the Eustachian tube; a *posterior* wall, bounded by the mastoid process; a *floor*, bounded by the carotid canal, and fossa jugularis; and a *roof*, communicating with the opening to the mastoid cells.

The *external* wall is formed by the membrana tympani, which is received in a groove of bone, and is situate obliquely, forming an acute angle with the parietes of the tympanum. It is convex on its internal, and concave on its external face, the most convex point not being exactly in the centre. In the human ear the membrana tympani is nearly circular; the longest diameter is eight-twentieths of an inch, the shortest seven-twentieths.[8] In the fœtus the membrana tympani is nearly as large as in the adult, and is covered by a sort of gluten.

It is formed of *three* membranes.

1. An *external*,—being a continuation of the membrane which lines the meatus.

2. A *middle*,—or muscular portion.[9]

[7] The cavity of the tympanum in the fœtus is nearly as large as in the adult.

[8] Phil. Trans. 1800, part i. Croonian Lect.

[9] "If the membrana tympani of the human ear is completely exposed on both sides, by removing the contiguous parts, and the cuticular covering is carefully washed off from its external surface, then, by placing it in a clear light, the radiated direction of its fibres may be easily detected. If a common magnifying glass is used, they are rendered nearly as distinct as those of the elephant appear to the naked eye; their course is exactly the same, and

3. An *internal*,—or continuation of the membrane lining the tympanine cavity, being a part of the gastro pulmonary.

The manubrium of the malleus is received between the middle and internal layers; and it is at the upper two-thirds of the internal membrane that Mr. Shrapnell has described a difference of structure, to which he has given the name *membrana flaccida*—this portion of the opening is not received in the groove.[1] The opening so frequently found in the membrana tympani, is always the result of either accident or disease.[2]

I believe Cheselden, in his Anatomy, has described a valve closing the foramen so often found in this mem-

they differ in nothing but in being formed on a smaller scale. The muscular fibres appear only to form the *internal* layer of the membrane, and are most distinctly seen when viewed on that side.'

"Dr. Baillie injected this membrane with coloured wax, the vessels anastomosed one with another, and their general direction was from the circumference to the handle of the malleus; from near this handle, a small trunk sent off branches in a radiated manner, which anastomosed with those which had an opposite course."—*Sir E. Home, Croonian Lect. Phil. Trans.* part i. 1800.

[1] For a complete description of the membrana flaccida, see a paper by Mr. Shrapnell, in the *Medical Gazette*, vol. x. *p.* 120.

[2] Marchetti, in 1652, described the membrana tympani as being pierced by a small opening.

Rivurus, in 1680, claimed to have discovered a foramen in this membrane, and even asserted he had seen it furnished with a *valve* and with a sphincter muscle.

Walther, wishing to decide if the membrana tympani was impervious, injected, by the Eustachian tube, air, tobacco smoke, mercury, and infusion of saffron, and on the most attentive examination could not perceive any of these had passed the membrana tympani.—Ruysch has shown that the opening in the membrana tympani is always accidental. — *Thesaurus Anatomicus*, vol. iii. 1703. Amsterdam.

brane. Valsalva saw the opening very frequently, but had several times searched for it in vain, and thought it possible he might have made the opening with the point of a stylet.

The membrana tympani is supplied with blood by the stylo-mastoid branch of the auricular, and the tympanine branch of the internal maxillary.

The *inner* wall is pierced by the *fenestra ovalis*,[3] rather posterior to its centre; this foramen leads into the vestibule, and modern anatomists describe it as the *fenestra vestibuli*;[4] a name much better chosen, inasmuch as this foramen is not oval in many animals.

Above it passes the *canal* of *Fallopius*, and below it, and completely concealing the fenestra rotunda, is the *promontory*.[5] The *fenestra rotunda* leads into the scala of the cochlea, and is now usually called the *fenestra cochleæ*.[6] This foramen is not round even in man, but in animals it assumes various shapes. It is placed a little posteriorly to the fenestra vestibuli.

These foramina are each closed by a membrane, supposed to be a continuation of the lining membrane of the tympanum.

Mr. Shrapnell says, "Instead of a membrana fenestræ ovalis filling the foramen ovale, I find no such membrane exists; but from the anterior centre of the oval base of the stapes, a filament or ligament

[3] This foramen is as large in the fœtus as it is in the adult.

[4] Cuvier was the first who suggested the alteration of these names.

[5] The promontory is remarkably projecting in the fœtus.

[6] The foramen rotundum is more *triangular* than round, and receives its membrane in a furrow; its convexity faces the cochlea, and its concavity the tympanum.—*Scarpa*. 1772. *De structura fenest. rotunda*. 8vo.

passes across to the centre of the elastic membrane above named." [7]

Just where the inner and posterior walls join, there is a distinct *foramen* for the passage of a branch of the glosso-pharyngeal nerve, besides several foramina for the passage of filaments of nerves from the canal of Fallopius.

The *anterior* wall, in conjunction with the *inner*, forms an opening for the Eustachian tube, besides a separate foramen for the tensor tympani muscle, and a little above is a small opening leading to the fissura glasseri, giving passage to the chorda tympani nerve, and entrance to the laxator tympani muscle.

The *posterior wall ;* on the inner side is seen the processus pyramidalis, in which is placed the stapedeus muscle ; above it are several cells communicating with the canal of Fallopius, for the passage of nerves into the mastoid cells ; and external to the base of the pyramid, is the foramen[8] for the passage of the anastamosing branch of the glosso-pharyngeal nerve, or, as it is sometimes called, the chorda tympani.

The *roof* has numerous openings which pass upwards, backwards, and downwards, to communicate with the mastoid cells.[8] The floor has numerous foramina for the entrance of vessels and nervous filaments from the carotid canal.

Valsalva claimed to have discovered foramina, by which the cavity of the tympanum communicated with the cavity of the cranium. He placed them towards the superior part of the mastoid cells: he

[7] Medical Gazette, vol. x.

[8] In the fœtus the mastoid cells do not exist, but there is a small opening, where the muscle of the stapedeus subsequently passes.

has seen two or three, at other times only one; their situation, form, and size, did not vary less. In some cases he could distinguish them at once, in others he was obliged to inject the tympanum. But as Itard says, "Valsalva had too much sincerity to declare positively the existence of these foramina, to which he assigned the function of unloading the encephaloid cavity of liquids, which nature wished to expel by the ear."

The tympanum is lined throughout by an exceedingly delicate membrane; it is a continuation of the gastro-pulmonary: it is impossible to discern if it be villous; in appearance it much more resembles periosteum than mucous membrane, but from its function we feel assured that it is the latter.[9]

The *Eustachian tube*, sometimes called the iter a palato ad aurem, leads from the pharynx to the tympanum; it is situated behind the velum pendulum palati, and is connected anteriorly to the hamulus pterygoideus, and passes upwards, backwards and outwards from the pharynx;[1] it is about two inches in length, and is composed of bone, fibro-cartilage, and mucous membrane.[2]

The bony part of the tube forms only a small portion, the remainder of the canal being completed by two triangular cartilages of unequal size; the *inner* being the smaller, and is united by its apex to the

[9] In the fœtus the lining membrane of the tympanum is very vascular, and secretes an abundant mucus.

[1] Its mouth, by which it opens behind the nostril, is wide enough to receive the point of the finger: it has muscular fibres to govern it.—*Bell's Anatomy.*

[2] The Eustachian tube is not formed so soon as the tympanum in the fœtus.

osseous part of the canal, and by its base to the internal ala of the pterygoid process of the temporal bone. The *outer* cartilage being much thicker and larger is united to the bone, and connected with its fellow by fibrous membrane. The Eustachian tube is lined throughout by mucous membrane, which is very red at its pharyngeal extremity, and the mucous follicles are very distinct, but it gradually becomes paler as it gains the tympanum.[3]

The tensor tympani, with several other muscles, are attached to the different parts of the Eustachian tube.

The *ossicula auditûs*, placed at the upper part of the cavity of the tympanum, are *three* in number, although usually described as four;[4] and are,

1. The malleus, or hammer.
2. The incus, or anvil.
3. The stapes, or stirrup.

The *malleus*[5] may be divided into a head, neck, processus gracilis, and the manubrium. The *head*, the superior part, presents posteriorly an ovoid articulating surface, divided into two unequal portions by a

[3] M. Lelut considers that the mucous membrane of the Eustachian tube wants the *epithelium* or internal epidermis at its orifice, but thinks it possesses that structure throughout the rest of the canal.—*Répertoire d'Anatomie*, tom. iii.

[4] Cassebohm has seen a fifth bone between the hammer and anvil in an infant, amongst 300 subjects whose ears he had examined.

[5] The malleus and incus were discovered by Alexander, as mentioned by Massa, (Massa. Epistolæ, Venice, 1558,) although Alexander's work does not make any mention of them.—Anatomicæ Annotationes, Bologna, 1520, petit in 4to. de 18, feuillets. Le seul exemplaire qui existe à Paris dans la Bibliothèque Royale.—Il n'en existe aucun à celles du Panthéon et de l'Ecole.—*Itard sur l'Oreille.*

rough line; it is received in the socket of the incus. The slender *neck* unites the head to the manubrium. The long and thin *processus gracilis* proceeds from the neck, passes outwards and forwards to enter the fissura glasseri; to it is attached the laxator tympani muscle. The *manubrium*, more delicate than the neck, passes obliquely downwards, forwards, and outwards, to be connected with the membrana tympani, and terminates in a rounded extremity. From the superior and external part of the manubrium, a short process, called the *processus obtusus*, passes to be attached to the outer wall of the tympanum, and forms a fulcrum for the motions of the malleus; to it is attached the tensor tympani muscle.

The *incus* may be divided into a head and two crura of unequal length.

The *head* forms the concave articulating socket which receives the head of the malleus. It is marked by a furrow which divides it into two articulating surfaces, as in the malleus.

The *superior crus*, short and strong, passes downwards and backwards to be connected with the posterior wall of the tympanum, close to the openings of the mastoid cells, and forming another fulcrum for the ossicula.

The *inferior crus*, considerably longer than the other, passes downwards, forwards, and inwards, and terminates in a *rounded articulating surface*, to be connected with the stapes. This has usually been described as a distinct bone, and called the *os orbiculare*.[6]

[6] This process of bone was first noticed as a distinct bone by J. C. Aranzi in 1587, and was described with care in 1640 by

Mr. Shrapnell has written a paper with a view of deciding whether the os orbiculare is entitled to be considered as a separate bone, or merely as a process of the incus.

The surface by which it is articulated with the head of the os stapes may very readily be perceived ; it forms an oval ball (*convex*) the long axis of which is about a third of a line in length ; for, minute as this dimension is, the joint presents the usual shining surface, and has edges to which its capsular ligament is attached, and which may be seen, both to the processus lenticularis and the corresponding concave depression in the head of the stapes ; together forming an enarthrodial, or ball and socket articulation.

Now it may readily be conceived that to an eye accustomed to the inspection of minute objects, and assisted by a good magnifying power, an articulating surface will be as apparent on the side next to the incus, as it is on the part next to the stapes.

It is not probable that the joint is anchylosed, as that is the result of disease, and this connexion is found in young animals without the slightest evidence of any disease.

Mr. Shrapnell considers the os orbiculare to be a process of the incus, and gives the name *processus lenticularis* of the incus. He says, "I subjected four temporal bones to a full process of maceration, that all ligamentous connexions might be destroyed,

Francis Deleböe, who found a sesamoid bone in the tendon of the stapedeus muscle in some animals.

The existence of this as a separate bone was contested by D. Marchettis in 1652.

See also Blumenbach's Osteology, p. 155, sq. edit. 2 ; and Blumenbach's Comp. Anat. Lawrence, p. 357.

and the bones separated without violence; but in each of these instances, and in numerous temporal bones of various animals, no separation of the os lenticulare from the incus could be effected by maceration. The same circumstance may be observed in temporal bones which have been long buried."[7]

Blumenbach would not admit the os orbiculare to be a separate bone, but described it as an epiphysis of the incus, and as being often wanting in negroes and North American savages. He says it can never be separated without force, and, upon examining it with the microscope, the surfaces show that the lenticulus has been broken from the incus. He also mentions having found a supernumerary ossiculum.

The *stapes*, so named from its resembling the stirrup of a saddle, was accidentally discovered, towards the middle of the sixteenth century, by Ingrassias, while delivering a public lecture. It may be divided into head, neck, two crura, and base.

The *head* receives the articulating *orbicular* surface of the inferior crus of the incus. It is joined to the two diverging crura by a narrow *neck*, which has on its side a small *tubercle*, to which is attached the tendon of the stapedeus muscle. The *crura* are of unequal length, the anterior being the longer; they are placed horizontally, and gradually terminate in the *base*, which is of an oval figure, and is opposed to the fenestra vestibuli.

The human stapes is six-fortieths of an inch in height, and five-fortieths in width at its basis. It weighs, when dried, one thirty-second of a grain.

[7] Medical Gazette, vol. xii. p. 172.

When the stapes rests on its basis, with the straight side next to the observer, then it is the stapes of the right ear; but if on the right, then it is the left stapes.[8]

The stapes stands perpendicular to the plane of the membrana tympani. A plane drawn through the crura, parallel to the length of the basis, equally bisects the cavity of the tympanum.

Duverney described a delicate membrane as passing between these crura, completely covering the arch; but Sir Anthony Carlisle is of opinion that no such membrane exists, and thinks a pellicle of mucilaginous fluid, often found in the recent bone, to have been mistaken for a membrane.

Cassebohm states that the ossicula, even in a rudimentary state, do not exist in the second month after conception, and at this epoch one can only commence to distinguish the tympanum. In a fœtus of three months he found the hammer cartilaginous, with one point ossified: the anvil was in the same state, except its long apophysis, which was partly ossified, as well as the head of the stirrup. At four months, the head of the hammer was osseous internally, and cartilaginous externally; the long apophysis cartilaginous, the other was not yet visible. The portion of the anvil articulating with the hammer was covered with a cartilaginous sheath, and that part connected with the stirrup was not yet ossified, nor was the corresponding portion of the stirrup. At five months ossification was complete.

Cassebohm has thus proved that the development

[8] Sir A. Carlisle, Phil. Trans. vol. xcv. pt. i. 1805.

of the ossicula begins at the third month, whereas Kerkring did not make them commence until the fifth month.[9]

The ossicula auditûs, in a growing state, are composed of a vascular pulp—ossification is completed soon after birth, and, like the teeth, never after increase in size. The malleus and incus are hollow, and possess an internal periosteum, and the whole series is covered by a reticular membrane, which has no red blood-vessels in the adult. Sir A. Carlisle does not believe there is any fat or marrow contained in these bones, but attributes their occasional greasy appearance to transudation from the neighbouring parts, during the stage of putrefactive maceration, seeing that all such bones, when taken from recent subjects, are free from the marks of fat.[1]

*Muscles of the ossicula auditûs.—Tensor tympani* arises from the petrous portion of the temporal bone, and the bony part of the Eustachian tube. It passes through the opening above the Eustachian tube, in a distinct canal, to the cavity of the tympanum, where, becoming tendinous, it passes upwards and outwards to be inserted into the processus obtusus of the malleus.

*Laxator tympani* arises from the styloid process at the extremity of the spine of the sphenoid bone; and from the cartilaginous portion of the Eustachian tube; it passes backwards to enter the fissura glasseri, then gains the tympanum, and is inserted into the processus gracilis of the malleus.

*Stapedeus* arises fleshy within the cavity of the processus pyramidalis; it becomes tendinous before it

[9] Itard.

[1] Phil. Trans. p. 199, vol. xcv. pt. i. 1805.

passes through the foramen, and is inserted into the tubercle found on the side of the neck of the stapes.

These muscles were first pointed out by Fallopius. Söemerring has described three muscles as attached to the malleus. 1. Musculus tensor tympani. 2. Musculus externus mallei, sive laxator major tympani. 3. Musculus laxator tympani minor. And Mr. Tod has given a description of several other muscles.

*The labyrinth.*—The internal portion of the ear is called the labyrinth, and is placed between the tympanum and meatus auditivus internus, and consists of the vestibule, semicircular canals, and cochlea, all enclosed within the petrous portion of the temporal bone.

The *vestibule* is a small cavity about the size of a swan-shot,[2] having seven openings into it, besides the fenestra vestibuli, which is closed by a membrane. The vestibule is placed rather to the inner side of the fenestra vestibuli, which we will enumerate as the *first* foramen, forming nearly the whole outer wall. The posterior wall has *five* openings from the semicircular canals. At the junction of the posterior with the inner wall is the aquæductus vestibuli,[3] making the *seventh* foramen; and on the inferior part of the anterior wall is the *eighth* foramen, the scala vestibuli, which forms part of the cochlea.

*The semicircular canals.*—Above and behind the vestibule are situate three *semicircular canals*, called the vertical, oblique, and horizontal, each forming three-fourths of a circle. The horizontal is the smallest and most inferior; the oblique the largest and most

[2] B. B. Cooper's Anatomy.

[3] Cotunnius de aquæductibus auris humanæ. 1761. Neap. 4to.

internal; while the vertical is the intermediate in size, and the superior. The diameter of these canals is sufficiently large to receive the head of a small pin.

The *vertical* canal has its convexity directed superiorly; its *external* extremity, containing the *ampulla*, opens into the vestibule, and the internal terminates in an opening common with it and the oblique canal on the internal wall.

The *oblique canal* has its convexity turned towards the mastoid process of the temporal bone; its superior extremity terminates in common with the internal of the vertical, and its inferior on the anterior wall, close to the entrance of the scala vestibuli, its ampulla forming almost a part of it.

The *horizontal canal* has its convexity directed backwards towards the mastoid process; it terminates by *two proper* openings in the vestibule; the external, which contains the ampulla, being below the external termination of the vertical canal, while the internal opens between the two terminations of the oblique canal.

The orifices of the semi-circular canals were first described by Duverney in 1683. M. Breschet divides the canals into the semicircular *tubes*, being the membranous sacs, and the semicircular *canals*, being the bony part. In the fœtus you may perceive part of the superior and posterior canals without any dissection. They are very apparent from their whiteness and the red parts which envelope them. The superior vertical canal is the most evident.[4]

The ampulla is the dilatation found at the external extremity of the vertical and horizontal canals, and at the inferior termination of the oblique canal.

[4] Bichât.

In the early fœtus the canals are of the same diameter throughout, and the ampullæ are supposed to be formed by the canals in that part not contracting.

The *cochlea* is placed on the inner side of the tympanum, and consists of two canals, which wind round a central pillar of bone, and are separated from each other by a spiral plate, partly bony, partly cartilaginous.

The *modiolus*, of a spongy texture, crosses the petrous portion of the temporal bone at right angles; its cribriform base is opposed to the meatus auditivus internus, while it gradually tapers in the form of a cone towards the extremity of the petrous portion, where there is a projection called the *cupola*, and it is here that the scalæ vestibuli and tympani terminate in the *infundibulum*, being at the pointed extremity of the cochlea. The infundibulum is conical, its base being larger than its apex.

The *lamina spiralis*, partly bony, partly fibro-cartilaginous, the bony part being attached to the modiolus, commences between the fenestræ vestibuli et cochleæ, and separates them on the vestibular side, in the same way as the promontory does on the inner wall of the tympanum. It passes forwards and inwards, meets the modiolus, makes two turns and a half round it, dividing the scalæ, forming the roof of the scala tympani and the floor of the scala vestibuli, and terminates in the hamulary process.

The *scala tympani* commences at the fenestra cochleæ, passes downwards, forwards, and inwards, makes two turns and a half round the modiolus, and opens at the apex of this pillar. Close to the commencement of this scala is the *aquæductus cochleæ*, which leads to the

base of the petrous portion of the temporal bone, before described.

The *scala vestibuli* commences at the anterior part of the vestibule, passes downwards and forwards, where it meets the modiolus; it also makes two turns and a half around this pillar, and terminates at its apex.

Itard says the scala tympani is larger than the scala vestibuli; this is contrary to the description of most authors.

The *canal of Fallopius*[5] commences at the superior and smaller fovea, at the base of the meatus auditivus internus: it first passes upwards, then downwards and backwards, winding round the tympanum above the fenestra vestibuli, close by the posterior semicircular canal, and terminates at the stylo-mastoid foramen. It is as it passes upwards, while near the surface of the petrous portion, that it receives the videan nerve, which comes through the foramen innominatum.

The labyrinth is lined by an exceedingly delicate membrane, which secretes a clear fluid, called the *aqua labyrinthi.* Meckel froze a subject, and opened the labyrinth with care, and found it entirely filled by a piece of ice, moulded according to the form of this cavity, and perfectly hard. In the fœtus this fluid is always bloody.[6]

In the vestibule, in addition to this membrane, there are two small sacs, called *sacculi vestibuli*, inseparably connected with each other, and firmly attached to the foveæ, at the termination of the meatus internus, by nerves.

[5] Fallopius. Observ. Anat. Venet. 1561.

[6] Ribes. Lond. Med. and Surg. Journal.

These sacs, first described by Scarpa,[7] contain a clear fluid and some cretaceous matter analogous to the otolithes found in animals, but more particularly in fishes. There are also three membranous sacs lying in the semicircular canals, containing fluid, and themselves floating in the aqua labyrinthi before mentioned, and which M. Breschet has called the *perilymph.*[8] These sacs do not come at all in contact with the bony canals; they expand at the ampullæ in the same way as do the osseous canals. The scala tympani and scala vestibuli contain these delicate sacs, and it appears they do not communicate with each other, as advanced by Cassebohm.

"I have frequently perforated the fenestra rotunda, and evacuated the fluid from the scala tympani, and then exposed the vestibulum, and found its fluid entire. I have also reversed this experiment, by first evacuating the fluid from the vestibulum, and then perforated the fenestra rotunda, and found that its fluid had not escaped. I have likewise evacuated all the fluids, and allowed the cavities to dry for three or four hours, and then poured a fluid into the vestibulum, and found a communication established, evidently owing to the membranes having been lacerated in the drying."[9]

The *meatus auditivus internus.* Its situation has been already described.[1] It becomes larger in diameter as it passes inwards, and terminates in wo pits, called *foveæ;* they form the base of the

[7] Disquisitiones Anatomicæ de Auditu et Olfactu. Tab. iv. fig. 5, tab. vii. fig. 3.

[8] Annales des Sciences Naturelles, xxix. 17.

[9] Tod on the Organ of Hearing, p. 30.

[1] See page 6.

modiolus, and are placed one above the other, being pierced by numerous foramina for the transmission of nervous filaments to the vestibule, canals, and cochlea. There is also a distinct foramen to convey the portio dura into the canal of Fallopius. In the fœtus the meatus internus is smaller in diameter, but longer in proportion than in the adult.

*Vessels supplying the ear.*—The *posterior aural*, one of the posterior branches of the external carotid, passes between the mastoid process and the auricle; it gives off a small branch, which passes into the stylo-mastoid foramen to supply the tympanum and mastoid cells, and then terminates in two branches, one going behind the ear, the other being distributed to the dorsum of the auricle. The external ear is also supplied by branches given off from the *temporal*, while near the auditory process.

The *ascending pharyngeal*, the internal branch of the external carotid, supplying the pharynx, fauces, and tonsils, sends branches to ramify upon the Eustachian tube.

An *auditory branch*, generally given off from the basilar, sometimes from the superior of the cerebel'um, enters the meatus auditivus internus, passing between the portio dura and portio mollis, and accompanying the latter to supply the labyrinth; besides these internal arteries, are two branches passing into the aquæductus cochleæ and vestibuli, which have been injected and traced by Ribes.

Sir Charles Bell says—"I see very considerable vessels distributed on the vestibule; particularly I see their minute ramifications on the circular fovea, while very considerable branches are seen to course along

the semicircular canals. In the cochlea I see distinct branches of vessels rising from the root of the lamina spiralis, and arching on the scalæ, to the number of ten in the circle; and, after a more minute injection, I have found the osseous part of the lamina spiralis tinged red, and the membranous part of a deep scarlet. In a preparation before me, I see a considerable artery, derived from the basilar artery, entering the meatus auditivus internus. From this trunk I conceive that most of these arteries which I have described are derived."[2]

A small *tympanine branch* is given off by the internal maxillary; it passes through the fissura glasseri, to ramify upon the walls of the tympanum. There are besides small branches given off from the occipital, the stylo-mastoid, and the meningeal, but they are exceedingly irregular.

Two principal *veins* return the blood from the ear, passing out from the vestibule and cochlea; the former empties itself into the jugular vein, and the latter into the lateral sinus.

The *nerves* destined for the supply of the ear are the portio dura and portio mollis, the glosso-pharyngeal and sympathetic, and the second and third divisions of the fifth; and some very delicate filaments have been traced from the otic ganglion.

The *portio mollis*, the special nerve of hearing, arises by two roots from the medulla oblongata; one set of fibres passes to the floor of the fourth ventricle, the other consisting of white striæ, and forming part of the calamus scriptorius,[3] turns round the corpus

[2] Bell's Anatomy, p. 169.

[3] It is a curious circumstance, should future observation confirm

restiforme, and by a circuitous route reaches the same origin with the first. Some of these fibres decussate exactly in the same way as do the optic nerves.

These fibres are at their origin very soft, but gradually become firmer as they proceed to the meatus; those filaments going to the cochlea[5] are much whiter, firmer, and more distinct, than those which supply the vestibule[6] and semicircular canals. There is a distinct set of fibres to supply each of the three portions of the labyrinth.

Mr. Shrapnell imagines he has found two ganglia, one on the large twig of the portio mollis, and one on the portio dura, both communicating with the nervus innominatus. He says, Those fasciculæ for the vestibule are the most conspicuous, and a ganglion is found on the portion destined for the ampullæ of the superior and external canals. Before the nerve penetrates the foramen, it is divested of its membrane, becomes remarkably white, and may be traced as a pulpy substance in the sacs and ampullæ.

That part of the nerve which stretches to the ampullæ, immediately divides into an opaque white mucous expansion. Beyond these ampullæ there has been no expansion of the nerve discovered in the membranous tubes.

it, which has been mentioned by Santorini, that the fibres from the calamus scriptorius, and pons varolii, of which the portio mollis is formed, have been observed particularly strong in a blind man, whose hearing had been very acute.—*Fyfe's Comp. Anat.* vol. ii. p. 443.

[5] Scarpa called the nervous expansion in the cochlea *zona mollis*, and that in the vestibule and ampullæ *barbula*.

[6] Ribes asserts with Morgagni, that the ramifications of the auditory nerve are very manifest on the membrane of the spiral of the cochlea, but that they cannot be traced to the vestibule.

A division of the nerve passes from the meatus auditivus internus through the cribriform base of the modiolus into the cochlea, and, when torn out, retains a circular form, owing to the divisions which entered the various foramina being lacerated; some branches perforate the sides of the modiolus, others pass between the plates of the lamina spiralis, and a distinct branch passes up through the centre of the modiolus, and penetrates numerous foramina to supply the infundibulum and cupola.[7]

These nerves form a network, quite transparent on their extremities; they terminate on the lining membrane, and not in the periosteum. They may be most easily traced along the lamina spiralis.[8]

The *portio dura*, or respiratory nerve of the face, passes through the meatus auditivus internus, together with the portio mollis, in which it is partially received: having reached the base of the meatus, it passes through its own *proper* opening, and gains the canal of Fallopius, which it traverses, and makes its exit from the skull, at the stylo-mastoid foramen. While passing through the canal it gives off two small branches, one for the tensor tympani, and one for the stapedeus muscle.

The *glosso-pharyngeal*, the ninth pair, after arising from the tractus respiratorius of Sir Charles Bell, passes out of the cranium, and gives off the *anastomosing* branch, which passes into the tympanum by a foramen close to the stylo-mastoid foramen; it goes directly to the promontory, and there unites with the videan nerve, as well as with filaments of the sympathetic from the carotid canal.

[7] Medical Gazette, vol. x. p. 506.

[8] See Monro's Treatise on the Ear, p. 197.

"In tracing the tympanine branch of the glosso-pharyngeal nerve, which has been so particularly described by Jacobson, much of its distribution may be seen on the transparent membrane lining the tympanum, when this part is perfectly sound; but when it is diseased, a very considerable difficulty is experienced. In an attempt to trace this nerve in the head of an old woman, the membrane lining the tympanum was not only thickened, but there was at the same time some roughness of the bone. In the head of a man who had a suppurating node on the forehead, and whose posterior nostrils were stopped by adhesions of the soft palate, this membrane was also thickened, and the spheno-palatine ganglion was very considerably enlarged. In the dissection of the head of a very young woman, the Schneiderian membrane covering the inferior turbinated bone of the left nostril adhered very considerably to that of the septum, so that a very little passage was left for the air; there was a perforation in the membrane of the tympanum of the same side, and purulent matter was contained in each tympanum. The membrane lining the tympanum was so much thickened, that the nerves could not be observed."[9]

The *auricular* branch of the superficial cervical plexus, after gaining the parotid gland, divides into several branches; some of them pass to be distributed to the auricle, and two or three small branches supply the dorsum of the auricle and the mastoid process.

The *posterior auricular* branch of the portio dura is

[9] Swan on the Nerves, p. 271.

given off immediately that nerve passes out of the stylo-mastoid foramen; it ramifies on the auricle, and supplies the posterior auricular muscle.

The *auricular* branch of the third division of the fifth passes to the parotid gland, communicates with the facial, and sends off, besides other branches, several small filaments to the auricle; some of these pass into the meatus externus, and are lost upon the membrana tympani.

The *videan*, called also the *pterygoid*, a branch of the second division of the fifth, coming from Meckel's ganglion, passes through the pterygoid canal, then divides into two branches, one going to the carotid canal; the other passes through the foramen lacerum basis cranii anterius into the cranium, enters the groove in the petrous portion of the temporal bone leading to the *foramen innominatum*, passes along the canal of Fallopius with the portio dura, to which it is firmly united. It then passes between the long crus of the incus, and the left manubrium of the malleus, and makes its exit from the skull at the fissura glasseri, where it assumes the name of chorda tympani; it becomes attached to the lingual gustatory, a branch of the third division of the fifth, just as it comes out between the two pterygoid muscles; and this connexion having been formed, it passes to terminate in the sub-maxillary gland. Cloquet, Herzel, and Magendie, think the videan nerve to be only in contact with the facial; Arnold [1] and Varrentrapp [2] are both of opinion, that

[1] Kopf theil des vegetat nervensyst.—*Heidelb.* 1831.

[2] Observ. Anat. de parte cephal. nerv. symp. 1831.

the nerves are most intimately connected the one with the other. Close to the promontory several nerves unite, such as the chorda tympani, glosso-pharyngeal, sympathetic, &c., to which the name of *tympanic plexus* has been given.

The otic ganglion, discovered by Arnold, is of a grayish red colour, is found at the posterior and inferior part of the foramen ovale, and is connected with the trunk of the third division of the fifth by cellular tissue; it is covered by the cartilaginous portion of the Eustachian tube, and behind is the meningeal artery. The whole is imbedded in fat, in which it communicates with several nerves, as the pterygoid, the tympanine branch of the glosso-pharyngeal, sympathetic, &c. It divides into two branches, one going to the nervous plexus of the tympanum, the other passing upwards is lost in the tensor tympani muscle.[3] Its existence can at present be no longer doubted, several anatomists, who previously searched for it in vain,[4] having now discovered and described it. Some having found it, thought it rather a lymphatic gland, and described the nerves proceeding from it, as bands of cellular tissue, or filaments of the dura mater.

In the human subject, the otic ganglion has been found as large as a pea, and as small as a pin's head; it does not give uniform branches. Its presence appears to be only occasional; in eight subjects dissected by Mr. Bennett, it was only found in three. It has been found fully developed on one side, and absent on the other; its position also varies extremely.[5]

[3] Lancet, vol. ii. p. 362. 1836-7.

[4] See Medical Gazette, No. 45.

[5] Medical Gazette, vol. xviii. p. 690.

## COMPARATIVE ANATOMY.

An auricle the most closely resembling that of man is met with in the oran-utan; it is, however, more pointed, and the free portion predominates. In monkeys it is even more pointed, the helix being very indistinct, and in apes is altogether wanting. The ear of the porcupine closely resembles that of man. The auricle is triangular in the horse, semi-lunar in the sheep, pointed behind and bifurcated in front in the rabbit, and rhomboidal in the dog.

The ruminantia and herbivora have much larger ears in proportion than man; the elephant and bullock have very small auricles in proportion to their size.

Timid and nocturnal animals and birds have large ears, as the hare, deer, and bat. The *proper* muscles of the auricle are highly developed in timid animals, and particularly so in the hare. The concha and meatus have a direction backwards in those to be pursued, as the hare, and forwards in such as pursue, as the lion. In some they are directed downwards, as the spaniel, sheep, hog, and elephant, which enables them to hear sounds from below.

The four-footed mammalia alone possess external ears. In those animals which live in water and under

ground, these parts are wanting, as the cetacea, seals, walrus, ornithorynchus, mole, and manis. Most of the seal tribe have no external ears, but in some, as the phoca jubata, or maned seal, there is a rudiment of an auricle, conical, and about six or seven lines long. In some instances, as the opossum, (didelphis marsupialis,) the external ears are merely membranous.

The bat (vespertilio auritus) has ears of an immense size, which led to the error of their being considered as double.[6] Some of this species have an auricle larger than the head : it is so constructed as to prevent air from rushing in while flying. The anti-tragus is rounded in most of the bat kind. The tragus is found in the dog, but is very indistinct in hares and horses. In some animals, as the water shrew, the anti-tragus serves as an operculum to the ear.

" In animals having a long and moveable auricle, there are three cartilages; one adheres to the concha, another tubular is fixed by a ligament to the meatus auditivus externus; the third situate above the first, and equally assisting in forming the concavity of the auricle, gives a point d'appui to numerous muscles."[7]

The lobe of the ear is found in no other animal but man.[8]

The muscles are numerous and varied, in proportion as the auricle is large and moveable.

Birds possess a rudimentary external ear, consisting

[6] Blumenbach's Comp. Anat. translated by Lawrence, 1807. For a very full description of the ear of the mammalia, *see Fyfe's Comparative Anatomy*, 1813.

[7] Itard.

[8] See page 7.

of feathers so arranged around the meatus externus, that they can erect or depress them at pleasure. These feathers are most distinct in night birds, as owls. In worms, insects, fishes, and reptiles, there is no auricle.

*Meatus Auditivus Externus.*—The whole of the class Mammalia, except the cetacea, have a bony meatus externus; this is almost always tortuous, for the purpose of protecting the membrana tympani. It is long and straight in the ape and monkey, and especially in the baboon; very short in the bat; it is also quite straight in the dog, cat, and badger; and has an inclination from before to behind in the otter and polecat. In the mole, it is at first small and vertical; it then becomes horizontal, and larger. In the hare, it has an inclination from above to below, and from behind to before. In the porcupine, from before to behind. In the sloth, it is short, large, and circular. In the elephant, it is large and long, having a direction a little downwards and backwards. Very long and narrow, with an inclination of forty-five degrees, without inclining behind or before, in the rhinoceros and hippopotamus; slightly turned forwards in the domestic pig, and backwards in the horse. In the ruminantia it has generally a direction upwards.[9] In the cetacea the meatus is cartilaginous.

The external auditory passage is furnished with a *valve* in such animals as go frequently into the water, by which they can close it when they dive.

In the forex fodiens, or water shrew,[1] there is a valve composed of a double membrane, capable of accurately closing the meatus externus. In the hip-

[9] Itard.

[1] Home, Phil. Trans. 1800. part ii.

popotamus, which feeds at the bottom of the sea, the meatus is guarded by an apparatus which answers all the purposes of a valve. In the shark, an osseous fish, the external meatus is covered by skin.

"In the ornithorynchus paradoxus, the external opening of the ear was so small as not readily to be perceived; it is simply an orifice, but the meatus enlarges considerably beyond the size of the opening, and passes some way under the skin before it reaches the organ."[2] Sir Everard Home afterwards says, "The external ears are two oval slits, directly behind the eyes, and much larger than the orifices of the eyelids."

"In the dolphin, the orifice is only the size of a pin's head; it is also very small in the dugong, to prevent the entrance of water. In the seal it makes a circular turn; in the ornithorynchus paradoxus it winds round the temporal bone, and has its external orifice at a great distance from the vestibule."

In the échidné epineux, the external auditory canal is large enough at its orifice to admit the end of the finger.[3]

Osseous fishes have no meatus externus; but cartilaginous fishes have a straight canal, running outwards and backwards from the vestibule, which is covered externally by the skin, as the skate, shark, and lamprey.

In the head of the skate are observed two mucous orifices, which Monro supposes to be the outer ear, but which is denied by Scarpa; it appears, these openings do not lead into the vestibule and semicircular canals, otherwise there would be access of air

[2] Phil. Trans. 1802. part i. p. 70.

[3] Geoffroi St. Hilaire.

and water to the soft pulp of the auditory nerve. There is, beside this, under the skin, at the back part of the head, a membrane extended across a pretty regular opening.[4]

M. Breschet has found, that in the chondropterygii there does exist an opening at the upper and back part of the head, closed by a membrane, and covered by common integuments, which terminates on the outside of the membranous labyrinth.

In birds, the meatus is chiefly cartilaginous, very short, and surrounded externally by feathers, varying very much in the different species. In the bird of paradise they are of great length; they are long in night birds, particularly the owl. "Owls, and some birds of the rapacious kind, have a peculiar valve placed at this opening, partly of a membranous, partly of a muscular structure."[5]

The meatus externus is wanting in worms, insects, most fish, cray fish, &c.

In the class reptilia there is merely a rudiment of a meatus, consisting of two folds of skin, puckered up over the situation of the tympanum; it is most developed in the crocodile.

*The tympanum* consists of one small cavity in man, the ruminantia, and monkey. It communicates with that of the opposite side, by single cells, in the dog, cat, hare, squirrel, and civet; and by numerous cells in the elephant and hog.

Hares killed in the chase often have effused blood in the cavity of the tympanum; this is not the case

[4] Bell's Anatomy. In the head of the skate, the meatus externus would about admit a stocking wire. See p. 208. Three Treatises on Brain, Eye, and Ear, by Alexander Monro. 1797. Edin.

[5] Blumenbach's Comp. Anat. Lawrence. p. 350.

with those killed under other circumstances. Errors have not unfrequently been committed in consequence of mistaking the fibrine of the blood for ligaments or nerves.

In the elephant there is no middle bony septum separating the cells belonging to one ear, from those which open into the other, but a ready communication exists between them. A cellular structure occupies the upper and posterior part of the skull, enclosed between the two tables, and communicating by a considerable aperture. These cells communicate freely with each other at their lower extremities, but not near the upper, forming irregular cylinders placed in a converging direction, towards the cavity of the tympanum. In the calf, there are numerous concentric canals, which unite into a common cavity.

In different species of cats and civets, an osseous plate obliquely stretches from the posterior and inferior boundary of the tympanum to the promontory, separating the tympanum into two cavities, which only communicate by a foramen; the anterior and external containing the ossicula, is pierced by the fenestra vestibuli; whilst the other, much larger, contains the fenestra cochleæ. The arrangement is rather different in the lion.

In the hippopotamus, the tympanum is extremely small, and communicates by a foramen with a second cavity, divided into a great number of irregular cells.[6]

In the tardigrada, the tympanum communicates with the zygomatic process, in which are numerous cells. In the ornithorynchus the tympanum is very large.

[6] See Itard on the construction of the tympanum in various animals.

The hard bony substance which was formerly very erroneously called *lapis manati*, or liburonis, is merely the tympanum and bulla ossea of the whale.[7]

In some species of monkeys, and in bears, the walls of the cavity of the tympanum do not project. This cavity is somewhat rounded externally in dogs and cats, and more decidedly so in hares and castors. In the pig, the tympanum forms a long projection, narrow at the part which joins the cranium.

In birds the tympanum is formed by projections of the occipital bone, but anteriorly it is completed by the *os quadratum*, which is peculiar to this class; it is moveable, and is attached to the lower jaw, as well as the malar bone. The tympanum is connected with that of the opposite side, by air-cells, which are highly developed in nocturnal and predaceous birds.

Turtles, frogs, crocodiles, and most of the lizard kind, possess a tympanum; but some have no membrana tympani, as the cameleon. Serpents, with a very few exceptions, as the blind worm, (anguis fragilis,) have no tympanum. The salamander has no tympanum; it has never been heard to cry.

In most of the class reptilia there is a rudimentary tympanum, surrounded by a fibrous membrane, containing a single ossiculum: there are two openings; the larger one for the Eustachian tube, and the smaller to correspond to the fenestra vestibuli: there is no meatus externus.

Fish, in general, have no tympanum; the opercular bones are placed externally. Osseous fishes have no tympanum; nor have lobsters, cray-fish, &c. A rudiment is found in the skate and shark.[8]

[7] Blumenbach's Comp. Anat. p. 349. Lawrence.

[8] Blumenbach's Comp. Anat.

*The membrana tympani* is, in all the mammifera, thin, moist, transparent, elastic, and situate at the bottom of the meatus externus; concave externally, and convex towards the tympanine cavity, (with but very few exceptions).

It is obliquely situated, with respect to the meatus, in all animals hearing well. In the mole, it is nearly parallel with the base of the cranium, seeming almost to form a ceiling for the tympanum. It is more vertical in monkeys, dogs, cats, &c. The osseous circle, which in man gives attachment to the membrana tympani, forms in many of the mammifera a circular or elliptical projection, situate within the cavity, to the external part of which it is attached by one of its extremities, whilst the other is free; these are more or less acute, according to the species, often being supported by salient angles, which, from different parts of the tympanum, join themselves perpendicularly to these processes.

The membrana tympani is completely circular in the mole and Indian pig; and nearly so in the ruminantia. Its superior fourth is wanting in the cat and dog, and its superior half in the elephant.[9]

In the ornithorynchus the membrana tympani is much larger than in any other quadruped, and is *convex* on its external face.[1] In the mole it is perfectly flat. In the whale this membrane is convex externally; which has induced some physiologists to consider, that the Eustachian tube acts as the meatus externus, and *vice versâ*.

In the membrana tympani of the elephant, muscular fibres are seen passing along the membrane in a

[9] See Itard.

[1] Geoffroi St. Hilaire.

radiated manner, from the bony rim which surrounds it, towards the handle of the malleus, to which the central part of the membrane is firmly attached. This membrane is much larger in proportion, than in quadrupeds or man. The membrane was found of an oval form ; the short diameter of the oval rather more than an inch in length, the long diameter an inch and seven-twentieths.

" As the membrane in the elephant exceeds that of the human ear in thickness as much as in extent, which is as the squares of their diameters, or in the proportion of 135 to 14, it is natural to conclude that the muscular fibres which are to stretch the one, must greatly exceed in strength those capable of producing the same degree of tension in the other.

" In the horse the membrana tympani is smaller than in man ; its long diameter is eight-twentieths of an inch, the short one six-twentieths, and it is almost quite flat ; while in man it is concave, which makes the difference of extent considerably exceed the difference in diameter.

" In the horse the fibrous structure is not visible to the naked eye : it is indistinctly seen when viewed through a common magnifying glass ; but in a microscope it is very visible, and in every other respect agrees in structure with the membrane in the human ear, and in that of the elephant. In birds the membrana tympani is larger in proportion than in the quadruped, and more circular in its shape. In the goose it is six-twentieths of an inch in its longest diameter, and five-twentieths in its shortest diameter. In the turkey seven-twentieths by five-twentieths. Its fibres may be distinguished when viewed in the microscope.

"The principal attachment of muscular fibres is to the extremity of the handle of the malleus, which is nearly in the centre of the membrane. In the membrane of the elephant, which is oval, the attachment to the handle of the malleus is at some distance from the centre. In the horse, deer, and cat, which have the membrane still more oval than the elephant, the handle of the malleus is situated in the long axis of the membrane, with its extremity extending beyond the centre, reaching nearer to the circumference: and the fibres of the radiated muscle are not only attached to its end, but also laterally to nearly the whole length of its handle."[2]

In birds, the membrana tympani is *convex* externally.

"All varieties of reptiles, which in their habits and delicacy of hearing resemble terrestrial animals, have either the membrane of the tympanum, or a skin so delicate as to produce the same effect; while those which inhabit the water have a rough integument, or a hard scale, drawn over the tympanum."[3]

This membrane is found in crocodiles, frogs, and common lizards, but not in cameleons; nor is it found in salamanders. In frogs it is large.[4]

The membrana tympani of the turtle resembles a mass of cartilage, and is covered externally by the common integuments. This membrane is slightly convex externally, in the class reptilia, but less so than in aves.

*A Eustachian tube* is found in all red-blooded animals possessing a membrana tympani.

[2] Sir E. Home's Phil. Tran. part i. Croonian Lectures.
[3] Bell's Anatomy.
[4] Blumenbach's Comp. Anat.

In the mammalia it has nearly the same kind of structure and opening as in man.

In the horse the cartilaginous part of this tube communicates with a large membranous sac, placed in the fauces, on each side of the posterior nares.

In the class aves, the Eustachian tube is *bony* throughout its whole extent; it opens near the median line, a little behind the posterior nares, so that the two tubes are close together, and in some instances have a common opening: it terminates in the cavity of the tympanum by rather a large opening.

Dr. Mouler says, "In the heads of all the fowl that I had an opportunity to examine, I constantly found only one aquæduct, or passage from the ear into the pallat; whereas, in man, quadrupeds, and some amphibious fish, there are always two, one on each side below the entrance of the nostrils into the pallat, and opening towards the nostrils, for the more convenient reception of air, as is supposed. This passage in fowl is exactly in the middle of the pallat, below the entrance of the nostrils into it. It is a membranous tube, capable of admitting a raven's, if not a goose-quill, in larger fowl, such as turkeys, geese, &c., and reaches backward as far as the communication from ear to ear, and hence it comes to serve both; whereas there is a necessity of two in those animals whose ears do not communicate."[5]

Reptiles have a Eustachian tube, as turtles, frogs, and most of the lizard tribe.

Serpents, with very few exceptions, as the blind worm (anguis fragilis), have no Eustachian tube.[6]

[5] Phil. Trans. 1694.

[6] Blumenbach's Comp. Anat.

The salamander, fishes, and cray-fish, &c., are without this tube.

In the cetacea the Eustachian tube opens at the blowing hole, and is furnished with a valve, to prevent the entrance of water, which the animal expels through this opening.[7]

*The ossicula* are only completely developed in the mammalia.

" The stapes is always more massive in the mammalia inhabiting the waters, as the seal, walrus, and whale tribes. In the otter, which only dives occasionally, the stapes does not vary from that of the fox. In the tiger, dog, and other feræ, the crura are straight, meeting in an acute angle; but the same figure occurs in the horse, beaver, goat, and many more herbiverous quadrupeds, so that no inference can be drawn from their different habits of life.[8]

The stapes of the seal has solid, rounded crura and a small aperture; that of the walrus is entirely solid, and the edges, as well as the plane of the sides, are a little twisted.[9]

The stapes is imperforate in the hippopotamus. In different animals the crura are more or less curved; the branches are at their greatest separation in the mole. In the marmot and guinea-pig a bolt runs through the rounded arch, formed by the crura.

Sir A. Carlisle says, " I have discovered a very remarkable singularity in tracing the comparison of this bone in the marmot and guinea-pig. The stapes

[7] Blumenbach's Comp. Anatomy, p. 356.

[8] Phil. Trans. 1805, vol. xcv. part i. p. 203. See in same number twenty-four engravings representing the stapes in various animals.

[9] Cuvier. Leçons d'Anatomie Comparée, tome ii. p. 505.

in these animals is formed with slender crura, constituting a rounded arch, through which an osseous bolt passes, so as to rivet it to its situation.

"This bolt I have named *pessulus;* it is placed near the top of the arch, so that by the action of the stapedeus muscle the upper part of the straight crus is brought into contact with the pessulus, and by this means the depression of the basis is limited. It does not seem obvious for what further end this provision is designed, because, excepting the shrill whistle, there is nothing peculiarly different in the habits of those animals from others which are destitute of such mechanism.[1]

The kangaroo has a stapes somewhat resembling the columella in birds: it possesses also the malleus and incus.

The head of the malleus is pointed in the oran-utan: in dogs and cats the long handle is pyramidal on three sides, and adheres by the narrowest to the membrana tympani.

The malleus is almost a rhomboidal figure in the mole, on account of the excessive size of its anterior apophysis.

The anvil presents few peculiarities: in the oran-utan it resembles that of man.

The ornithorynchus, or duck-billed animal, is the only exception of the class mammalia possessing only two ossicula. These ossicula bear a great resemblance to the columella of birds, the one being in contact with the membrana tympani, the other with the fenestra vestibuli.

In the dugong "the malleus and incus, which

[1] Phil. Trans. vol. xcv. p. 204, part i. 1805.

have nearly the same shape as in other animals, are fastened to the sides of the tympanum by a bony substance extending across the intervening space. The malleus is in this way connected to one side of the tympanum, the incus to the other, so as to render the ossicula in a great measure immovable. The stapes is unconnected with the foramen ovale, to which it is opposed, nor is it anchylosed with the ramus of the incus. The handle of the malleus projects in the centre of the circle over which the membrana tympani had been spread, so as to leave no doubt that in the living animal it is attached to the centre of that membrane."

The dugong is in its habits not unlike the hippopotamus, inasmuch as it feeds on plants at the bottom of the sea. In the hippopotamus the ossicula are separate.[2]

In the amphibia the columella is long and moveable.

The frog has two ossicula, composed of cartilage, one attached to the membrana tympani by a thin apophysis, forming an acute angle with the other ossiculum, which is in contact with the fenestra vestibuli. Some describe this as a columella, extending from the membrana tympani to the fenestra vestibuli, and having a small process attached to it anteriorly, being somewhat of a trumpet shape.

" In the rana esculenta the highest of the caducibranchiate amphibia, or common frog, the tympanic bone, as in most of the lower vertebrata, sends down a condyloid process, to be articulated with a glenoid cavity on the back part of the lower jaw."[3]

[2] Sir E. Home. Phil. Trans. 1820. p. 149.

[3] Grant's Outlines. See fig. 36.

Lizards have one ossiculum; the crocodile has one. In milotic crocodiles, gavials, and alligators, the tympanic bone is fixed by sutures to the other parts of the temporal, and forms a prominent condyle for the lower jaw.[4]

Serpents, although not possessing a tympanum, have an ossiculum, surrounded by muscles, and attached to the fenestra vestibuli. The single ossiculum of the turtle resembles that of birds.[5]

The ossicula do not exist in cameleons, salamanders, tortoises, nor even in fish.

The operculum of fishes is placed behind the lower jaw, and consists of a *large* opercular, a *sub*-opercular, an *inter* opercular, and a *small bone* below the sub-opercular. Geoffroi St. Hilaire considers the opercular bones of fishes the same as ossicula, and thinks that in fish the highest development is found: the opercular representing the stapes, the sub-opercular the os orbiculare, the inter-opercular the malleus, and the small bone the incus.[6]

The size, form, and inclination of the *columella*, so named by Julius Casserius, varies very much in the different varieties of birds. They have only one ossiculum, bent in such a manner as to form two branches; the external is attached to the membrana tympani; the internal, being at an acute angle with the external, passes towards the fenestra vestibuli, and closes it by a triangular or oval plate of bone, in the same way as it is closed by the stapes in the mammalia. The columella in birds is less brittle than the ossicula auditûs in the mammalia.

[4] Grant, fig. 41.

[5] Blumenbach.

[6] For an original paper, communicated by M. Geoffroi St. Hilaire,

*The muscles* of the ossicula are most perfect in the mammalia.

Man alone has two muscles attached to the malleus. The quadrumana have only muscle for this bone.[8] In many of the lower classes tendinous connexions are found, which have, even in the human subject, been mistaken for muscles

"In the cete, the porpoise, whose organs of hearing precisely resemble those of whales which I have seen, the muscle of the stapes pulls the capitulum at an angle of forty-five degrees with the plane of the basis, so as remarkably to depress its subjacent end into the fenestra vestibuli; besides, the thickness of the basis, and its exact adaptation to the fenestra, exhibit a joint of considerable motion."[9]

The columella in birds has a single muscle, which is supposed to be a laxator; it is situated externally upon the cranium, and penetrates by a foramen into the tympanum.

*Fenestra vestibuli et cochleæ.*—Cuvier has proposed giving the name of fenestra *vestibuli* to the foramen *ovale*, and fenestra *cochleæ* to the foramen *rotundum*, inasmuch as in animals these foramina are seldom found oval or round.

The fenestra cochleæ is the larger in most of the ruminantia, pig, hippopotamus, &c.; it is exceedingly small in the elephant: is triangular in the castor, and nothing but a vertical fissure in the hare. In the

on the opercula of fishes, as compared with the ossicula of the tympanum in man, see Quarterly Journal of Foreign Medicine, vol. i. p. 89. See also Grant's Outlines of Comparative Anatomy, figs. 28, 31, 32, 33.

[8] Magendie.

[9] Home.

ornithorynchus the fenestra vestibuli is more *round* than oval; in the mole both fenestræ are oval.

"In all the aquatic mammalia, the fenestra rotunda, called also the fenestra cochleæ, is large, being three or four diameters more than in other animals of similar bulk."[1]

Salamanders, although possessing neither tympanum nor ossiculum, have a fenestra vestibuli, covered by cartilage, and concealed under the integuments and flesh.

*The labyrinth.*—The labyrinth is encased in bone in the mammalia; in the salamander it is entirely shut in the cranium, *without any external communication;* in the crocodile it is enclosed in bone; in the mole the cochlea is enveloped by a sort of diplöe. The petrous portion is harder in the cetacea than in any other animal.

In osseous fishes it is not enclosed in bone, but projects into the cavity of the cranium, and is only separated from the brain by the dura mater. In cartilaginous fishes, such as the ray, shark, &c., it is encased by cartilage. In the sturgeon, an operculated cartilaginous fish, the labyrinth is partially covered, the vestibule alone being within the cavity of the cranium. The vestibule of fishes is membranous, while the semicircular canals and the rudimentary cochlea are generally encased by thin bone or cartilage.

In birds the labyrinth is composed of vestibule, semicircular canals, and a rudimentary cochlea. The sac of the vestibule is larger in proportion than in the mammalia.

The cochlea of the *échidné epineux* much resembles

[1] Phil. Trans. 1805, vol. xcv. part i.

that of birds, being much less complete than that of quadrupeds.[2]

The labyrinth is always filled with fluid, which is more or less gelatinous, and is more particularly so in animals destined to hear under water. The internal ear of fishes increases with the size of the fish, forming a remarkable peculiarity from the three classes of red-blooded animals.[3]

In all the mammalia, as in man, there are five openings on the internal surface of the vestibule for the semicircular canals, one for the fenestra vestibuli, and a seventh for the scala vestibuli, in addition to which is the aquæductus vestibuli. The position of these openings varies very much. The aquæductus vestibuli and cochleæ are found in all the mammalia; the latter is very small in the elephant and horse.

The membranous vestibule is composed of two sacs, called the *utricle* and *sacculus*: in each, small concretions are found; these vary considerably as to size and hardness, and have been more particularly described by M. Breschet, who has called the hard concretions *otolithes*, and the soft *otoconies*. The former are found in osseous, and the latter in cartilaginous fishes. These concretions are found in all vertebrated animals, in some appearing like powdered chalk, suspended in the fluid by filaments of the acoustic nerve, and in others, being exceedingly large and hard, with distinct nervous expansions enveloping them. In fishes, where these otolithes are highly developed, it can be demonstrated that the portio mollis terminates upon them.[4] They vary also as to number, being more numerous as they decrease in size.

[2] Itard. [3] Blumenbach's Comp. Anat.

[4] See prep. No. 1559[b], Lond. Coll. of Surgeons.

The triton, or newt, has only one otolithe; the crocodile has three; lizards and serpents also possess them; frogs have a rudiment. There are *two* sets of white concretions found in the mammalia, and the portio mollis supplies them with numerous filaments. They are always found in the mammalia, but are much larger and harder in aquatic animals.

In the mammalia there are three semicircular canals, one horizontal and two vertical, which cross each other at almost a right angle. When dried, these canals have a thin cord passing through their centre, which has been mistaken for nerves, and called zonulæ nervosæ, but are nothing more than shrivelled membranous sacs. The semicircular canals are found in the ornithorynchus paradoxus;[5] they are small in the cetacea. Camper denied the existence of the semicircular canals in the whale, but Cuvier found them in the fœtus of a whale.

The existence of these canals was doubted by continental anatomists long after Monro had dissected and demonstrated them; and, indeed, when he had published an account of them, some even doubted his veracity; and it required the testimony of the Royal Society of Edinburgh to convince these prejudiced observers that such canals really existed. One of these disputants was no less a person than Scarpa.[6]

In the mole the three canals are projecting and visible in the interior of the cranium.

In birds these canals are smaller than even in reptiles;[7] they are, however, much larger in birds of prey, especially in such as are nocturnal, than they are in the gallinacea. Two of these canals are vertical

[5] Cuvier.

[6] See Monro's Treatises, p. 204. Edinburgh. 1797.

[7] Grant's Outlines.

and one horizontal, the middle being the largest. They terminate in five openings in the vestibule. In the goldfinch the semicircular canals are nearly half as large as they are in the otter or cat, and in the eagle they are larger than in the horse, or in man.[8] In some birds the semicircular canals *intersect* each other; this I have seen in some dissections made by Mr. Edward Cock.

These canals exist in all reptiles, and are found in turtles, frogs, lizards, &c. They are very large, and almost circular in crocodiles and lizards, triangular in salamanders, and partially so in frogs.

Fish generally have three large cartilaginous canals, which project into the cavity of the tympanum; they have no communication with the sacculi which contain the lapilli, although they are connected with them.[9] In the spinous fishes, the three semicircular canals unite in a common belly; but, in cartilaginous fishes, the posterior semicircular canal is distinct from the others. They are larger in cartilaginous than in osseous fishes.

In the sturgeon, these canals are encased by cartilaginous tubes; in the triton, or newt, they are unprotected by any surrounding bone or cartilage. In the lamprey they exist only in a rudimentary state, appearing as folds of the membrane of the vestibule; and it appears there are no cretaceous bodies in the vestibular sac.[1]

The lining membrane of the canals in fishes, which secretes the gelatinous fluid, is very vascular, and upon it the acoustic nerve ramifies; it is particularly

[8] Tod on the Organ of Hearing, p. 56.

[9] Scarpa.

[1] Roget, Bridgewater Treatise, vol. ii. p. 437. See also Grant

evident in the ampullæ, and the vestibular sacs containing the otolithes.

*The cochlea* is found spiral in the mammalia only: it generally makes two turns and a half: there is, however, some variation. It is chiefly composed of two scalæ, surrounding a reticulated piece of bone called the modiolus; these scalæ vary in size.

In man, elephant, horse, sloth, dog, &c., the scala tympani is the larger; in the calf, sheep, rat, Indian pig, &c., the scala vestibuli is the larger. They are nearly equal in size in the hippopotamus and pig.[2]

The earliest formation of the cochlea in the mammalia appears to be in the ornythorynchus nystrix, where it only consists of a curved horn.[3] It is most perfect in the bat, guinea pig, and porcupine.

*Number of turns in various animals.*

| | | |
|---|---|---|
| Cetacea | $1\frac{1}{2}$ | Spiral convolutions. |
| [4] Rabbit | 2 | |
| [4] Horse | $2\frac{1}{4}$ | |
| Man | $2\frac{1}{2}$ | |
| [4] Cow, hog, and cat | $2\frac{1}{2}$ | |
| [4] Dog and fox | 3 | |
| Bat | 3 | |
| Guinea pig and porcupine | $3\frac{1}{2}$ | |

In birds, the cochlea is formed of two cylinders of cartilage, connected by a delicate membrane, and slightly twisted upon each other, forming a pyramidal figure; the two canals converge and terminate in a blind sac, at the point of the cochlea; at the opposite extremity they diverge; one opening into the vesti-

[2] Itard.

[3] Sir E. Home. Phil. Trans. 1802.

[4] See Prize Essay, by Ch. L. Esser. Bonn.

bule, the other into the tympanum. In singing birds, the cochlea has been described as a straight tube.

The cochlea is found imperfect in the class reptilia. In the crocodile and lizard it resembles that of birds, being divided by a cartilaginous septum into two parts. It is much more imperfect in cameleons; and scarcely a trace is found in serpents. There are not even vestiges in fishes.

*The meatus auditivus internus* exists, with scarcely an exception, in all animals, birds, and reptiles. In the salamander there is no internal opening. In the elephant, a bony projection covers this foramen. The meatus is large in the hippopotamus, and oval and small in the rhinoceros. In the monkey it is deep, and a small cavity is found above it, which does not exist in the oran-utan.

The meatus internus is generally well developed in birds, being rather an oval depression than a canal; its greater diameter is almost horizontal, and presents five openings; four for the transmission of the acoustic nerve, and the remaining foramen for the facial nerve. This internal meatus is found in fishes.

The acoustic nerve is proportionably larger in some brutes than in man. The mammalia have two nerves passing through the ear, the portio dura and portio mollis. These nerves vary much in size. The portio mollis is always large where there is no external ear; but where the portio dura is large and extensive for the purpose of collecting sound, then the portio mollis is small.

In the lion, horse, camel, peccary, and kangaroo, the facial nerve is the larger. In the cetacea and castor the portio mollis is larger than the portio dura. In the quadrumana and mole they are nearly equal.

Mr. Shaw found the branch of the facial supplying the proboscis of the elephant equal in size to the sciatic in man, and only a small branch supplied the external ear.[5]

In fishes, there is an intimate union between these two nerves, because a greater influence is required for animals which hear under water, as exemplified in turtles. In the land turtle, the auditory nerve being smaller than the facial: in the water turtle, the acoustic nerve is much the larger.

In reptilia, the portia mollis is much smaller than in pisces, and divides into several branches before penetrating the labyrinth. The facial is very indistinct in *birds*; although some branches may be traced; it receives a filament of the vagum. The acoustic nerve is large, and divides into four branches; three supplying the semicircular canals, principally the ampullæ, the fourth passing through the cochlea to the apex.

The acoustic nerve in fish arises from the *fifth* pair, and penetrates into the labyrinth of cartilaginous fishes by a small foramen, but by a cribriform plate in osseous fishes, except in those where the labyrinth is exposed in the cavity of the cranium.

Treviranus and Weber have found in some fishes an *accessory nerve* of hearing, arising in some from the brain, in others from the fifth, or from the vagus: this has been confirmed by Buechner, Schlemn, D'Alton, and Muller.[6]

These nerves supply the ampullæ of the semicircular canals, but more particularly interlace with each other, and ramify upon the otolithes.

[5] System of Nerves. Sir Charles Bell. p. 127.

[6] See Muller's Physiolog. Trans. p. 768. 1838.

In a plate given by Dr. Roget, of the membranous labyrinth of the lophius piscatorius, are seen three calcareous bodies, which are each supplied by quite distinct branches of nerves from those passing to the ampullæ.[7]

The otic ganglion is not large, when the external ear is large and moveable, as advanced by Arnold, who says, "In those animals which have very large and moveable ears, it is even double."

Mr. Bennett has dissected it nine times in the rabbit, and found it double only once; and four times in the hare, in whom it was by no means so much developed as in the rabbit. In the pig it is small; in the horse and ass, doubtful; calf and sheep, well developed. Mr. B. has dissected it fourteen times in the latter animal, and uniformly found it present: he has also found it in the mole and dog.[8]

The antennæ of insects have been supposed to possess the peculiar power of appreciating vibrations. Sir Charles Bell says, "they may receive an impression from the vibration of air; but as these nerves are nerves of touch, it cannot be sound which they experience." Strauss and Burmeister have each placed the hearing in the antennæ.

Insects possess not only the first elements of an ear, such as the acoustic nerve and vestibule, but have also the rudiments of two semicircular canals, containing fluid; there is also a fenestra vestibuli closed by a thin membrane.[9] These organs have been observed in ants, flies, and other insects by Randohr, who has found them in the common bee, situate near the base

[7] Bridgewater Treatise, plate 403.

[8] Med. Gazette, vol. xix. p. 47.

[9] Comparetti.

of the maxillæ. Comparetti has found them in the class arachnida. The vestibule has distinct nervous filaments ramifying upon the sac; these are supposed to be branches of the antennæal nerves.

In insects, fishes, and worms, a branch of the *fifth* nerve is the nerve of hearing.[1]

The organ of hearing has not been discovered in the mollusca, as the oyster, barnacle, slug, snail, &c.

In the *cephalopoda*, however, a tubercle has been found close to the cartilaginous ring, joining the cranium, consisting of two membranous vesicles filled with fluid, and each containing small calcareous bodies, suspended by numerous nervous filaments.

In the sepia,[2] a vestige of the organ of hearing has been found, consisting of two oval cavities, filled with fluid, containing cretaceous matter, and receiving the termination of nerves. This sac is found at the base of the tentacula, covered by integuments, and having no external opening.

*Crustacea* have two pairs of antennæ. The inner pair are commonly divided at their free extremities; and the exterior pair have at their proximal extremity, in their broad expanded basilar joint, the small circular prominent opening of the vestibule or ear, on each side, directed downwards; sometimes covered with a membrane, and sometimes with a calcified plate.[3]

Crabs and lobsters have an opening in the projecting portion of the skull, at the base of the antennæ,

[1] Scarpa.

[2] See preparation, Lond. Coll. of Surgeons, No. 1559$^{b}$, showing the pulpy matter in which the otolithe is suspended by numerous nervous filaments, by Prof. Owen.

[3] Grant's Outlines of Comp. Anat. vol. i. fig. 18.

which leads to a sac,[4] filled with fluid, and containing a triangular otolithe, which is firm in the lobster, but much softer in the crab. Scarpa describes this as an organ adapted for hearing through the medium of air as well as water; it being a double provision, as in the case of amphibia. The nerve ramifies upon the otolithe. The opening to this sac is closed by a membrane in the lobster corresponding to the fenestra vestibuli; and by a crustaceous layer in the crab, to which is attached an antenna.

The antennæ are met with in the *myriapoda*, and are two in number,[5] as in insects.[6] The species *arachnida*[7] are without antennæ, but possess a pair of lateral pincers or cheli. The antennæ have been supposed to be the organs of hearing; but it seems most probable that they are intended for some other purpose; inasmuch as many insects hear well without them; and even those possessing them have heard equally well when the antennæ have been removed.[8]

"Many insects have hard organs for producing audible sounds, by their rapid attrition against each other; and these sounds are often heard and repeated by their mates, being a means of communication between the sexes, especially in the darkness of the night."[9]

[4] See preparation, Lond. Coll. of Surgeons, No. 1559[a], by Prof. Owen. Hermit Crab, (Pagurus Miles. Oliv.) Simple vestibular cavity, situate at the under part of the basal joint of the external antennæ.

[5] Grant's Outlines of Comp. Anat. vol. i. fig. 15.

[6] Fig. 16.

[7] Comparetti has described them in this class.

[8] Comparetti. See De Blainville de l'Organisation des Animaux, Lehmann.

[9] Grant's Outlines, part ii. p. 276.

"The tritonia arborescens emits audible sounds under water, which are without doubt intended to be heard by others of the same species, as we see in insects."[1]

"The antennæ are perfectly solid, and without tube or cavity; they possess no external orifice by which sound could enter; nor any internal orifice by which they could transmit sound to the auditory nerve.

"Mr. Newman says, we must conclude not only that these instruments are ill adapted to collect and transmit sound, but that, were the task imposed on us of forming an instrument expressly to avoid arresting the progress of sound, we should fashion it precisely after the similitude of these antennæ. Again, the male insects are the musicians; the females therefore require the greater development of auditory instruments. We cannot doubt that, in accordance with the universal law of adapting the instrument to its end, this greater development has been provided. In vain we look for the required development in the antennæ; for in them it is invariably possessed by the males, not by the females."[2]

*Pisces* have a membranous vestibule, and three membranous semicircular canals, sometimes encased in bony or cartilaginous tubes; the whole labyrinth is generally enclosed in bone or cartilage, but sometimes it is projecting into the cavity of the cranium.[3]

[1] Grant's Outlines, part ii. p. 279.

[2] See some interesting remarks on the antennæ of insects, in relation to the theory that these appendages are analogous to the ears of higher animals. Mag. of Nat. History, edited by E. Charlesworth, Esq. May 1838. No. 17.

[3] See preparations of Lond. Coll. of Surgeons, from No. 1560 to 1574.

The semicircular canals in some fish are very imperfect, forming only a rudiment; but as we rise in this class, they become more and more perfect. Fish which always remain under water have no external membrane, as those have which rise to the surface to breathe; hence it is not found in cartilaginous and spinous fishes.

*Reptilia.*—Some have a rudimentary tympanum, containing two openings, one for the Eustachian tube, the other corresponding to the fenestra vestibuli. The tympanic bone is connected with the lower jaw, and both have considerable motion. They have no meatus externus, but some species have a membrana tympani.

All of this class have semicircular canals, and a rudimentary cochlea, which in some of the higher reptiles much resembles that of birds; there is a meatus auditivus internus, and the vestibule contains otolithes. In serpents, a small bone is found behind and attached to the lower jaw, which passes directly to the fenestra vestibuli; there is a vestibule, with fluid, nerve, and rudimentary otolithes. There are also semicircular canals, united by a common belly; there is no membrana tympani.

*Amphibia* sometimes more closely resemble aquatic, at other times terrestrial animals; dependent upon their natural habits; they form the connecting link between the two classes. They have a membrana tympani, ossicula for receiving and transmitting sound; and also otolithes for receiving impressions through water. The labyrinth is more or less perfect in all of this class. The frog, behind the eye and immediately under the skin, has a circular opening, where a small cartilaginous body is found, connected

with the lower jaw, as in most of the lower invertebrata; this is connected with another cartilaginous ossiculum, in contact with the fenestra vestibuli. The vestibule is large in proportion, containing fluid, an acoustic nerve, and otolithes.

In the turtle there is a long slender bone passing through the tympanum, situated under the scaly integument above the articulation of the lower jaw. One end of this ossiculum is in contact with the integuments, while the other is connected with the fenestra vestibuli. There are here a vestibule, fluid, nerve, otolithes, and three semicircular canals, connected by a common belly.

*Aves* have a rudimentary auricle, a perfect meatus auditivus externus, leading to the tympanum, which is connected with that of the opposite side. There is an ossiculum with its muscle, Eustachian tube, membrana tympani, fenestræ vestibuli et cochleæ, a *large* vestibule, perfect semicircular canals, a cochlea composed of two partially curved scalæ, and a meatus auditivus internus.

*Mammalia.*—Each part of this organ is developed, with few exceptions, as perfectly as in man.

## ON SOUND.

The proper stimulus for the ear is sound, or, more correctly speaking, *vibration*, sound being rather the *appreciation* of vibration; but, in order to prevent mistake, I shall frequently use the term sound in its original sense. This vibration stimulates the acoustic nerve, as light stimulates the iris, blood the heart, pressure the œsophagus, odours the olfactory nerves, &c. It will be necessary to give some slight account of vibration, before proceeding to mention its effects upon the ear.

*Sound is the result of vibratory motions excited in an elastic medium, be it aëriform, fluid, or solid.* Sound is not simply a vibration of air, as some have supposed; and this may be proved by striking a tuning-fork, which is solid, and placing it in contact with the teeth, and the vibration is very apparent. Continued sound is always attended by sensible vibration,[4] and may be familiarly shown by rubbing the moistened finger round a finger-glass, when, so long as the sound continues, the surface of the water will be rippled.

A single impulse communicated to an elastic

[4] See some interesting experiments on the oscillation of the particles of sand upon elastic plates, when under the influence of vibration.—*Wheatstone on Sound. Annals of Philos. New Series*, vol. vi. 1823.

medium produces a noise; a succession of impulses following each other too rapidly to be separately distinguished produces a continued sound, and if they are equal among themselves in duration, they produce a musical or equable sound. An harmonic or musical sound is that which, being clear and even, is agreeable to the ear, and gives a certain and discernible tune. Musical sounds may be long or short, upon which depend *measure* and *time;* they may also be *simple* or *compound*, *smooth* or *even*, *rough* or *harsh*, *clear* or *hoarse*.

Concord depends upon the frequent, and discord upon the less frequent, coincidences of vibrations.

The sound of musical instruments is generally produced by causing a chord or a column of air to vibrate, the note or tone being higher when short, and deeper when long. The tension of a string also determines the number of vibrations.

A *musical ear* is that sense by which we judge of harmonic sounds. Some persons, whose hearing is not remarkably acute, are exceedingly good judges of music; and this power of appreciating musical notes seems to be dependent upon a special faculty placed in a particular part of the brain. "A good ear may distinctly observe, especially in a loud bass voice, besides the fundamental note, at least four harmonic sounds, in the order of the natural numbers; and the more *reedy* the tone of the voice, the more easily they are heard."[5]

Dogs have a great aversion to music, and almost invariably howl when they hear it; serpents like it,

[5] Phil. Trans. 1800. Young on Sound.

and are even enticed and tamed by it. Fish will come to be fed on the tinkling of a bell ; the Chinese frighten them from the rocks by sounding a gong. Music has been said to cure diseases, as, for instance, the bite of the tarantula.[6]

Tones become lower as vibrations are less numerous, and higher as they are more so : tune or pitch is dependent on the frequency with which vibrations succeed each other ; and loudness on the amplitude of vibration.

The longer the interval between the vibrations the graver the sound, the shorter the interval the more acute. Dr. Roget says, these terms, grave and acute, are perfectly arbitrary, as it is well known that they were applied by the ancients in a sense exactly the reverse of that in which we now use them.[7]

" Loudness of sound is dependent on the excursions of vibrations; volume or fulness of sound on the number of co-existing particles put into motion. Thus the tunes of the Æolian harp, on account of the number of subdivisions of the strings, are remarkably beautiful and rich, without possessing much power; and the sounds of an harmonica glass, in which a greater number of particles are excited than by any other means, are extraordinarily so united, according to the method of excitation, with considerable intensity. Their pervading nature is one of the greatest peculiarities of these sounds.

[6] For the good effects of music in mitigating disease, see p. 23 et seq. vol. i. Theses. 1751. Edinb. De sonorum modulatorum vi in corpora humana.—*J. Brown ;* and De musices effectu in doloribus leniendis.—*D. Campbell*, 1777. I believe Sir H. Halford has also written a treatise on this subject.

[7] Bridgewater Treatise, vol. ii. p. 419.

*Table of the various properties of sound, which are attributable to modifications of the vibratory corpuscules.*

| | | |
|---|---|---|
| The tune. | Dependent upon | Velocities of the vibrations. |
| The time. | | Continuance of the vibrations. |
| The intensity. | | Excursions of the vibrations. |
| The richness or volume. | | Number of co-existing vibrations. |
| The quantity (timbre). | | Magnitude of the vibratory corpuscules.[8]" |

The average extent of the scale of sounds is from thirty to twelve thousand vibrations.[9]

M. Euler is of opinion, that no sound making fewer vibrations than thirty, or more than seven thousand five hundred and twenty in a second, is distinguishable by the human ear, and, according to this doctrine, the limit of our hearing, as to acute and grave, is an interval of eight octaves.[1]

The range of human hearing appears to be much more extensive in some persons than in others, and some curious facts have been published upon this subject by Dr. Wollaston. "I have found that an ear which would be considered as perfect with regard to the generality of sounds, may at the same time be completely insensible to such as are at one or the other extremity of the scale of musical notes, the hearing or not hearing of which seems to depend wholly on the pitch or frequency of vibration constituting the note, and not upon the intensity or loudness of the note. While I was endeavouring to estimate the pitch of certain sharp sounds, I remarked in one of my

[8] Annals of Philosophy. New Series. Vol. vi. p. 85. 1823.

[9] Wollaston.

[1] Tentam. Nov. Theor. Mus. cap. ii. sect. 13.—See Rees' Cyclopedia.

friends a total insensibility to the sound of a small organ pipe, which, in respect to acuteness, was far within the limits of my own hearing as well as of others of our acquaintance.

By subsequent examination we found that his sense of hearing terminated at a note four octaves above the middle E of the piano-forte. This note he seemed to hear rather imperfectly, but he could not hear the F next above it, although the hearing is in other respects as perfect, and his perception of musical pitch as correct, as that of any ordinary ears."

He also mentions the case of a relation, who said "she never could hear the chirping that commonly occurs in hedges during a summer's evening," which he believes to be that of the gryllus campestris; he also thinks her sister to have been similarly affected.

He relates the circumstance of two ladies of his acquaintance, who agree that their father could never hear the chirping of the common house-sparrow. This is the lowest limit to acute hearing that he has met with, and he believes it to be extremely rare; even deafness to chirping of the house-cricket is not common, which is several notes higher. Inability to hear the piercing squeaks of the bat seems not very rare, as he has met with several instances of persons not aware of such a sound.

"The chirping of the sparrow will vary, but seems to be about four octaves above E in the middle of the piano-forte. The note of a bat is a full octave higher than the sparrow, and I believe that some insects may reach as far as one octave more. The range of human hearing comprised between the lowest notes of the organ, and the highest known cry of insects, includes more than nine octaves, the whole of which

are distinctly perceptible by most ears, although the vibrations of a note at the higher extreme are six or seven hundred-fold more frequent than those which constitute the gravest audible sound.

Perhaps the grylli, whose powers appear to commence nearly where ours terminate, may have the faculty of hearing still sharper sounds."[2]

Sound passes in every direction, and is diminished in intensity in the ratio of the square of the distance; so that at the distance of ten feet from the sounding body, the velocity of the particles of the medium becomes one-tenth as great as at the distance of one foot, and their energy, or the strength of the sound, only one-hundredth as great.[3]

There is no body incapable of conducting vibration; it is transmitted best by solids, then liquids, and last by air. Mr. Wunsch found, that by the blow of a hammer on the wall, at the upper part of a high house, two sounds are heard below, the one succeeding the other; the first descending through the wall, the other through the air.[4]

During the ordinary state of the atmosphere near the earth, intense sounds would seem to travel to almost incredible distances.[5]

[2] Phil. Trans. 1820. Wollaston, p. 310.

[3] Young's Lect. on Nat. Phil. vol. i. lect. 31.

[4] See also M. Biot's Experiment, p. 75.

[5] Guns fired at Florence were plainly enough heard at Leghorn, which in a straight line is no less than fifty-five miles. The Leghorn guns are often heard at Porto Ferraro, a distance of sixty-six miles. When the French bombarded Genoa, they heard it near Leghorn, ninety miles distant. In the Messina insurrection the guns were heard from thence as far as Angusta and Syracuse, about one hundred Italian miles. Some guns fired at Stockholm were heard one hundred and eighty English miles.—*Derham's Physico-Theology,* vol. i. p. 202. 1798.

| | |
|---|---|
| Wood transmits sound about | 12,000 feet per second. |
| Water . . | 4,900 feet per second.[6] |
| Air . . | 1,130 feet per second. |

Some have made it 1,142 feet per second, while others have given 1,100 feet, being about 12½ miles a minute. This discrepancy arises from the experiments being made at various times and in different places, sound being much influenced by the state of the atmosphere.

Professor Robinson heard the sound of a bell, transmitted by water, at the distance of 1200 feet. The Abbé Mollet could hear the human voice under water, and even distinguish conversation and music.[7]

The Abbé Mollet sank under water, and struck together two stones which he held in his hands; it gave to his ear a shock which was insupportable, and which was felt on all the surface of his body.

Dr. Monro plunged his whole body with two bells, holding their handles in his hands, under water, and then rang them, and was surprised with the loudness and distinctness of their sounds. "And in like manner, when plunged under the water, I struck two

During the naval action between the English and Dutch in 1672, the guns were heard at Shrewsbury, being a distance exceeding two hundred miles.—*Phil. Trans.*

Many persons still living in Ipswich can testify that on the day of the battle of Waterloo they distinctly heard loud and long reports; and if the previous accounts are to be credited, there would seem no sufficient reason why this should be doubted, the more especially when we consider the continued roaring of artillery which was kept up for several hours on each side, probably exceeding in duration and intensity any noise ever before artificially produced. Sir Stamford Raffles, in 1815, heard the reports occasioned by the eruption of a volcano, when at a distance of nine hundred and seventy miles.

[6] Chaladni.

[7] See Dr. Hutton's Experiment, p. 72.

stones, held in my hands, against each other; I was surprised with the shock communicated to the ears."[8]

These experiments prove that water transmits a stronger vibration than air. Sound is conveyed more quickly and farther by water than by air. Franklin found, by experiment, that sound loses but little of its intensity after travelling more than a mile through water. Again, sound travels more quickly by ice than by water. "If a cannon be fired from a distant fort, where a frozen river intervenes, each flash of light is followed by two distinct reports, the first being conveyed by the ice, and the second by the air."[9] The earth also conveys sound better than air, and for this reason North American hunters and savages apply their ears to the ground, to distinguish distant footsteps.

The motion of a troop of cavalry is said to be perceived at a greater distance by listening with the head in contact with the ground, than by attending to the sound conveyed through the air.

Sound moves more rapidly than wind: the reason

[8] Experiments on Sound. Monro on Fishes. Edinb. 1784. fol. p. 53.

Derham made similar experiments with the same result. "Divers at the bottom of the sea can hear the noises made above only confusedly; but, on the contrary, those above cannot hear the divers below, of which an experiment was made, that had like to have been fatal. One of the divers blew a horn in his diving bell at the bottom of the sea, the sound whereof in that compressed air was so very loud and irksome that it stunned the diver, and made him so giddy, that he had like to have dropt out of his bell and to have been drowned.—*Physico-Theology, by Derham,* 9th ed. 1737. p. 132, foot-note.

For other remarks on descent in a diving bell, see Med. Chir. Review, p. 481, 1832, by Dr. Colladon; also Phil. Trans. vol. lxiv. p. 348.

[9] Bridgewater Treatise.—Roget. 1834, vol. ii. p. 418.

we hear sounds at a greater distance when the wind is favourable, is because the wind diminishes the space of the aerial waves. The velocity of wind must be added to that of sound, when making experiments.

According to the government survey maps, the distance between Sheerness and Southend is about six miles and a half. From some observations I made during the summer of 1838, I found that between the flash, as seen on firing the evening gun from the flagship at Sheerness, and the report as heard at Southend, there was an interval of from 30′ to 40′, the difference depending upon the strength of the wind. When the wind blew strongly in a contrary direction, no sound *whatever* was heard. Sound cannot traverse a void space as light does :[1] this may be proved by placing a bell in a vacuum, and when agitated, no vibration takes place ; it becomes louder when excited in condensed air,[2] and is always greater in dense, and smaller in rarified air.

As travellers ascend mountains, owing to the diminished density of the air, it is with difficulty they can hear the voices of their fellow-travellers even at a moderate distance, when the same noise at a lower level would be overpowering.

The report of a pistol on the top of Mont Blanc is no louder than that of a common Indian cracker.[3] Sir John Herschel noticed the extremely faint tones of the voice when 13,000 feet high on Mont Rosa.

When the thermometer stood at 4° Fahrenheit, Captain Parry could hear people conversing in a common tone of voice, at the distance of a mile.

[1] See some interesting experiments and inquiries respecting the analogy of light and sound, by Dr. Young, Phil. Trans. 1800.

[2] Hawksbee, Phil. Trans. 1705.

[3] Sir David Brewster, Saussure, and Barry.

At a freezing temperature, sound travels 1,090 feet per second. At 62° Fahrenheit, 1,120 feet per second, or 765 miles in an hour. In sulphurous acid gas, sound travels 750 feet per second; in pure hydrogen gas, 3,000 feet per second. Fogs, falling rain, but especially recent snow, much impede the transmission of sound.[4]

Dr. Hutton of Woolwich could hear persons reading seventy-six feet by land, and one hundred feet by water.

Although rarified air is a bad conductor of vibration, yet it will transmit, even to a great distance, sounds of extraordinary intensity, as is well shown by the reports heard when meteors explode.[5]

Some have supposed sound to be propagated in right lines, in the same way as the rays of light; but this does not seem to be the fact, inasmuch as the atoms in sonorous cones are oscillatory,[6] while those of the cones of light have a real transitive motion.

Sound coming in contact with any body is reflected with equal velocity to that with which it strikes the solid body. The rapidity with which an echo returns,

[4] Extracts from MS. Notes of Professor Jameson's Lectures on Natural History.

[5] In 1719, a meteor, when exploding, although sixty-nine miles high, produced a noise like a cannon, or broadside. In 1756, the report of a meteor threw down several chimneys, and did other damage, leading persons to suppose an earthquake had taken place. Buildings have been thrown down by the concussion of air produced by thunder, or the discharges of artillery. In 1777, July 17th, the report of a meteor was most distinctly heard near Paris, although its height was about twenty-five miles. In 1783, the explosion of *the great* meteor was heard, although fifty miles distant. The report was distinctly heard at Windsor ten minutes after the disappearance of the meteor, and this perhaps is the longest interval known.—Extracts from MS. Notes of Professor Jameson's Lectures.

[6] See note, p. 63.

depends upon the distance of the reflecting surface. Sound travels 1,130 feet per second; so that a mountain at half that distance would return the sound in one second. Sometimes the reflected is louder than the original sound;[7] this is particularly observed in whispering galleries, which depend upon this principle, that the voice being applied to one end of an arch, easily passes by repeated reflections to the other.

"If from any point in the circumference of an ellipse two lines be drawn to the foci, those lines mark equal angles with one curve at that point; consequently the sound which is produced in one focus of an elliptical chamber, and is reflected from the wall to the other focus, makes all the angles of incidence equal to the angles of reflection respectively. Hence that focus is the place where the sound is best heard. All the necessary contrivance in a whispering place is, that near the person who whispers, there be a smooth wall, arched either cylindrically or elliptically, in which case he will be heard by another person who places his ear pretty near the wall on the opposite side. A circular wall will do, but not so well."[8]

There have been several noted places remarkable for this reverberation, such as St. Paul's and Gloucester cathedrals, and Dionysius's prison, he being able to hear in his parlour what his captives said in the prison. The Hall of Secrets, at the Observatoire, Paris, is another remarkably perfect example.

For an interesting account of echoes, see article in the Edinburgh Cyclopædia, where it is mentioned

[7] For a curious confirmation of this, see account of an interesting acoustic phenomenon, occurring on the firing of cannon at Port Royal Harbour, Jamaica, by Mr. Shand, Medical Gazette, Feb. 9th, 1839, p. 720.

[8] See Article Conics, Rees' Cyclopedia.

that an echo in Sussex repeats twenty-one syllables; and another in Woodstock Park, Oxfordshire, repeats seventeen in the day, and twenty in the night.

We have had exhibitions, for their deception dependent upon the same principle, as "The Enchanted Lyre," and "The Invisible Girl."

Ventriloquism consists in articulating during *inspiration;* the sounds are always weak, and to succeed, the ventriloquist must deceive as to distance. This is occasionally produced by the ventriloquist emitting his sounds so that they strike against some opposing object; and the *point* whence they are *reflected* is the spot to which the auditors *correctly* refer the sound, but being generally unconscious how it is effected. The exhibitor must take care that the *real* do not overpower the reflected sounds, otherwise the real voice will be detected instead of its reverberation. The resonance of rooms is dependent upon internal reverberation.

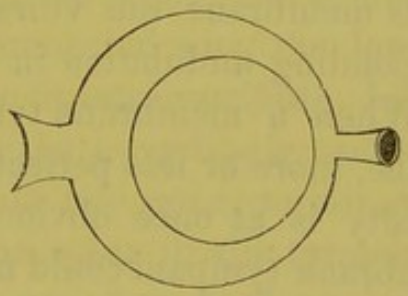
The sound increased by hearing-trumpets is occasioned in the same manner; the weak undulations being collected and received by the large end of the tube, are reflected several times from its sides in passing to the small extremity intended for the meatus. It is precisely the reverse in speaking trumpets; the sound, being forced through the small end, gradually increases as it passes out through the expanded extremity. The best form for a hearing-trumpet is a parabolic conoid, with a winding tube; a spiral figure being considered the best for producing *distinctness* of sound. To effect this purpose, M. Itard recommends that several layers of gold-beater's skin should be placed perpendicularly in the tube, at proper distances.[9] The longer the tube, the greater the augmentation of sound. The best trumpet I have seen

[9] See his Traité.

or used, is one invented by Miss Martineau. Its objection is its size; but surely to a person very deaf, the pleasure of hearing must more than compensate for its inconvenience. It is made of tin, and is so contrived as to cause a more complete reverberation than takes place in common trumpets.

A feeble sound, when transmitted through a long solid tube, becomes greatly increased during its passage. A man speaking through a tube four feet in length may be understood at the distance of 500 geometrical paces; with a tube $16\frac{2}{3}$ feet, at the distance of 1,800 paces; with a tube 24 feet long, at a greater distance than 2,500 geometrical paces. A person speaking through Alexander the Great's tube, might be heard 100 stadia; of which there is a figure preserved in the Vatican of Rome. Its diameter, according to Kircher, was five cubits, and it was suspended on a supporter.[9]

Cornu
Alexand. Mag.
quo exercit.
100 stad. coegit.



The aqueduct of Claudius carried a voice sixteen miles. M. Biot found that the lowest whisper could be heard 3,120 feet through the iron conduit pipes which supply Paris with water. That it was the air, and not the solid material of these pipes, that transmitted the sound, was proved in the further experiments of striking the metal at one end of the pipes, when two sounds were heard at the other end, one transmitted by the iron of the pipes, and another $2\frac{1}{4}$ seconds later, conveyed by the air within them.[1]

[9] See Derham's Physico-Theology.

## PHYSIOLOGY.

The simplest form of ear appears to be a sac, containing otolithes, suspended in a fluid by nervous filaments, and this seems to be alone *essential* for the perception of vibration. Next we observe not only a vestibule with otolithes, but three semicircular canals, varying in shape and size, and always filled with fluid; the nervous filaments they contain are most distinct upon the otolithes, and in the ampullæ.

In ascending the scale of organization, when the animal breathes, a membrane closes an opening in the sac, corresponding to the fenestra vestibuli; and upon this membrane the vibrations strike, producing a corresponding undulation in the fluid of the vestibule. When a membrana tympani exists, a Eustachian tube, more or less perfect, is invariably present; its necessity is at once obvious, when we reflect that the membrana tympani could not be kept in its proper state of tension, was not air admitted on each side. If an animal live entirely under water, no membrana tympani is ever found; but if destined to rise even occasionally, as in the amphibia, then there is a membrane. When the membrana tympani does not exist, the otolithes are always large; the vibration is in this case conducted through the bones of the cranium, and the tremulous motion is conveyed to the otolithes through the gelatinous fluid.

Those animals which only hear through the medium of water, have neither tympanum nor ossicula.

[1] Medical Gazette, vol. 20, p. 352.

We always find the fenestra vestibuli when there is a membrana tympani ; and the ossiculum is invariably in contact with these two membranes.

In rising still higher, there are not only the vestibule, semicircular canals, membrana tympani, Eustachian tube, and fenestra vestibuli, but also a well-developed meatus externus, a more complete tympanum, containing a more perfect ossiculum, or several such ; there is also another fenestra, leading into the cochlea, which consists of two scalæ, more or less twisted, one terminating in the vestibule, the other in the tympanum.

Thus we find the *vestibule* the most essential part, next in order a vestibule and semicircular canals, then a vestibule with a fenestra vestibuli, but without semicircular canals ; then a vestibule, semicircular canals, rudimentary cochlea, and tympanum with Eustachian tube, but no membrana tympani, the tympanic bone being connected with the lower jaw, and passing at once to the fenestra vestibuli. In ascending still higher, there exist a vestibule, semicircular canals, a cochlea with its two scalæ, terminating the one in the vestibule, the other in the tympanum ; a perfect tympanum with one, two, or three ossicula, a Eustachian tube, and a membrana tympani.

The sense by which we are capable of hearing consists of *two* organs, placed on either side of the head ; and I believe, in all cases where this sense exists, it is universally found to be double, the utility of which seems to be, that when listening with two ears, we can better determine the distance and locality of a sound ;[2] but perhaps the most important reason that

[2] For a very interesting paper on the method of judging by the ear, as to the distances of sound, &c. by Mr. Gough, see p. 622 sqq. Manchester Memoirs, vol. 5.

can be assigned is, that in case of loss or injury of one ear, there is still another to depend upon.

All the vertebrata, and some of the higher invertebrata, have some vestiges of an acoustic apparatus, and it is possible that vibration may be felt where no traces of the ear have been found. Red-blooded animals, without exception, possess this organ.

Although very young infants are undoubtedly aware of some sounds, yet it does not appear that their range of hearing is very extensive; this is precisely what we should anticipate, in consequence of various parts of the ear not being yet perfected. After the first year, the cartilages become firmer, the fibrous membrane is converted into bone, the osseous portions of the Eustachian tube and meatus are completed, the membrana tympani becomes transparent, and contracts. The Eustachian tube alters its direction, and forms an acute angle with the mastoid process. The tympanum becomes enlarged by the contraction of the membrana tympani; the hammer, which is almost perpendicular in the fœtus, becomes firmly opposed to the membrana tympani. The tympanum does not contain the apparent mucus after the second year, and its lining membrane becomes less red and more fibrous, and appears more like a mucous membrane. The mastoidal cells become more and more evident; the semicircular canals less visible on account of ossification proceeding; the liquid of the labyrinth becomes clearer, and the meatus auditivus internus enlarges.

The organ of hearing has been divided by most physiologists into three parts; an *external* for collecting and transmitting, a *middle* for modifying, and an *internal* for appreciating sound.

We find the shape, size, direction, and situation of the auricle to be dependent upon the habits of the animal; in some being large and open, to enable them to hear the least approach of danger; in some very long and moveable, for the purpose of collecting sound, as well as freeing themselves from flies; in others covered, to keep out noxious insects, or prevent the air from rushing in when flying. Had the auricles been large and projecting in birds, it would have impeded flight; and in moles, the internal parts would have been constantly irritated by the entrance of mould, as well as preventing the animal from burrowing in the ground.

As a general rule, when an animal acts upon the offensive, the external ears are small; and when it depends upon flight, the ears are large..

There is a distinct variety of the human race characterized by the position of their ears. "Not only as they are represented in the Memnonium and other Egyptian statues and coins, were the old Egypto-Caucasians remarkable for their high ears, but in more than forty mummies which were unrolled by M. de Lamalle at Turin, the auricular foramen, which, drawing a horizontal line, is placed in us on a level with the inferior part of the nose, was in these examples found to be on a level with the middle of the eye. The elevation, as measured, amounted to a full inch and a half. The facial angle was, at the same time, found equal to that of Europeans; but the temporal region much more developed than in our variety. Nor does it appear that the high eared-race are extinct; there are instances of it among the people of Upper Egypt at this day; and, indeed, there is in Paris, at present, a teacher of Arabic—a Copt of

Upper Egypt—who is possessed of this conformation in a most decided degree."[3]

Although the auricle in man is supplied with small muscles, yet in general they are not under the power of the will, as is usual in most animals.

The power of using voluntary muscles is the result of experience, and is gained by imitation and instruction; thus, in Europeans, whose subsistence and safety do not depend upon the acuteness of hearing, we find an incapability of voluntary movements of the ear; but in savage life it is almost universal to enjoy a perfect control over these auricular muscles; and this voluntary power has been noticed in those who having once heard perfectly well, have subsequently become partially deaf.

In a case mentioned by Sir A. Cooper, when extreme attention was necessary, both auricles were continually in motion.[4]

The fibro-cartilage of which the auricle is composed, is the very best structure that could possibly have been devised for retaining the shape of the ear, and admitting of the reverberation of sound; had it been formed of fat, this reverberation must necessarily have been much impaired.

The lobe of the ear does not seem to perform any particular part in the function of hearing. The auricle serves not only for the purpose of collecting sounds, but, by means of the parabolic curves previously described, conducts the vibrations into the tympanum. Itard imagines it to be useless so far as hearing is concerned; while Buchanan considers it almost indis-

[3] Med. Gazette, vol. xi. p. 156.

[4] Phil. Trans. 1800.

pensable, and imagines deafness to be frequently dependent upon its form and depth; and there can be no doubt but that the configuration and tension of the auricle do, in a great measure, determine the *finesse* of hearing; and this seems confirmed by the fact, that by pressing the auricle forwards, and forming at the same time a concavity with the hand, sounds become very much augmented.

Firm support behind the ear will of itself increase the power of hearing, when the deafness is dependent upon a relaxed state of the auricle; and upon this principle an instrument has been invented, called the otaphone.

The meatus auditivus externus in man is, as in most animals, slightly tortuous, which in a great measure tends to preserve the internal ear from the danger of accidents. There are different contrivances to protect the internal ear; in animals which burrow under ground, or dive under water, there is either a valve closing the meatus, or a remarkably small and tortuous opening, the object in each case being to preserve the internal ear from the presence of extraneous bodies; and in birds the external opening is guarded by feathers to effect the same object.

The external surface of the membrana tympani is covered with wax, which is for the purpose of modi fying sound, keeping the meatus moist, and by its extreme bitterness preventing the entrance of insects. It is found in all animals having a long meatus externus. In birds, where the meatus is short, and the tympanum is near the feathers which protect it, there is no cerumen. In man the membrana tympani is slightly concave externally; in some animals and birds it is convex, while in others it is flat. It varies

considerably in magnitude in various animals, not being at all in the relative proportion to their respective sizes. It is constantly moist, which allows of the transmission of vibration better than if dry. M. Savart has shown by experiment, that *wet* tissue paper conveys vibration *better* than when dry.

Previously to the time of Volcher Coyter, physiologists imagined that respiration took place through the meatus externus, which he disproved by asserting the presence of the membrana tympani.

Sir Everard Home[5] attributed a more important function to this membrane than either ancient or modern physiologists seem disposed to allow. He says, "The difference between a musical or non-musical ear arises from the great or less nicety with which the muscle of the malleus renders the membrane capable of being truly adjusted." And again, "The nicety or correctness of a musical ear being the result of muscular action, renders it in part an acquirement." And in speaking of the muscularity of this membrane, he says, "It is principally by means of this muscle that accurate perceptions of sound are communicated to the internal organ, and that the membrana tympani is enabled to vary the state of its tension, so as to receive them in the quick succession in which they are conveyed to it."

Now Sir Astley Cooper relates a case[6] where a person, having lost the whole of one membrana tympani, and part of the other, could hear better with the former, in which no traces of the membrane could be found, than with the latter. This person's ear was susceptible of musical tones, for he played well on the

[5] Phil. Trans. 1800. Part I. Croonian Lect.

[6] See Phil. Trans. 1800.

flute, and had frequently borne a part in a concert; he also sang with much taste, and *perfectly in tune*. This is at once a convincing proof that the power of appreciating musical tones is not dependent upon the adjustment of the membrana tympani, as advanced by Sir Everard Home. He has doubtless very much overrated the function of this membrane, and indeed, from its very minute muscular fibres, *if it really possess them*, which is at present much doubted, we must consider that its office is not so important as he would lead us to believe.

Numerous cases have occurred where persons, having lost this membrane, have still retained the power of hearing, and therefore I think we must still accord with the opinion advanced by Valsalva, "that the membrane of the tympanum is not absolutely necessary to hearing, but only to perfect hearing."

Some physiologists have doubted whether this membrane undulates, when under the influence of vibration, but I think there can be but little doubt that such is really the case. Another use that may be assigned to the membrana tympani is, that it protects the internal ear from external agents.

In man and some animals the tympanum consists of one cavity, enlarged by the mastoid cells, with which it communicates; but in many animals and birds the tympanum is of great size, and much increased in extent by its connexion with that of the opposite side, consisting of a number of cells, resembling the structure of the mastoid process, which is wanting in those animals where this connexion exists. There can be no doubt but that this enlarged surface greatly tends to increase the power of hearing,

and this opinion seems confirmed, from the fact that these cells are most highly developed in nocturnal and predaceous animals and birds. In elephants, where this cellular structure is highly developed, the power of hearing is very acute, as will be seen from the following anecdotes:—

"A tame elephant, who was never reconciled to have a horse moving behind him, although he expressed no uneasiness if the horse was within his view, either before or one side, could distinguish the sound of a horse's foot at a distance, some time before any person in the company heard it; this was known by his pricking up his ears, quickening his pace, and turning his head from side to side."

"Another tame elephant, who had a young one, was occasionally sent out with other elephants for food, without the young one being allowed to follow. She was not in the habit of pining after her young one, unless she heard its voice; but frequently on the road home, when no one could distinguish any sound whatever, she pricked up her ears, and made a noise, expressive of having heard the call of her young."

When the membrana tympani exists,[7] then a Eustachian tube is found, and, as has been previously mentioned, its use is to equalize the pressure upon this membrane, it being kept in a state of equilibrium, by the admission of air on each side. If from any cause this tube becomes impervious, deafness follows from vibration being prevented, as the undulations cannot take place in the tympanum, if there be not some opening.

When a person is at the height of gaping, he cannot

[7] The membrane of the fenestra vestibuli must not be mistaken for the membrana tympani.

hear a sound which he may have heard immediately before or after the gaping fit. This probably arises from the pharyngeal opening of the Eustachian tube being temporarily closed. When the Eustachian tube is impervious, the membrana tympani becomes concave or convex, as the barometer rises or falls.

Previously to the time of Eustachius, a peculiar gas was supposed to fill the cavity of the tympanum; but he first showed that common air passed from the pharynx into the tympanum, through the tube which now bears his name. Its importance in the function of hearing is sufficiently proved by the very frequent cases of deafness which arise from obliteration of this tube.

With respect to the ossicula, they vary in number, shape, and size; but no physiological inferences have at present been even suggested, as we find the *same* sort of ossicula in animals endowed with very opposite habits. There can be no doubt but that the ossicula of animals and the columella of birds are destined for the direct transmission of vibration. This vibration passes from one bone to the other, and consequently a lapse of time, however short, must occur. In birds, there being only one bone, called the columella, vibration is at *once* conducted from the external to the vestibular end, and consequently the *intervals* in the scale of birds will be much more minute than those of animals.[8] The internal extremity of the columella, or of the ossicula auditûs, is always in contact with the fenestra vestibuli; its external extremity is always opposed to the membrana tympani when it exists. In some instances there is no membrana tympani, but the tympanic bone is attached to the lower jaw, and the

[8] See Sir E. Home. Phil. Trans. 1800.

other extremity is opposed to the fenestra vestibuli, thus affording the direct transit of vibration from without, to the internal parts of the ear.

The *stapes* would appear to be the principal ossiculum, inasmuch as, when it is lost, deafness almost always takes place, no doubt arising from the almost necessary destruction of the membrane of the fenestra vestibuli. Mr. Cruikshank, in his lectures, mentioned that he cautiously had destroyed in dogs the tympanum, malleus, and incus, notwithstanding which the dogs retained the power of hearing; but the destruction of the stapes was attended by an irrecoverable loss of hearing.[9] From its shape it is exceedingly light; it is a good conductor of vibration, and from its hinge-like connexion with the fenestra vestibuli, it presses upon the fluid contained in the labyrinth when under the influence of the stapedeus muscle.

The only motion that takes place between the ossicula, is for the sole purpose of relaxing, or rendering tense, the membrana tympani and the membrane of the fenestra vestibuli. Mr. Chevalier thought that the incus and malleus were so closely connected together as to preclude the possibility of their moving as levers upon each other;[1] and Sir Everard Home says, "the ossicula have only a tremulous motion on each other."[2] The ultimate effect of pressure upon the membrane of the fenestra vestibuli, is increased tension of the membrane of the fenestra cochleæ.

The malleus has attached to it two muscles; some describe three; the stapes has one, and the incus

9 Lond. Med. Society's Trans. vol. iii. p. 549. See, however, the case mentioned, Med. and Phys. Journal, vol. liv. p. 519.

1 Med. Chir. Trans. vol. iii.

2 Croonian Lect. Phil. Trans. 1800. Part I.

none. The tensor muscle pulls the malleus inwards, and tightens the membrana tympani: the fixed point of the lever being that portion of the membrana tympani to which the malleus is attached. The laxator, which is small, relaxes the membrana tympani by pulling the opposite way. The stapedeus acts by bringing the base of the stapes close to the fenestra vestibuli. The stapedeus muscle has a round tendon, which unites to the collum stapedis in an angle of fifty degrees toward a line drawn perpendicular to the plane of the basis, and obliquely across its convex side, in an angle of five degrees from the bearing of its straight side. The action of this stapedeus muscle is to draw the capitulum downwards and toward the curved side of the basis. This oblique motion depresses the end of the basis under the curved crus, whilst it rotates the incus upon its short leg, and presses its articulation with the malleus into closer contact, but the stapes is not withdrawn from under the long leg of the incus, being prevented by the strong connecting ligaments. The smaller angle of the tendon crossing the parallel of the crura over the convex side of the basis, necessarily depresses that edge, the straight side acting as a hinge. The externus muscle of the malleus rotates the incus back again, and restores it to its passive perpendicular situation, becoming on such occasions the antagonist of the stapedeus.

It is worthy of remark, that all the muscles of the ossicula auditûs act nearly at right angles, or in straight lines, contrary to the ordinary course of muscular application, by which their forces are comparatively augmented.[2] These muscles are not under

[2] Sir A. Carlisle. Phil. Trans. vol. xcv. Part I. 1805.

the influence of the will, but are perfectly involuntary, their stimulus being vibration. I do not think it worth while to enter into the various theoretical opinions entertained of their use by Massa, Ingrassias, Duverney, Casserius, Cotugno, or Valsalva.

Immediately after the ossicula have transmitted the vibration, they become relaxed, the effect of which is, that tension is taken off from the membrana tympani and the fenestra vestibuli; probably, in the latter instance, to allow of its yielding upon the return of the undulating wave, especially when much excited by intense vibration.

In tracing the anatomy of the labyrinth in the mammalia, we have seen the fenestra vestibuli leading into the vestibule, where are the terminations of five semicircular canals, the scala and aquæductus vestibuli, and the cochlea, formed by two scalæ winding round the modiolus. The whole of this bony labyrinth is first lined by a thin periosteum; there is besides a delicate membrane which secretes the perilymph. This fluid prevents the sacs of the canals and vestibule from coming into contact with the osseous walls; consequently, all undulations must be transmitted through the perilymph to the sac in which the pulverulent concretions are found. The sacs themselves are filled with a fluid which does not communicate with, but floats upon, the perilymph. There can be no doubt but that these fluids are as vital, and perform functions as delicate, as do the aqueous and vitreous humours of the eye. This aqueous fluid in the labyrinth produces a stronger impulse than air, in consequence of its specific gravity being greater, and it also multiplies the points of contact of the vibrating body with the acoustic nerve. The labyrinth contains

no air. This was ascertained by the following experiment in the horse by Mr. Clift. The organ of hearing was separated from the skull immediately after death, and the cavity of the tympanum exposed. The parts were then immersed in water, and the stapes removed, by which means the membrane of the foramen ovale was destroyed, but no globule of air was seen to escape through the water.[3] Itard has made similar experiments, and his conclusion is the same. Meckel has also performed several experiments to prove that the cavity of the tympanum does not communicate with the cavity of the labyrinth. Cotugno imagined that the superabundant fluid of the labyrinth, when sometimes undulating too powerfully, escaped through the aquæductus cochleæ et vestibuli into the cranium. This theory is at present not generally received; but the use of these foramina seems satisfactorily to be shown to be for the passage of blood-vessels.

The semicircular canals are supposed to augment weak vibrations, and are found most developed in nocturnal animals and birds. The ampullæ are well supplied with nervous filaments; and from the expanded surface of these canals, independently of some peculiar powers they doubtless possess, of increasing weak, or perhaps even distinguishing different tones, must, from this cause, augment the power of hearing; for the larger the surface for the expansion of the acoustic nerve, the more perfect must be the sense of hearing.

The cochlea presents an extended surface for the reception of vibration, and it is highly probable that

[3] Croonian Lect. Phil. Trans. Part I. 1800.

this lengthened spiral tube strengthens the vibration. It is much developed in some animals not possessing large external ears, as man, mole, &c.; but it is also found largely developed in the bat tribe, some of which have enormous external ears. When the semicircular canals are small, the cochlea is large, and *vice versâ*.

The cochlea has been thought to be the peculiar seat of music, but it is found largely developed in animals, and only partially so in birds, some of the latter being able to sing airs in high notes, as the bullfinch. The imitation of birds, and their accuracy in whistling *tunes*, prove that sound gives the same impression to them as to man. We cannot tell what impression it may make upon animals. In addition to whistling tunes, birds are also taught to imitate various words, and even sentences, as is familiarly seen in parrots. There is at present exhibiting in London a canary-bird capable of distinctly uttering several sentences. Roget considers that the development of the cochlea indicates the ratio of hearing; bats, whose hearing is very acute, have it largely developed. I may here mention, that some have suggested that different parts of the labyrinth are capable of distinguishing particular sounds, bearing some analogy to various portions of the tongue, being capable of appreciating different tastes, as the bitters, acids, and sweets; and this I think highly probable; and it is only by observing the particular habits of animals, and comparing them with the formation of the internal ear, that we can expect to arrive at any correct inferences, respecting the functions of these individual parts. Thus, in bats, which utter very high and piercing cries, the cochlea consists of three turns, and in whales,

where acute hearing is not very necessary, we find only one turn and a half, and it is possible that this latter tribe are only capable of hearing low sounds.

Some physiologists suppose that vibratory undulations, first collected by the auricle, come in contact with the membrana tympani, then pass into the tympanum; some of these strike against the fenestra cochleæ, and pass along the scala tympani; while the other undulations are transmitted by the chain of the ossicula auditûs, directly to the fenestra vestibuli, then pass into the vestibule, where meeting with several openings, some pass along the semicircular canals, and again return into the vestibule, while others pass along the scala vestibuli to the cupola, where they come in contact with the other undulations which have been conveyed by the scala tympani. The return of vibration into the vestibule, by the scala vestibuli, is thought to have the effect of at once stopping the undulation.

These views I think to be highly incorrect; for the vibration conveyed by the ossicula, would be much stronger and quicker in its progress, inasmuch as solid bodies convey vibration better than aëriform, and consequently the two sounds would not meet with equal force in the cupola. And again, we know no reason why the vibrating air should press with any force upon the fenestra cochleæ, while the Eustachian tube remains open.

Another theory is, that the undulating vibrations striking upon the membrana tympani, are conducted by the chain of bones to the fenestra vestibuli; they then pass into the vestibule, where they are received

by the three larger extremities of the semicircular canals, pass through them back again into the vestibule, gain the scala vestibuli, which they traverse, arrive at the cupola, pass along the scala tympani, and are checked by the membrane of the fenestra cochleæ. Had this foramen been closed by anything but a yielding membrane, no vibration could take place.

Sir Charles Bell says, "As there is no space for motion in the fluids in either the one or the other of these tracts, the vibration must have been received in the infundibulum at the same time that the motion was communicated to the membranes of the foramen ovale and rotundum; for if a tube full of water, a mile in length, loses one drop from the extremity, there must be an instantaneous motion through the whole to supply its place. The evident consequence of this double impulse would be, if they were of the same strength, to suppress all motion or vibration in the fluids of the labyrinth."[5]

In whatever way these vibrations travel through the labyrinth, there can be no doubt but that they produce an impression upon the nervous expansions, which, being conveyed to the brain, immediately gives rise to the sensations denominated sound. Various parts have been assigned to be the seat of hearing; but it is most probable, that whenever vibration comes

[5] Bell's Anatomy, vol. iii. p. 177.

Read a paper by Mr. Swan on the Function of the Labyrinth of the Ear, Med. Gazette, vol. v. p. 172.

For information respecting the ancient theories, consult Eustachius, Cotugno, Duverney, Valsalva, Meckel, Cassebohm, Morgagni, Scarpa, Bichât, &c.

in contact with any part of the healthy acoustic nerve, there the peculiar sensation sound is perceived.

There is still another way by which we become sensible of vibration, by direct transmission through the bony parts of the head, as may be shown by placing a watch between the teeth, or upon the mastoid process, or any other part of the cranium, at the same time closing the meatus externus, when the sound will be very apparent. To prove that the Eustachian tube does not convey the sound, if the watch be placed upon the tongue, or against the cheek, not touching any solid parts, then *no* sound is heard; but the instant it comes in contact with the teeth, then it is most distinctly audible.

Professor Monjon of Geneva, in a paper read before the Royal Academy of Medicine, has suggested that the cranium may be regarded as a sort of harmonic case, which communicates its vibrations to the organ of hearing. "In the post-mortem examination of Dr. Bennati, the bones of the cranium were much thinner than usual, translucent at many points, and soldered together along the line, of the sutures. A similar condition of the cranial bones, has subsequently been found in the body of another celebrated musician."

It has been noticed that persons who wear wigs, hear more distinctly without, than with them. When wishing to deaden sounds, we place our hands upon the head. Those who have been trephined, have been found to hear quite distinctly any sound directed upon the cicatrix, even when both ears have been plugged.

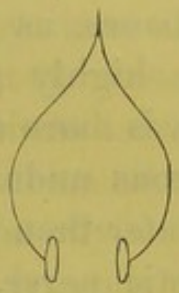
Sound may be conveyed by a stick held between the teeth, the meatus being artificially plugged; and

in this way a conversation may be held at a greater or shorter distance. In this manner some have proposed educating those deaf and dumb, who can hear when sounds are brought into contact with the hard parts of the head.[6] If the hand be placed so as to cover the ear, or if the entrance of the meatus auditorius be closed by the finger without pressure, the perception of external sounds will be diminished, but the sounds of the voice produced internally will be greatly augmented.

"Placing the conducting stem of a sounding tuning-fork on any part of the head, when the ears are closed as above described, a similar augmentation of sound will be observed. When one ear remains open, the sound will always be referred to the closed ear; but when both ears are closed, the sound will appear louder in that ear the nearer to which it is produced. If, therefore, the tuning-fork be applied above the temporal bone, near either ear, it will be apparently heard by that ear to which it is adjacent; but, on removing the hand from this ear, (although the fork remains in the same situation,) the sound will appear to be referred immediately to the opposite ear."

These, with some other experiments, show that sounds *immediately* communicated to the closed meatus are very greatly augmented; and it is an obvious inference, that if *external* sounds can be communicated, so as to act on the cavity, in a similar manner, they must receive a corresponding augmentation.

[6] See Cavallo's Elements of Natural Philosophy. See also Haller, Phys. T. V. p. 295.



Mr. C. Wheatstone has constructed, with this object, an instrument which he has named a microphone; it is made of solid iron rods, one plate being in contact with each meatus.[7]

It is evident that fishes must become sensible of vibration, in a different manner to man and animals, as there is a great difference in the construction of their respective organs. We find the vestibule containing two, or generally three large otolithes, or otoconies, which are suspended in a dense medium, by ramifications of the acoustic nerve; and connected but not communicating with the vestibule, are three semicircular canals, the whole being generally, although not always, encased in bone. Water, which we have seen transmits vibration more powerfully than air, being under the influence of vibration, comes in contact with the bones of the cranium, and through them the vibratory air is transmitted to the vestibule and otolithes; these, from striking against the sides of the tympanum, well supplied with nerves, and also coming in contact with each other, produce that effect upon the brain which we denominate sound. The thickness of the bone, and the *density* of the fluid of the labyrinth, contribute very considerably to augment the vibration. The mere presence of fluid considerably increases the force with which the otolithes move, as may be familiarly shown by Camper's experiment, which consists in filling a bladder full of water, and enclosing a marble. Upon shaking the bladder very gently, the marble is instantly displaced, and an unexpected and powerful concussion is felt.

Man and animals do partially hear *directly* through

[7] Quarterly Journal of Science, Literature, and Art, p. 68, 1827.

the bones, as in fishes [as was shown in page 93.] It is highly probable that the reason, the ear of fishes is more simple than that of animals, is, because sonorous undulations are conveyed with greater force by water than by air. The expanded surface of the acoustic nerve, which in some fishes is very great, must increase the power of hearing.

The acoustic nerve is, doubtless, the most important part of the internal ear, whether it be spread upon the simple membranous sac, or the more complicated and expanded labyrinth.

To prove that the portio mollis was the special nerve of hearing, M. Magendie divided these nerves; the dog fell immediately into a state of deep prostration; he remained completely insensible to the noise which the Professor made close to his ear, and the sense of hearing appeared to be completely annihilated.[8]

It is difficult to account for the effects of the experiments of Flourens, who declares, that in cutting the semicircular canals, in which the acoustic nerves only are spread, peculiar motions occurred. If the horizontal canal on each side was divided, horizontal movement of the head took place from side to side, and rotation of the whole body.

Division of the inferior vertical canals on each side produced vertical movements of the head, and caused the animal to lie on its back. Division of the superior vertical canals caused vertical movements of the head, but the animal lay forwards. The direction of the inferior vertical canal is backwards, and of the superior forwards. If all the canals were divided, all sorts of violent motions took place.[9]

[8] Lancet, vol. ii. p. 362, 1837.

[9] Elliotson's Physiology, Part II. p. 425, 5th edit. Mém. de l'Académie des Sciences, t. ix. p. 454, seq.

M. Magendie endeavoured to show, by direct experiment, that the sensibility of the chorda tympani, and of the parts to which that nerve is distributed, depends on the fifth pair; *i. e.* that the former loses all sensibility when the latter pair of nerves is destroyed.

In experimenting on a young rabbit he says, "The first step which is necessary to show you is, that in a natural state, the membrane of the tympanum and adjacent parts is actually sensible; for this purpose I introduce a blunt-pointed probe into the animal's ear, and you may judge of the sensibility developed, by the energetic movements which you see the animal now execute. It only remains to divide the fifth pair of nerves in the manner already described, and with which you must be familiar. I have now performed the section of the nerve on both sides of the body.

"Let me first acquire the assurance that it has been complete; this you know is done by touching the animal's eye, or any other part of the face. I do so, and it exhibits no sign whatever of sensibility. Now for the ear; I introduce, as you see, the same probe as far as the tympanum, I even penetrate into its cavity, and turn the probe about in all directions; but the rabbit remains quiet; you cannot detect the least sign of its perceiving the presence of a foreign body, in the interior of an organ otherwise so highly sensitive."

To make the experiment more obvious, he afterwards divided the fifth on one side only, with the same result, the uninjured side remaining sensitive. In the same *séance* he presented a patient with partially paralyzed sensibility of the fifth, of the left side. On introducing a probe into the meatus, and even pushing it as far as the membrane of the tympanum,

the patient merely felt the contact of a foreign body, without experiencing the least uneasiness, irritation, or pain ; while, on the right side, the parts retained their normal degree of feeling.[1]

" In herbivorous animals, the rodentia, &c., the sense of hearing is destroyed by a section of the fifth pair of nerves ; but when we perform the same experiment on dogs, we do not constantly obtain the same effects. You may irritate the acoustic nerve without producing the least disagreeable sensation ; you may even lacerate it without making the animal cry ; hence the auditory nerve possesses only special sensibility.[2] The division of the fifth nerve in cats, within the cranial cavity, does not seemingly affect the acuteness of hearing on the same side.[3]

[1] Lancet, vol. ii. p. 363, 1837.
[2] Magendie. Lancet, vol. ii. p. 335, 1836-7.
[3] Mayo's Physiology.

## PATHOLOGY.

In tracing the anatomy of the ear, we have found it to consist of skin, mucous membrane, glands, cellular tissue, cartilage, periosteum, bone, nerves, and muscles, and each of these structures are liable to most of the diseases which attack the same tissues in other parts of the body.

Some affections will be found acute, requiring the most prompt and energetic treatment, although a more chronic form will frequently demand the more patient and assiduous attention of the medical attendant.

The object throughout will be to show that none but a regularly educated practitioner should be entrusted with the treatment of the various diseases of the ear, inasmuch as they are not always local, but are frequently symptomatic of, or concomitant with, some of the most serious maladies, demanding the most scientific and skilful treatment; and it is not sufficient for a person who has only paid special attention to aural diseases, to console himself or delude his patients by imagining that *when* dangerous symptoms set in, he will call in medical aid; for it is a fact well known to an experienced physician, that one of the chief difficulties often is, to say when the *brain* is or is not affected; inflammation of the brain or its membranes is often so insidious in its attack, and subsequently so

rapid in its progress, as to have at first deceived and finally baffled the most renowned physicians.

As, then, the same treatment is applicable to these affections as to those attacking other parts of the body, that man who has studied disease in all its branches, should be the most capable and proper person to consult upon these diseases, which were formerly so much neglected by medical men, and were but too frequently resigned into the hands of the unprincipled empiric, who has for so many ages disgraced this and other countries.

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In treating of the pathology of the ear, I shall first commence with the various external diseases, and then pass to those of the internal portions of the ear.

The auricle is of various shapes and sizes,[4] and presents more or less of a hollow, in some measure dependent upon the pressure or liberty it may have been subjected to during childhood.

No plan can be more pernicious than that usually adopted by mothers, of *tucking in* the child's ears, because they should not grow out; in this way the ears become flat, and consequently are not so well adapted for collecting sound; but the chief mischief is, that the auricle loses its proper degree of tension, occasioning sometimes partial deafness.[5] Persons so affected are in the habit not only of applying the hand to the ear to increase the concavity, but they also habitually and instinctively apply the fore-finger and thumb to *give support* to that part of the auricle immediately behind and upon a level with the meatus externus. An instrument has been invented to wear

[4] A small ear is generally regarded as an indication of beauty.

[5] In savages, whose hearing is remarkably acute, the auricle has a direction *forwards*, and forms a *large* concavity.

behind the ear, and prevent the trouble of constantly keeping the hand so applied.

The ears have been made a means of diagnosis in various diseases; thus, in acute congestion, or inflammation of the brain or scalp, the ears are red. In those affections which derange the respiratory and circulatory systems, they are livid; and are remarkably pale in persons having long laboured under phthisis, or in malignant diseases, or in old persons where, from any of the numerous circumstances which may occasion it, there is a deficiency of nutrition.

The auricle is subject, as other parts of the body, to inflammation and erysipelas, which may be idiopathic or traumatic.

*Idiopathic inflammation* sometimes attacks the auricle without any apparent cause; it is generally acute, and is attended by great pain, heat, throbbing, and itching. The whole auricle appears red, swollen, and is very sensitive to the touch. If these symptoms continue only a short time, the patient has pyrexia, caused by the extreme irritation. The treatment is obvious, to remove local inflammation, and to subdue fever when it exists.

As to the local treatment, I prefer puncturing the helix and lobe, as well as the dorsum of the concha, to applying leeches, as it not unfrequently happens that the application of leeches to this part induces erysipelas. From twenty to thirty punctures should be made with a *sharp*-pointed lancet; and it is perfectly astonishing the quantity of blood which may be obtained in this manner from an inflamed surface. A hot bread and water poultice should then be applied to encourage the bleeding; and followed by warm fo-

mentations, frequently repeated. Warmth is almost always agreeable to the sensations of the patient, whereas cold applications generally considerably augment the pain. A smart purgative should be given; and fever, if it exist, must be treated by the antiphlogistic regimen.

Inflammation is, however, more frequently *traumatic*, and may be caused by punctured wounds, as boring the lobe for ear-rings, thrusting thorns through the lobe, (not an uncommon trick with school-boys,) stings of gnats, &c. In these cases the treatment is much the same as for idiopathic inflammation. The application of cold, however, is not only attended with beneficial results, but is positively agreeable to the patient. The same extraordinary fact is frequently observed in other parts of the body, that *warmth* is more agreeable to the sensations of the patient in idiopathic inflammation; whereas *cold* is preferred, and found the most useful in many cases of traumatic inflammation. When, however, it arises from the stings of insects, a poultice should in the first instance be applied.

*Erysipelas* rarely attacks the auricle idiopathically; it is generally dependent upon an *extension* of erysipelas from other parts of the head.

The diagnosis and treatment is the same in idiopathic and traumatic erysipelas; I shall therefore describe the latter, which may arise from punctured or lacerated wounds, the introduction of copper ear-rings, the stings of insects, and extreme uncleanliness; it is also caused by long exposure to the scorching rays of the sun. It is known by great heat, throbbing, and swelling, the *florid* red colour of the auricle, and the extreme pain, restlessness, and fever, which are always present. It is rarely limited to the auricle, but,

even when traumatically induced, generally spreads upon other parts of the head. The meatus externus is usually involved, and from it there is a thin ichorous discharge.

About the fifth or sixth day, but extremely variable, phlyctenæ make their appearance; these gradually dry up or burst, and desquamation of the cuticle takes place. The danger of a relapse should always be guarded against, as it not unfrequently happens that erratic erysipelas again and again attacks the auricle. Sometimes this erysipelatous inflammation becomes phlegmonous, attacking the cellular tissue, and terminating in suppuration; collections of matter take place in different parts of the auricle, often between the tragus and cheek, and especially in the lobe; in such cases the early evacuation of matter is desirable, and the incisions should be free.

When these cases have been very severe or mismanaged, fistulous openings are often left between the fibro-cartilages.

As to the local treatment, never apply leeches, and never apply cold, but puncture the auricle freely, as has been before described; apply hot bread and water poultices every hour, and between their removal foment with a decoction of poppies.

As to the general treatment, it must depend upon the peculiarities of each individual case; and as physicians are at present much divided as to the method of subduing general erysipelas, I shall not here attempt to advocate the antiphlogistic, or the stimulating plan of treatment, but shall merely mention that cases of extensive erysipelas do occur, in which, if venesection be advised, the patient invariably sinks.

In all cases of erysipelas the alimentary canal is a

good deal disordered, and mild and unirritating purgatives and diaphoretics are of signal benefit. Small doses of calomel, with hyoscyamus or camphor, have been recommended by the highest authorities.

*Common acne* frequently cause a great deal of irritation over the auricle, until they have either spontaneously burst, or been punctured with the lancet, soon after which all uneasiness ceases.

*Furuncle or boil* sometimes attacks the auricle, and occasions considerable pain; poultices should be applied to induce the early formation of matter, which should be evacuated as soon as possible. Sedatives should be administered if the irritation be very great.

Dr. Bird has published an account of such cases occurring in insane persons, attended by inflammation, where the external ear swelled to an enormous size. The skin breaks in several fissures, and from these a yellowish serum exudes; after a week or so, the tumor breaks at the top, and discharges a matter like black curdled blood. From the commencement of the inflammatory process, until the swelling loses its heat and painfulness, the period is three, four, or more weeks. The ear remains in some cases thickened, and somewhat hardened; occasionally it becomes disfigured and shrunk. Dr. B. has never been able to trace it to any outward injury: six cases have come under his notice.[6] The description he has given exactly corresponds to what sometimes takes place when the ear has been exposed to too great a degree of cold, when reaction having occurred too powerfully, a chilblain remains which sometimes forms an exteremely ill-conditioned sore. If the inflammation run high, cold may be applied, and it must be treated

[6] Med. Chir. Review, page 201. 1834.

upon the general rules usually laid down by authors; but if only moderate, the gently stimulating plan will be found very agreeable and useful.

The following prescription of, I believe, Mr. Wardrop, will be found extremely useful in cases of chilblains where the circulation is torpid, and where there is not much re-action. I have used it for some years with the greatest success.

℞. Tr. lyttæ. Liq. ammoniæ. Tr. opii. ana ʒss. Lin. sapon. comp. ʒivss. Ft. linimentum, quo partes adfectæ perfricandæ sunt.

*Herpetic eruptions* frequently extend to the auricle, and are very difficult to get rid of: amongst the best means may be enumerated *cleanliness*, and alterative doses of mercury; and where there is considerable irritation, a little Ung. Zinci may be smeared over the sores. If of a more chronic kind, unattended by inflammation, the Ung. Hyd. Nitratis or Lotio Hydrarg. Bichloridi may be applied.

The external ear is more subject to disease during childhood than in the after periods of life; and this may be accounted for from the fact, that during the first seven years the exanthemata generally make their appearance. In delicate and scrofulous children, sores often remain behind the ears, months after an exanthematous disease has disappeared; and it is a frequent habit, especially with poor persons, to apply soap, or even soft soap, to these ulcers; and no practice can be more injurious. The only thing necessary is, to keep the ears clean with warm water, and apply some mild ointment, taking care at the same time to improve the secretions with small and occasional doses of Hyd. c. Creta c. Soda. When *lepra* attacks

the auricle, the Ung. Zinci may be applied, and tonics with the Liq. Potassæ should be given internally.

Children, and even sometimes adults, who are labouring under *itch*, have occasionally very troublesome suppurating sores upon or behind the auricle; if dependent upon scabies, of course the usual specific, sulphur, must be administered internally and applied externally.

*Venereal blotches* are sometimes found upon the lobe of the ear, sometimes in the meatus, and occasionally spreading to the tympanum, causing inflammation of the membrana tympani with thickening, and producing obstruction of the meatus from incrustations. Mercury with iodine is often most useful in these cases.

*Scirrhus* of the auricle is a rare disease, but it is now and then met with: it is rarely the original seat, but is generally attacked by the spreading of an ulcer on the cheek. The patient complains of intense pain in the whole ear, and sometimes vesicles appear; these soon form into small ulcers, which very gradually enlarge, and but too plainly indicate the presence of malignant disease. Kramer mentions that those who have had lepra or impetigo frequently attacking the auricle, have been more subject to scirrhous degeneration.

Mr. Travers has seen the upper third of the external ear, the exclusive seat of an indurated sore, having every character of cancer. He amputated the piece; the wound healed, and the patient he believed remained sound.[7]

The lobe of the ear sometimes increases enormously

[7] See Lancet, p. 624, 1828-9.

in size, so as to prove exceedingly inconvenient, and to require removal.

Cases.—On the 7th of January, 1839, I saw Professor Syme remove a small tumour from the lobe, weighing about two drachms. The patient, a female, when in the country a short time previously, had a similar tumour removed from the lobe of the other ear; it was, however, considerably larger. It was thought proper to postpone the latter operation, with a view of ascertaining whether the disease was malignant; such not being the case, the operation was performed. Upon slicing the tumour after removal, it was found to be non-malignant.

It appears that goître prevails in the valley of Nipal in Hindostan, and that a pendulous tumour growing from the external ear is also frequent in the natives of that district. The two morbid growths are often observed in the same individual. Two such tumours, when removed, weighed twenty-four ounces.[8]

Dr. Graves has published a case which came under the notice of the Surgeon-General, Mr. Ferral, and himself. A young gentleman of fortune perceived that the pendant lobes or tips of his ears were becoming elongated; they increased gradually in such a manner that he considered himself disfigured by their unseemly length, and therefore attempted their concealment by allowing his hair to grow in long curls, so as to hide the ears. This gentleman soon afterwards became dropsical and died, and on dissection, Mr. Ferral found his liver in a state of fatty degeneration. On slitting up the elongated portion of the ears, he discovered hypertrophy had been occasioned by the deposition of a large quantity of fat.[9]

Boyer and other continental surgeons have also removed these superabundant growths.

[8] For full description, see p. 186, Med. Chir. Rev. 1835; also Trans. of Med. and Phys. Soc. Calcutta, vol. vi. p. 488.

[9] Med. Gazette, vol. xx. p. 210.

The lobe is also liable to the metastasis of gout, and, in such cases, occasions considerable pain. Professor Graves, in his clinical lectures, mentioned the case of a gentleman, the lobe of whose ear was sometimes attacked suddenly by gouty congestion, accompanied by agonizing pain, but which never lasted more than a few hours. Long-continued pressure, as lying upon the ear, not unfrequently causes sloughing; this takes place more speedily in cases of fever, as is daily exemplified in fever wards.

*Wounds* of the ear generally heal well, in consequence of its being well supplied with blood, which often leads to extensive hemorrhage in incised wounds. It is always better in such cases, if the hemorrhage be arterial, to endeavour at once to tie the artery.

It is quite astonishing the rapidity with which union takes place, in laceration of the auricle.

I remember particularly a man, who fell from a loft, with a sack of corn on his back, against the wheel of a waggon which he was unloading; his auricle was torn into two layers, from the upper part of the helix to the lobe; and from the severe bruise appeared nearly black. I thought the ear must mortify, from the extent of the injury; but having connected it with sutures, and placed a pad under the auricle, and bound the ear gently down upon the head, I was surprised to find, by the expiration of a fortnight, that perfect union had taken place. Large granulations remained upon the auricle for upwards of three weeks more; they then disappeared, and the auricle was only slightly disfigured. I should have mentioned, that three days after the accident, erysipelas appeared upon the injured ear, which spread over the greater

part of the face; this was promptly subdued by the remedies previously described.

The restorative powers are more fully shown in the accompanying cases, where the ears were separated, and afterwards reunited.

The memoir for May of Filiatre contains the history of a man who entered a house of ill fame, where in a scuffle he had his ear cut off. He picked it up and withdrew from the contest. Dr. Marini, who saw him, re-applied the divided portion, before which, he well washed the ear in diluted spirit of wine. The part was kept in its proper situation by means of four sutures; and so as to be more exact in keeping it in its relative position, a piece of elastic bougie was placed in the external auditory duct, and the operation was terminated by means of bandages, adhesive plaster, &c. The next day the bandages were raised, so as to discover if there was any displacement of the parts, and M. Marini saw with pleasure a slight inflammatory blush on the borders of the reunion. The patient was slightly feverish, thirsty, had cephalalgia, &c. By the eighth day, these symptoms had subsided, and the pinna had become of a natural temperature. The lobular portion was the first to unite, after which the extremities became adherent. The other parts putrefied, and suppuration continued until the cartilage was covered by fleshy granulations. In a month the cure was completed, and the linear cicatrix which remained was scarcely perceptible.[1]

Mr. Lawrence attended a man who, while on the top of a stage-coach, was carried under a gateway, which did not leave sufficient room for him to pass without injury, and his head was so much wounded, that one of his ears was entirely separated, with the exception of an attachment by a trivial piece of integument. Mr. Lawrence assented to the man's wish of not having the separation completed, and fixed the

[1] Filiatre Sebezio di Napoli Maggio; see Lond. Med. and Surg. Journal, vol. vi. p. 171.

part in its situation with a few sutures. The ear soon united again, and the patient escaped all disfigurement.[2]

Wounds of the auricle may be treated as those of other parts of the body; should the laceration be extensive, sutures should be applied.

Leschevin, senior surgeon of the hospital at Rouen, and who, in 1765, obtained a prize for the best essay on the diseases of the ear, given by the French Academy, objects to sutures in the cartilage, and prefers trusting to adjustment by means of a roller gently binding the ear upon the head; but whenever the laceration is extensive, this cannot be trusted to, nor would it appear necessary, inasmuch as these sutures do not by any means cause the irritation, not unfrequently met with, when introduced into the scalp.

I should particularly recommend, where it is necessary to employ sutures, with wounds of the head more especially, from which erysipelas so frequently ensues, that metallic sutures should be used of pure platina, first introduced by Mr. Morgan. They produce *no* irritation.

A very convenient pad to place under the auricle, in such cases, is that recommended by Mr. Buchanan: it consists of a piece of cork adapted to the shape of the posterior part of the auricle, and the adjoining portion of the cranium. The form having been obtained, he recommends to moisten the cork with thin glue, and then roll in cotton wool.[3] The advantages of this pad are, its easy adaptation, its lightness, and its incapability of absorbing the discharge.

Itard and Vering have imagined the auricle to be

[2] Cooper's Surg. Dict. p. 1472, ed. 7.

[3] For full account, see his Illustrat. of Acoustic Surg. p. 32.

superfluous, but Buchanan seems to overrate its use. He mentions one case where the auricle had been lacerated, and had cicatrized at an angle with the temple of 45°, and the hearing was in consequence considerably improved.[4]

Itard says—"I have seen a soldier who had both his ears cut off: he had artifical conchæ made, merely to disguise this horrid mutilation, for his hearing had lost none of its finesse."[5] Wepfer relates a case in which the external ear was totally destroyed by an ulcer, and yet the patient did not hear less perfectly; and Richerand has known the auricle to be torn off, and hearing continued, the auditory nerve becoming more sensitive, to compensate for the loss;[6] and Hennen mentions a case where the external ear was carried away by a cannon-shot, and yet hearing remained as acute as ever.[7] Ears have been supplied by the Tagliacotian operation.[8]

Malformation of the auricle is sometimes met with, assuming various shapes; it may be so defective as to require artificial auricles. They are occasionally, although very rarely, altogether wanting. Supernumerary ears have been observed; Cassebohm saw an infant who was born with four ears, of which two were naturally placed, whilst the others were situated near the nape of the neck; each of the temporal bones had two petrous portions.

[4] See Buchanan on the Physiological Illustrations of the Organ of Hearing.

[5] Itard sur l'Oreille, tom. ii. p. 324.

[6] Nosog. Chir. tom. ii. p. 122, ed. 2.

[7] Hennen's Mil. Surgery, p. 348, ed. 2.

[8] Tagliocozzi has not only restored noses, but likewise ears and lips. Biblioth. Chirurg. vol. i. p. 293.

Case.—A child named Alexandre Trippet, aged eight years, was admitted into the hospital in the month of September, 1822, for a slight complaint of the bowels. A few days after his admission, we perceived behind the ears, in front of the mastoid processes, a deep funnel-like cavity, the bottom of which was directed upwards and inwards, and by which the patient heard, whether the natural opening was closed or not. A stilet introduced into this accidental cavity penetrated to the depth of several lines. The cartilaginous portion of the ear had undergone no alteration, only the opening of the meatus auditivus externus was thrown forwards, and was narrower than common. The patient's hearing was hard, and he answered only in monosyllables. The child was on the point of quitting the hospital, when he was attacked by a malignant angina, which carried him off in a few days.

On a careful examination of the two ears, we discovered the following appearances. The accidental opening, concealed entirely by the cartilaginous portion of the ear, was enlarged and terminated in the bottom of the meatus auditivus externus, the cartilage of which was interrupted in this place, as we shall presently observe.

There existed no membrane of the tympanum, nor small bones of the ear; a very thin mucous membrane lined the cavity of the tympanum and the two meatus, and was blended exteriorly with the skin. The length of the accidental meatus was from about four to five lines; that of the right side was closed by thick crusts, which never could be extracted during the child's life. The meatus auditivus externus, slightly contracted, was from five to six lines in length; it was bent anteriorly; the posterior part of its cartilage, interrupted by the internal orifice of the accidental meatus, was attached on one side to the base of the zygomatic process, and on the other to the summit of the mastoidean eminence. This eminence was hollowed at its base, to form the posterior paries of the accidental meatus; the mastoidean cells were only covered by a fine lamina of compact substance. The internal parietes of the cavity of the tympanum, and the

openings communicating with the labyrinth, were observed at the bottom of the meatus auditivus externus.[9]

Tumors occasionally are found behind the ear, between the meatus and the mastoid process, which sometimes produce paralysis of the face, by pressing upon the facial nerve, as it makes its exit at the stylo-mastoid foramen. It is very common in scrofulous persons to find the glands in this neighbourhood enlarged, sometimes to an enormous extent.

*Meatus externus.* — The structures forming the meatus externus, are subject to the diseases found in other parts of the body. Thus, we find a subacute inflammation of the *lining membrane*, attended with slight uneasiness or itching, causing an increased secretion of cerumen. There is also subacute inflammation of the *mucous follicles*, giving rise to that peculiar form of otorrhœa more usually found in children, the discharge being simply mucous; the inflammation becoming more severe, the discharge is muco-purulent; and when intense, suppuration is produced. The cellular tissue may be also inflamed, characterized by the rapidity which attends all phlegmonous inflammations. When the periosteum is affected, it is generally the result of acute inflammation of the other tissues; but occasionally the periosteum is primarily attacked, generally when the system is tainted with syphilis, as is seen in other parts of the body.

Inflammation very frequently attacks the meatus externus, and is called *external otitis;* it is not rare to find it connected with pharyngitis, as well as inflammation of the Eustachian tube.

[9] By M. Bernard, house-surgeon Hôpital des Enfans. Journal de Physiologie. See Lancet, July 3, 1834.

Persons of a scrofulous diathesis, or those subject to catarrh, or cutaneous eruptions, are most frequently attacked by this disease. The exciting cause is generally *cold;* but it may also be induced by stimulating injections, the sudden repression of cutaneous diseases, or from the irritation excited by hardened wax, &c. It is known by pain in the ear, increased upon moving the lower jaw, pyrexia; and is not unfrequently accompanied by tinnitus and deafness. The gentle introduction of a probe causes most acute pain. Inflammation having continued a few hours, a thin serous discharge takes place, varying as to quantity, sometimes being very great; this is soon tinged with blood, and in two or three days, and sometimes sooner, if the inflammation be not checked, the discharge becomes purulent.

Common as well as erysipelatous inflammation both attack the meatus, and the most frequent cause is *cold;* it may be induced by acrid and stimulating injections, the presence of extraneous bodies, violent blows, or falls upon the head, and by syphilis. While, in the acute stage, otitis should be treated by the antiphlogistic regimen; when complicated with pharyngitis, an emetic is particularly serviceable, as well as mild but continued purgatives, especially in those cases where it is dependent upon derangement of the mucous membrane of the alimentary canal. Warmth, applied externally, always appeases the pain; and the throat may be gargled with warm water frequently. If this disease be allowed to run its course, it soon terminates in the formation of matter, and is then called otorrhœa. The lining membrane of the meatus externus sometimes becomes thickened, and that to such a degree as to prevent the admission of vibration;

this is generally observed in those who have had frequent attacks of inflammation of the meatus, with thin discharge and temporary deafness; the whole extent of the meatus is narrowed by thickening of the cuticle, with a thick white discharge resembling curds, with diminished or even suspended secretion of cerumen. Mr. Earle was, I believe, the first to describe this peculiar thickening of the lining membrane of the meatus; and he proposes treating this disease by the application of the nitrate of silver. He mentions a case where a very strong solution of nitrate of silver was thrown in with a silver syringe, which completely blackened the epidermis of the meatus. In a few days, warm water was injected to loosen the exfoliations. They were detached in small portions at first, and subsequently in larger pieces, one of which, from its form, was evidently the reflected layer which covered the membrana tympani. After this, the injection of water caused a distressing sensation and loud noise. The other ear was served in a similar manner, and in a few days the hearing was very nearly restored.[1]

The meatus sometimes becomes filled up with scurfy scaly matter, especially after skin diseases; in these cases, warm water should be injected; and in the adult the Unguentum Hyd. Nit. may be applied; but in children, equal parts of this ointment and the Ung. Zinci will be found sufficiently stimulating.

"A temporary state of deafness is sometimes produced in lues venerea, by the meatus externus being filled up with a scurfy eruption, and in some instances by the membrane of the passage becoming thickened,

[1] Medico-Chirurg. Review, 1820, p. 453.

and even ulcerated. In this, as in other symptoms of the disease, we depend entirely on the internal use of mercury for removing the virus from the constitution; but the local affection may remain after the system is rendered safe."[2]

The lining membrane of the meatus is also subject to ulcers, occasioning severe and painful itching, ringing in the ears, and at times attended with a thin acrid discharge. These ulcers sometimes heal spontaneously, causing severe itching: they then gather and break again, giving rise to great tenderness for some distance around the meatus; the hearing may be considerably impaired. Blistering, and stimulating and astringent injections, seem to be but of little use. Dr. Dean has found mercurial ointment succeed in curing several obstinate cases, which resisted every other mode of treatment.[3] Should ulceration have taken place in the periosteum, the denuded bone may be easily detected by means of the probe. The prognosis is not always unfavourable under such circumstances, as small portions of the bony meatus have exfoliated, and in a short time all discharge from the meatus has ceased. Poultices and the local application of stimulants offer the best chance of effecting this desirable object.

The meatus is sometimes filled up by granulations, fleshy excrescences, and polypi. These granulations may be punctured, and caustic applied; or sponge tents, dipped in a solution of the nitrate of silver, may be introduced into the meatus; they are generally dependent upon disease of the tympanum. The fœtal

[2] Bell on Lues Venerea, vol. ii. p. 412. 1797.

[3] Medico-Chirurg. Review, p. 455. 1820.

secretion, for the purpose of protecting this canal and the membrana tympani, has been known to harden; in such cases, gently syringing with warm water will generally remove this concretion.

In examining the meatus, the auricle should be drawn upwards and backwards; and if the rays of the sun cannot be procured, an argand lamp must be used. Several useless inventions have come before the public at various times; a common argand lamp will answer every purpose, especially if a small concave reflector or mirror be attached. The speculum is of little use to *straighten* the canal, as it can exert no influence on the bony portion; and that part of the meatus capable of being straightened, may be effected by drawing the auricle upwards and outwards; besides, however delicately a pair of forceps may be made, they must take up a great part of the calibre of the canal. The multiplication of instruments forms no small part of the resources of the quack; and however unwilling he may be to explain their uses to the medical man, yet he takes good care that his patients shall not be ignorant that he possesses such weapons.

I may here mention that whenever a powerful stimulant is necessary to be applied to the meatus, let it be done by means of a camel-hair pencil; do not inject it, as you may run the risk of endangering the tympanum, and even in some cases the labyrinth.

A large meatus is not favourable to acute hearing; and Itard is convinced, that far from increasing audition, it notably diminishes its extent and finesse.[4] It has been proposed to remedy this defect by inserting a small leaden tube, exactly fitting the meatus; its external opening being covered by a piece of the

[4] Itard sur l'Oreille, tom. i. p. 148.

swimming bladder of the fish, which should be stretched on while wet. In some cases, the power of hearing has been considerably augmented by the introduction of a gold tube.

Infants are sometimes born without ears: in such cases they are generally still-born, and there is no depression for the meatus. Still, however, cases have occurred where there was total absence of the auricles, without a vestige of the meatus, *and yet deafness was not complete.*[5]

A child was exhibited in London some years ago, who enjoyed a tolerable degree of hearing, in whom no vestiges of the meatus existed, nor were there any external ears.

Sometimes the auricle is perfect, but no meatus exists;[6] in such cases, by pressing gently with the finger, the skin will be found to yield; and after the second month, if the false membrane still exist, it may be punctured and kept open by a dossil of lint; if the membrane be very thick and organized, a crucial incision should be made. It is not unfrequent to find that this external cuticular covering hardens and comes away spontaneously.

Case of congenital occlusion of the meatus auditorius externus, where nature effected a cure.—"When the child was three months' old, a very small aperture appeared in the spot where the foramen auditorium is usually situated, first on the right side, and in two months afterwards on the left. These apertures became gradually dilated; and it is now two years since the foramina were considered as large as they are naturally."[7]

[5] See Cooper's Surgical Dictionary. See also Itard, vol. ii. p. 406.

[6] Celsus de Medicinâ, lib. vii. cap. 8.

[7] Glasg. Journal. See Lond. Med. Gazette, vol. iii. p. 781.

Cases have occurred where this false membrane has been allowed to remain up to the adult period, and yet, upon puncturing the skin covering the meatus, hearing has been restored. Sir Astley Cooper operated upon a person under such circumstances, fourteen years of age, and restored him to perfect hearing. Leschevin of Rouen prefers applying caustic to puncturing a false membrane in the meatus.

Occasionally the meatus externus is altogether wanting, or it is entirely obliterated; this is not a frequent disease; and perhaps one reason that it is more rarely met with than other imperforate openings, is, because in the meatus the lining membrane is attached to bone throughout.[8]

I do not approve of the use of bougies in contracted meatus, but should recommend the frequent injections of warm water, and as the child advanced in years, if the meatus were still much contracted, the passage might be painted with a solution of the nitrate of silver twice a week, or less frequently if much irritation were produced, the object being to cause exfoliations of skin.—See page 115.

When the bony part of the meatus is malformed, nothing can be done to remedy the defect. Sir Astley Cooper mentioned in his lectures the case of a Scotch boy, where the removal of the skin produced no effect, the meatus being obliterated throughout. Kramer mentions a physician of celebrity who recommended Russian baths to a child thirteen years of age, who suffered from *complete obliteration* of both meatus, simply because the disease had arisen after cold during measles![9]

[8] Bell's Anatomy. Edinburgh. 1776.

[9] Bennett's Translation, p. 64. 1837.

Extraneous bodies sometimes get into the meatus externus, and this is much more frequent in children than in adults; should they remain in the meatus, sometimes no untoward symptoms occur; but still occasionally there is extreme pain, continuing a few days, followed by discharge, convulsions, and death; *so that in all cases it is imperative upon the practitioner, to endeavour to remove an extraneous body as soon as possible.*

Some, I am aware, have allowed foreign bodies to remain in the ear, and have even advocated this particular plan of practice; but so many fatal cases are upon record, that I think no one can with justice adhere to so dangerous a rule; besides, during the *presence* of any extraneous substance, hearing is partially, or even wholly, suspended.

Cases.—At the commencement of the present session of Parliament, an honourable Member was for some time prevented from attending on his arduous duties from severe pain, swelling, and subsequently discharge from the ear, occasioned by a portion of lead from a pencil having fallen into the meatus.

Epilepsy may be produced by the presence of an extraneous body in the ear.[1]

A grain of barley has produced epileptic convulsions and death.[2]

Sir Benjamin Brodie knew a little girl who was in St. George's Hospital, and who had broken a piece of slate pencil in the ear; inflammation of the membrane came on, and she died.[3]

A girl suffered from salivation, producing almost a

[1] See Itard, p. 343. Also Dict. des Sciences Méd. tom. xxxviii. p. 45. See also Medical Transactions for 1772.

[2] Itard, tom. i. p. 345.

[3] Lancet, May 31, 1832, p 348.

state of marasmus; these symptoms increased during two years, when, on examining the ear, a large quantity of decomposed wool was extracted: these symptoms then disappeared.[4]

"A few years ago a woman brought her daughter, aged six years, to M. Dupuytren, for an inflammation and swelling of the ear. It was proved that the child had been playing with some peas a few days before, and had introduced one into the left meatus auditorius externus. The foreign body had remained there three days, completely obstructing the passage of sound, so that she was quite deaf on that side. Pain came on, and soon increased, with serous discharge and fever. The pea could be perceived, on pulling the ear a little outwards and upwards, to straighten the canal, and was removed without difficulty. It had been dry when introduced, and was now found swelled, softened, and green, with a radicle or little stem, which had been developed in the ear. This incipient germination at first may appear extraordinary, but ceases to be so when we reflect, that in the auditory canal, the pea was placed in circumstances favourable to vegetation, having heat, moisture, and the presence of air." [5]

The frequent attempts made to extract these foreign bodies may do a great deal of mischief, and those only know the difficulty who have been frequently foiled in their attempts to remove them. Porous substances, that will easily pass into the ear while dry, are almost impossible to extract when saturated with moisture. Wool sometimes descends far into the meatus, and may escape observation; it occasions great irritation, and subsequently inflammation. In the Lancet such a case is detailed, where Mr. Wright extracted a piece of cotton wool, which, from the length of time it had

[4] Itard.

[5] Lond. Med. Gazette, vol. i. p. 406. See Itard, tom. i. p. 347.

remained there, had much injured the membrana tympani. The wool in this instance had been overlooked, although examined by a professed aurist.[6] In the same periodical are detailed several cases of beads, and other extraneous bodies, remaining and being subsequently extracted from the ears. One of these was a young lady, who had for a long time a glass bead in the meatus, which occasioned deafness. An apothecary and an aurist had seen her, but did not extract it, when one day the mother accidentally noticed the hole usually found in beads, she immediately straightened a double black pin, formed its end into a little hook, introduced it into the hole of the bead, and to her great joy completed the extraction.

In another case, Mr. Wright extracted four plugs of cotton wool, two of them being almost black, and partly decayed. After the extraction the hearing returned; all pain, sense of fulness, and weight disappeared.[7]

A small paper ball, accidentally introduced into the meatus, has occasioned suppuration in the tympanum, followed by caries.[8]

It is impossible to lay down any general rules for the extraction of foreign substances from the meatus. If the surface of the body be irregular or soft, delicate forceps will be found the most serviceable; if the substance be round or hard, they will seldom be available. As to making an opening behind the ear, as recommended by Duverney, for the purpose of extracting a foreign body, I believe no person at present

6 Lancet, 1833, vol. ii. p. 154.

7 Lancet, 1833, vol. ii. p. 90.

8 Dict. des Sciences Méd. tom. vii. p. 8.

would be guilty of such unnecessary cruelty, inasmuch as it cannot be of the *slightest* utility. Dr. Hill, of Greenock, has found the hook generally used for lacerating the capsule of the lens, useful in removing these extraneous bodies, it being so slender and light as to allow of its passing *behind* any object. They have sometimes been removed from the meatus by suction, and in this way, by means of a powerful syringe, a glass bead was drawn out.[9]

Professor Cooper, in his Surgical Lectures, says, "One day, when I was visiting the Fleet Prison infirmary, a child was brought to me with a pebble in each of its ears, that had been there a twelvemonth, and had now excited violent pain and inflammation, attended with total deafness. Various surgeons had failed in their attempts to get these foreign bodies out. I immediately tried what could be done with a large syringe, and had the satisfaction of soon bringing the pebbles so near the external orifice, that they admitted of being hooked out with a bent probe.[1] Extraneous bodies have occasionally been forced out by powerfully injecting a column of water into the meatus.[2] Buchanan has always succeeded in extracting foreign bodies from the meatus by syringing *alone*.[3]

Because a child, or the mother, or friends, *say* that there is something in the ear, that of itself does not establish the fact, and numerous instances have occurred where medical men have been for a length of time searching in the meatus, and have at last given it up, after doing considerable damage to the ear, and

[9] Lancet, p. 349. 1832.

[1] Lond. Med. and Surg. Journal, vol. v. p. 546.

[2] Cooper's Surgical Dictionary.

[3] See Buchanan's Illustrations of Acoustic Surgery, p. 42.

this when nothing had entered the meatus; so that, after having *well* examined ocularly and with the probe, if nothing can be detected, no further attempts should be made.

Case.—A child, æt. 10 or 11, was brought by its parents to the Hôtel Dieu, with hemiplegia of the whole left side, and violent and painful retraction of the limbs on this side, almost amounting to the tetanic spasm, &c. The parents declared that these symptoms had followed the introduction of the stone of a wild plum into the left ear many years previously, which stone could never be extracted. On carefully examining the part, M. Dupuytren could neither see nor find any foreign body, and the general cast of the symptoms led him to suspect organic disease of the brain.

Three months after admission this patient died, and, upon dissection, there was no disease of the bones at the basis cranii, *and no foreign body whatever in the ear, which was sound.*[4]

At the same time it is necessary to examine with the *greatest care*, as the most serious inconvenience, and deafness, and not unfrequently danger, may arise from any neglect. The importance of so minute an inspection will be sufficiently evident in the accompanying case.

Case.—Lieut.-Col. Webbie Smith was thrown from his horse at Bayonne, while on duty, upon the right side of the head, against some shortened branches of an oak tree. He had excessive pain in the injured ear, and hastened to camp. The staff-surgeons found the concha and meatus filled with blood, and the auricle considerably bruised and lacerated. The ear was syringed, and the wound was dressed. Local pain and irritation increased, accompanied by fever and slight delirium, which became alleviated in a few days by

[4] Med. Chir. Rev. p. 566. 1829.

the formation of pus from the meatus externus, which, together with *deafness*, were regarded as the mere consequence of the preceding inflammation. Upon arriving in this country, Mr. Stevenson found, on introducing a probe, a slight moveable substance. It was extracted with some difficulty, and, when cleared from adhering discharge, proved to be a rough, angular, flat splinter of *oak*, five lines in length and three in breadth, one extremity of which being pointed, had penetrated anteriorly, and in an oblique direction, to the depth of nearly two lines between the cuticular lining and the parietes of the bony canal, close to the membrana tympani.

Size and shape of the splinter. 

Its removal afforded immediate relief from pain, with the most perfect restoration of the sense of hearing.[5]

Should inflammation have arisen, it must be checked by the various means previously laid down. If insects pass into the meatus, they may be instantly destroyed by dropping or injecting sweet oil into the ear.

Violent blows upon the ear are not unattended with danger. A bullet striking the ear almost always proves fatal.[6]

Blood flowing from the ears is a symptom attending fracture of the skull. It may be consequent on mere concussion or vibration, which ruptures the membranes; but oftener it is a consequence of fissure across the base. The temporal bone suffering, the ear is full of blood, and in very violent shocks the serum of the surface of the brain flows through the ear.[7]

[5] Edinburgh Med. Journal, vol. xi. p. 81.

[6] Dupuytren. See account of a fatal case, where a man put a pistol to his ear, loaded with small shot. System of Nerves, by Sir Charles Bell, p. 118.

[7] Institutes of Surgery, by Sir Charles Bell, vol. i. p. 173. 1837.

It is quite extraordinary the immense quantity of watery fluid which drains away in some cases of fracture of the skull. This may or may not be preceded by blood. I believe, in all cases where this clear fluid escapes, there is fracture through the labyrinth; and hence arises a question as to whether this fluid is an increased secretion of the liquor of Cotunnius, whether serum of blood, or fluid from the membranes of the brain? It certainly is not the serum of blood, inasmuch as several ounces have drained away in the course of a few hours; and it has been tested, and was found not to be serum. I am sorry I cannot give more accurate information of some experiments respecting this fluid, which I know to have been made. In one instance it was collected during the night, and considerably exceeded in quantity a pint. I have seen a pillow wet through from a similar cause.

Part of the brain has been known to pass out through the meatus;[8] and discharges of various kinds sometimes flow from this canal.[9] A puncture, with a needle, through the meatus externus, has been known to cause death, and the same result has been occasioned by pouring into the ear acrid and burning liquids, as vitriol.

[8] See a curious case of severe injury to the head, in which there was a discharge of brain from the ear, an ounce having escaped during the afternoon, followed, after a few days, by a considerable discharge of pus. The man had severe symptoms for some time, but ultimately recovered.—*Medico-Chirurg. Review*, p. 539. 1832.

[9] In a case of dysuria, the urine was discharged from the *ears*, eyes, breasts, and navel.—*Lancet*, p. 453. 1828-9. See also a case in which sand was voided by the mouth, rectum, urethra, nose, *ear*, side, and umbilicus, and attended by various anomalous symptoms.—*Lond. Med. and Surg. Journal*, vol. vi. p. 18.

Cases.—Carlo Bruni, a healthy man, twenty years of age, was pricked in the left ear by a needle, which entered directly into the meatus; he screamed out, and fell down senseless. He was immediately bled and well purged, and, after the venesection, somewhat recovered his senses, but remained delirious for three days, after which time he was carried to the clinique of M. Speranza. The auditory canal exhibited no traces of any injury, nor was there any discharge; the patient was pale, lethargic, and often moved his hand towards his head. He was repeatedly seized with convulsions of the whole body, but especially of the left side of the face; respiration was stertorous, and the pulsation of the heart very slow. He died on the fourth day after the accident.

On examination, the membrana tympani was found lacerated; the cavitas tympani filled with pus; the auditory bones were displaced, and not adherent to one another, nor to the parietes of the tympanum. The stapes could not be found; the membrana fenestræ ovalis was lacerated; the chorda tympani was torn; the vessels of the membrane of the semicircular canals, cochlea, and vestibule, were much injected, and the nerve contained in them completely disorganized; in the vestibule, two fragments of the stapes, its base, and one of the branches, were found. The arachnoid exhibited evident signs of previous inflammation; the pia mater was covered with sero-purulent fluid; the cortical substance of the brain was very vascular and firm; the portion of the brain in contact with the temporal bone was filled with blood, of which also a considerable quantity was extravasated between the dura mater and the petrous bone.[1]

Case of death from nitric acid having been poured into the right ear.—The patient appears to have lived some seven or eight weeks after; and, upon dissection, "the meatus externus was widened: opposite the meatus auditorius internus, the dura mater seemed, in a spot of about the dimensions of a sixpence, darker than it should be. At the

[1] Nuovo Mercurio delle Scienze. June, 1829. Ospedale di Parma. See Lancet, p. 190. 1828-9.

entrance of the meatus there was a clot of blood the size of a pea. The right petrous bone was completely carious; no other positive alterations were discoverable.[2]

Inflammation of the tympanum, or *internal otitis*, is known by excessive pain, weight, and hissing in the ear, increased by noise and mastication; the eyes are suffused, tongue white, pulse hard, with all the symptoms of a most acute attack of fever. The external ear is often red and painful to the touch. These symptoms continuing a few hours, complete deafness ensues. The patient cannot obtain the least respite from pain, and there is perfect loss of sleep. Convulsions frequently occur in children, and delirium in adults, especially during the night. If this inflammation continue, about the second or third day, and frequently earlier, suppuration takes place; and if allowed to take its own course, at an uncertain time a sudden gush of fœtid, yellow, puriform matter, sometimes tinged with blood, bursts from the tympanum, either through the Eustachian tube, which is very rare, as it is generally closed by inflammation, or the membrana tympani is lacerated, allowing of its escape by the meatus externus; there not having necessarily been any discharge from the meatus previously. This sudden exit of pent-up matter at once relieves the patient of a great deal of his agonizing pain. The discharge may continue for an uncertain length of time, and under favourable circumstances may last three or four weeks, gradually becoming thicker, and finally stop; but, when left to itself, it more genera'ly happens that the mastoid cells become involved, subsequently the petrous portion; the brain and mem-

[2] Med. Chirurg. Review, p. 561. 1836.

branes are then attacked, and death follows. Sometimes, but very rarely, when the inflammation is not so severe, the increased secretion of the tympanum suddenly escapes through the Eustachian tube into the mouth.

Amongst some of the causes of this disease may be enumerated, *cold*, fever, the exanthemata, more especially measles and scarlatina, erysipelas, itch, dentition, blows or falls upon the head, syphilis, stimulant injections. It is also dependent upon that deranged state of the digestive organs which produces cynanche, and is not unfrequently met with in conjunction with anasarca. When dependent upon blows, the symptoms of inflammation may not appear for some length of time after the injury; but I cannot agree with the opinion of Itard, especially in the accompanying case, where he refers the otalgic symptoms to an injury received *twelve* months previously.

Case.—A young lady, who fell from a horse upon the right side, felt slight pain in the head, with sense of fulness occasionally. At the expiration of a year, while at a fête de campagne, she felt so much pain as to be compelled to return home and go to bed. The pain increased; this continued two days, the pain becoming excessive, when there was a sudden cracking (*craquement*) in the ear, followed by a discharge, which produced some relief. She had four or five relapses in the course of fifteen days. At the end of a month the discharge ceased, and she found herself quite deaf with the right ear. The deafness entirely disappeared, without remedial means, at the expiration of three months.[3]

It is far more probable that this young lady took *cold* upon the field, a thing so likely to happen when heated by dancing in the open air; all the symptoms

[3] Itard, vol. i. p. 191.

detailed being precisely those we should expect from the effects of such an exposure.

*Diagnosis.*—In otitis there is severe throbbing; the pain comes on insidiously, and *gradually* becomes more and more severe, and is *continued;* whereas in otalgia the pain often remits.

This internal inflammation frequently attacks children during dentition, and is often little suspected; and it is in these cases, especially if the diathesis be scrofulous, that it speedily goes on to suppuration; absorption of bone follows, and effusion of pus takes place between the petrous portion and the dura mater. When dependent upon measles, it is often very severe, and many of these cases only yield to salivation.[4]

Inflammation of the tympanum may be acute or chronic, and may be more or less severe; thus in a very acute attack suppuration proceeds rapidly, whereas if the inflammation be less, there may be only an increased secretion of mucus. In a mild attack, a few leeches behind the ear, with a purgative, followed by nauseating medicines, will generally be found sufficient; but if the pain be great, and increase in intensity, with the symptoms previously described, then the most strict antiphlogistic plan of treatment must be enforced, such as venesection ad prima sign. deliquii animi; leeches behind the ear, and, if the patient be robust, cupping-glasses should be applied to the nape of the neck; a purgative should be given, succeeded by antimonial mixtures, hot poultices being applied over the ear. Some do not approve of applying poultices, and have even said the patients found them aggravate the pain; but this is the reverse of what I

[4] Dr. Potter. Med. and Phys. Journal, vol. ii. p. 315.

have often observed. A necessary precaution in the application of any sort of poultice is, that a fold of linen should intervene between it and the ear, to prevent any foreign substance from passing into the meatus. If, at the expiration of a few hours, the pain should not be diminished, or, having ceased, should recur, venesection must be again had recourse to. Opium does not relieve the sufferings of the patient, but would seem rather to augment the febrile irritation under which the patient labours. After the application of leeches, it is generally necessary to order a *blister*, which often relieves the pain as soon as its stimulus occasions inflammatory action of the skin. Some recommend the administration of an emetic, and in some cases, especially in young persons, it will be of considerable service. It is very important to keep up a free and continued action upon the bowels. Where it may be thought improper to repeat the general or local abstraction of blood, and where the symptoms still continue, it is necessary to induce the action of calomel as speedily as possible; and, indeed, in cases where the inflammation has been very acute, or has been allowed to run its course unchecked, for thirty-six or forty-eight hours, affecting the system with mercury will often alone preserve the internal portions of the ear, from the devastating effects of caries.

No rules can be laid down for the guidance of the quantity of blood required to be taken, as this must depend upon the severity of the attack, and the age and constitution of the patient; but it must ever be borne in mind, *that the chief indication is to check the inflammation at once.*

Case.—Peter Flannagan, æt. 39, of a scrofulous diathesis; a soldier, but has lately been working as a builder, in which oocupation he met with a severe compound fracture about six months since, which rendered amputation of the leg necessary. His health is much impaired, and in consequence of some hepatic symptoms he has been an inmate of the Edinburgh Infirmary ever since the accident.

On the 14th of January, 1839, about three A.M., he suddenly awoke with most violent pain and hissing in the left ear; the agony he endured was so intense, that he declares it to have been much more severe than he experienced during the amputation. He referred the pain to the mastoid process and tympanum; there was no pain in the head. The house surgeon was called up, and immediately cupped him behind the ear to the amount of six ounces. This gave instant relief, but still a more moderate pain continued. The ear was syringed with warm water, a poultice applied, and an aperient administered. There was pain on pressure over the mastoid process, the external ear sensitive, and the face on the left side somewhat swollen. Could not hear the loudest sound with the left ear. The pain still continued, becoming more aggravated until the afternoon of the 16th, being about sixty hours after the pain had first commenced, when a sudden discharge of matter took place from the meatus, and continued very profuse during the night.

17th. Tinnitus still continues, with pain, but much less severe; discharge less, and more yellow. To syringe the ear with warm water night and morning, continue poultices, aperient medicine occasionally.

23rd. Discharge quite thin: there is tinnitus, but no pain.

27th. Discharge has entirely stopped; pain in ear increasing; more tinnitus.

29th. There is pain on pressure over the mastoid process; the glands behind the ear are inflamed; tinnitus and pain continue; bowels have been freely opened by aperient medicines. Still perfect deafness with the left ear. No discharge. As the pain is evidently increasing, a blister behind the ear was applied.

31st. Has been much relieved by the blister; pain and tinnitus less.

Feb. 4th. Tinnitus less, but of a more "dead dull" character; more pain behind the ear on pressure. No pain in the head; discharge from the ear increasing, but very watery.

7th. Has been suffering increased pain in the ear, which has extended to the head, with weight and numbness of the integuments; pain behind the ear much increased; tongue furred; pulse 90, without power; bowels open. Aperient medicine; a *large* blister, extending behind the ear *and over the greater part of the side of the head*, was applied last night, which has much relieved him.

8th. Fever diminished, tinnitus less, no pain in the head, and but slight pain in the ear. He cannot distinguish what is said, but is aware of a confused sound. Slight discharge from the meatus; bowels regulated with aperient medicine.

13th. A blister was yesterday applied, as there was more pain in the ear. No pain in the head. Discharge quite thin and watery, only escapes during the night. Suspecting that this watery discharge resulted from the retained injection, I requested him to discontinue it.

14th. No discharge last night. Not to repeat the injection.

16th. No pain in the ear; tinnitus less; only a confused noise heard when addressed. There is no rumbling noise heard when slightly pressing the meatus with the finger, indicating that the membrana tympani is still pervious. This noise is distinctly heard on the right side.

28th. His hearing has gradually returned, and he can now hear perfectly. There is neither pain nor tinnitus. The membrana tympani still remains open.

In children the application of a few leeches behind the ear, with nauseating and aperient medicine, will generally be sufficient, especially when treated at the commencement of the attack. The *excessive* pain suffered by patients in inflammation of the tympanum may be accounted for from the unyielding tissues, in

the still more firm and compact bony canal. When dependent upon the deranged state of the gastro-pulmonary mucous membrane, the emetico-cathartic treatment will be found highly beneficial, and should be rigidly enforced. Warm gargles, warm injections, the application of hot hyoscyamus or conium poultices, with thirty or forty drops of laudanum poured upon each, will be found useful; but never be induced to drop into the ear laudanum, camphor, &c.

Inflammation of the internal ear may spread to the brain ;[5] under such circumstances it sometimes commences in the meatus auditivus externus, but it by far more frequently begins in the throat, passes through the Eustachian tube into the tympanum, thence to the internal ear, and then the brain becomes involved. This happens especially in those cases where the gastro-pulmonary mucous membrane is in an unhealthy condition; it occurs from smallpox, measles, and pharyngitis dependent upon disordered stomach, but more especially it arises from bad cases of scarlet fever.

It ought always to be borne in mind by the practitioner, that whenever there is severe pain the ear, either with or without discharge, there *may* be danger of brain disease.

Case.—Itard mentions the case of a soldier who was admitted into the hospital for pleurisy, from which he was relieved. On the sixth day he had an attack of cephalalgia, with intense lancinating and pulsating pain in the *ears*, particularly in the left. The man died two days after the

[5] For case of inflammatory suppuration of the internal ear passing to the dura mater and brain, see Edinburgh Med. Journal, vol. xlii. p. 242. For disease of the internal ear, with abscess of the brain bursting into the lateral ventricle, see Med. Chir. Review, p. 233. 1830-1.

appearance of the cephalalgic symptoms, being the eighth day after admission.

On inspection, the left ear, which had been the seat of most acute pain, did not present traces of a very intense inflammation; the membrana tympani had neither lost its tenuity nor its transparency. The cavity of the tympanum and the mastoid cells presented no mucous congestion, although the membrane which lines those cavities was of a very deep red, as well as the lining membrane of the Eustachian tube; this canal was perfectly pervious, leading us to suppose that the mucus passed through it. That part of the dura mater which lines the petrous portion on its anterior and posterior faces, was attached to the brain by recent adhesions; it was red, thickened, and detached from the petrous portion, which had already a dark colour, (une couleur terne.) There was between this bone and the membrane, nearly half an ounce of a gelatinous and transparent fluid.

There is always danger when there is acute pain in the ear, *with pain and weight in the head*, especially if there be wandering of the eyes; and it is impossible to say when and how the inflammation may terminate, and therefore a cautious prognosis should always be given. Inflammation of the membranes of the brain is frequently an insidious disease, and a practitioner may easily be lulled into an idea of security, and imagine that he has merely a case of inflammation of the tympanum to treat, when meningitis actually exists. We should always suspect inflammation of the membranes when the pain, having previously been referred to the *ear*, suddenly *spreads* over the *head*.

For confirmation of what I have stated, I beg to refer to the accompanying most interesting and useful case, occurring in the clinical practice of Dr. Graves of Dublin, and mentioned by him in his clinical lec-

tures. This woman's disease was of so insidious a nature, that its true character totally escaped notice.

Cases.—Sarah Connor was admitted on the 22nd of November, with pain in the head and discharge from the meatus externus. "I examined the ear with the assistance of a candle, and observed that the meatus externus was covered with puriform discharge, but I could not detect any perforation of the membrana tympani. The mastoid process was somewhat tender on pressure, and she complained of some headache, and moaned constantly; but altogether the examination was a very unsatisfactory one, from the manner in which she was affected at that time. She had heard of her husband's death on the day after her admission, and when I entered the ward she was sitting up in bed, moaning and rocking to and fro, absorbed in grief, and incapable or unwilling to give me any information. Looking on her symptoms as the result of deep sorrow for her husband's death, I gave her as much consolation as I could afford, and did not wish to do anything while the impression of grief remained so vivid.

"You will have occasion to observe in the course of your practice, particularly in private families, that persons deeply affected by any domestic calamity will be attacked by various anomalous forms of disease. In this poor woman's case, where the feeling of sorrow was so intense, (for strong feelings are not limited to the rich,) I thought it best to wait until the first strong burst of emotions had passed away. The moaning, however, continued, and this I direct your attention to, as a symptom of disease of the brain. We lost this woman from a want of active treatment, and the source of the error was in her condition, arising from the circumstance before alluded to. The following is the history of her case:—

"Sally Connor, æt. suæ. 40, has been ill four weeks previous to admission; but, on account of the excessive grief under which she labours in consequence of her husband's death, no exact account of her symptoms previously to the time of admission can be obtained. She had at first the

ordinary symptoms of acute otitis, supposed to arise from cold. Eight days after the acute attack came on, she had a discharge of matter from the ear, *which gave no relief;* and with this exception there has been no variation in her symptoms up to the period of admission. She at present complains of constant pain in the ear, shooting towards the forehead and behind the ear, increased by pressure, coughing, deglutition, or mastication; and the mastoid process presents some degree of elevation, and feels tender on pressure. She has no mental aberration; answers questions in a perfectly rational manner; but generally lies with her back turned to the light, and her hands placed across the forehead. She moans frequently, but alleges that grief is the cause. She has some cough, with slight expectoration; the stomach is irritable and rejects fluids, but there is no epigastric tenderness; tongue furred, bowels confined, skin moist, pulse very slow and compressible.

"Nov. 22nd. Leeches behind the affected ear, and aperient medicines.

"23rd. Much the same; ordered an injection of sulphate of zinc for the ear, and a blister behind it; five grains of blue pill, one of ipecacuanha, and half a grain of capsicum, three times a day.

"24th. Discharge continues; symptoms as before; to have a purgative enema.

"25th. Appears much oppressed; pulse very slow and weak; tongue furred; bowels opened; pain in the forehead complained of; purulent discharge from the ear continues. Rep. enema. Empl. vesicat. inter scapulas.

"26th. Quite comatose; pupils dilated; face turgid and purplish; extremities cold; pulse very quick, small, and irregular. She died in the evening.

"On inspection, the veins of the neck unusually turgid; great vascularity of the scalp, skull, and dura mater; surface of the arachnoid membrane dry and shining; unusual arterial vascularity of the pia mater; substance of the brain firm and remarkably vascular; septum lucidum destroyed, and both lateral ventricles filled with a greenish-coloured serum containing

flakes of lymph and portions of softened brain; walls of the left lateral ventricle dark coloured, vascular, and so soft as to break down on the slightest touch; a large abscess, filled with thick, greenish, fœtid pus, occupied the entire of the middle lobe of the left hemisphere; the cyst of this abscess had a cartilaginous hardness, and was extremely vascular; the substance of the brain surrounding it was soft, and very like putrid brain; the lower part of this abscess adhered intimately to the upper margin of the petrous portion of the temporal bone, the bone at that point being evidently carious, and in contact with the contents of the abscess."[6]

A remarkable case occurred in the practice of Dr. Grattan of Dublin, in the person of a young lady, who had always been much subject to inflammation of the fauces and throat, from any incautious exposure to cold. One evening, having visited the theatre, which was much crowded, she walked home with her head lightly covered. In a day or two she felt a severe pain in the ear; this, together with a small excrescence in the meatus, which had existed some time previously, induced her to consult a surgeon. Camphorated oil and cotton were applied, with temporary relief; the pain, however, recurred at intervals; during its absence there was a numbness and sense of tightness affecting the ear and adjacent parts. It was at this time Dr. Grattan saw her. There was slight purulent discharge, and the meatus was filled up by an excrescence like a nipple growing from the tympanum, to which it was attached by a small neck. There was no other appearance of disease, nor any obvious sign of inflammation.

When pressure was made round the ear, where some little fulness was perceptible, the pain was rendered more severe. Her pulse was regular and natural, tongue clean, and appetite unusually good. Ordered a dose of sulphate of magnesia; to foment the ear; and should the pain increase, to apply four or five leeches. During the following days she

[6] Professor Graves, Clin. Lecture, Lond. Med. and Surg. Journ. vol. iii. p. 103.

was not visited, but at a late hour in the night of the third day, Dr. G. was called up; he found her quite collected; she told him that the pain having become more severe, she had been bled by leeches the day before, but without relief. She was then suffering most violent pain, shooting in different directions, from her ear to her forehead, and towards the top and back of the head. The day previously she had laughed and cried alternately, like one under the influence of hysteria. Eight ounces of blood were taken from the temporal artery of the affected side; a poultice was applied to the ear, and five grains of calomel were administered immediately, to be followed in an hour by an oil draught with half a drachm of the tincture of assafœtida. In the course of four hours, Dr. G., was again hastily summoned to her, as she had become quite delirious. When he arrived, she was lying in a stupid and heavy state. She was not altogether insensible, for she could raise her hand to her head, and point to the place where she felt the greatest pain.

Head to be shaved, and a blister applied to the occiput and nape. The temporal artery was again opened, whence only four ounces could be procured. At eleven next day, 4th of March, a consultation was held: she was in every respect worse, stupor had increased, perfectly comatose, eyes half closed, pupils dilated and insensible to light. Refused to swallow, and moaned much when moved. Countenance pale, arms rigid and inflexible. She had every appearance of effusion having taken place in the brain; and she was in such a state as to preclude all hope of recovery. The jugular vein was opened, and ten ounces of blood extremely dark were obtained; it presented no appearance of inflammation.

℞. Submuriat. hydrarg; pulv. jacobi veris, et sacchari albi, sing. scrupulum. Misce; fiant pulveres quatuor æquales; sumat unum tertiis horis. Injiciatur quamprimum enema catharticum cum spiritûs terebinthinæ drachmis duabus, post horas quatuor repetendum.

In the evening she had taken the powders; the injections

were administered, but her bowels had been only partially affected; pulse more full, more heat of skin, countenance improved, more sensible. Feet to be well fomented, and an onion poultice to be applied to the ear, and renewed every third hour.

5th. Quite sensible; had no recollection of any thing that had occurred the day before. External ear more swelled and more painful. Pain of head less severe. Blister had discharged well, tongue moist and white, unpleasant taste in mouth, bowels not yet fully freed, abdomen hard and tense. To take cathartic medicine until bowels relieved, then to take saline effervescing draughts.

6th. Bowels *freely* opened, attended with considerable abatement of all the symptoms; passed a better night. A purulent and very fœtid discharge from the ear; gums sore. To apply yeast poultices; repeat salines, and at bedtime a calomel pill, to be followed in the morning by a cathartic draught. She continued to suffer pain in the head, with dry hot skin and constipated bowels, for which aperients were prescribed, as well as the Liquor Ammoniæ Acetatis with Digitalis.

9th. An abscess was detected behind the ear; when opened, a profuse and very fœtid discharge took place. This abscess extended far under the skin, and was found connected with caries of the bone. Her gums continued sore.

11th. Fever removed, discharge continued; ear to be syringed with a weak solution of sulphate of zinc; she thought some of the fluid passed into the throat; discharge also continued from the opening behind the ear. The polypus was shrivelled and contracted. From this period her convalescence, though slow, was progressive. She persevered in the injection of the solution of sulphate of zinc, and sea-bathing was prescribed. After some months, although she did not hear so well with the affected ear as the other, yet she suffered no other inconvenience.[7]

It is not my intention to describe inflammation of the brain or its membranes; but I shall merely state,

[7] Abridged from a very full account, Transact. of King's and Queen's Coll. of Physicians, Ireland, vol. ii. p. 318.

that it may always be suspected, when there are pain and *weight* in the head, intolerance of light, wandering of the eyes and moaning, with the symptoms of an acute inflammatory or low typhoid fever. Frequently one of the earliest signs of inflammation having extended to the membranes, is pain on pressing the scalp.

The strictest antiphlogistic treatment must be enforced, and venesection must again and again be had recourse to, should pain in the head recur. The system should be speedily brought under the influence of calomel; and, after the more acute stage, counter-irritants should be extensively and repeatedly applied. It often happens that persons attacked with internal otitis, which may have been very severe at its onset, but has been speedily arrested by general and local depletion, and by the application of blisters, &c., in such cases, especially if the general health has been much deranged for some time previously, relapses frequently recur, not sufficiently acute to demand the abstraction of blood, and yet the pain harasses the patient, *and not unfrequently extends to the forehead and back part of the head.* Here is the difficulty of distinguishing whether the membranes and brain are inflamed, or whether merely sympathetically affected. How is it possible for a person who has alone studied *aural surgery*, to form a correct diagnosis in such a case? The question is purely medical, and requires the greatest discrimination and most patient investigation of the experienced physician.

Depletion in some of these cases will alone save the patient, and its adoption in others may speedily prove fatal. In such cases, where the pulse is neither irregular, sluggish, nor yet much accelerated, where the

intellect is unimpaired, and the conjunctiva not suffused, I have often seen blisters applied over the affected side of the head, and behind the ear, with the administration of calomel with diaphoretics, of very great service. I have tried the counter-irritants with diaphoretics and purgatives without calomel, and although the pain is generally checked, yet frequently the symptoms have returned in two or three days; and I believe that where a relapse has taken place, especially on its recurrence, the only safe plan of practice is to gently affect the system with mercury.

No stronger cases can be brought forward to convince us that the diseases of the ear are most intimately connected with those of other parts of the system; and only those persons who have been constantly in the habit of seeing and investigating diseases in *all* their various forms, can be expected to know when such affections really do or do not exist; showing the extreme absurdity, inutility, and danger of separately studying *aural diseases*.

Abscesses sometimes form in the neighbourhood of the ear, caused by the irritation of diseased portions of the temporal bone, giving rise to symptoms resembling cerebral inflammation, for which they have occasionally been mistaken, leading to the abstraction of large quantities of blood, which has prostrated the powers of the patient, and sometimes induced death. Mr. Burne has mentioned such a case, where abscess was found behind the ear; the symptoms were attributed to phrenitis; active depletion was prescribed, extreme depression was the consequence, from which the patient did not rally, but gradually sank.[8]

[8] Todd's Cyclopædia of Practical Medicine. See also Exposition of the Nerves, by Sir Charles Bell, p. 154.

Therefore it is necessary in all such cases carefully to examine, and make pressure over the scalp, more particularly in the neighbourhood of the mastoid processes.

When injections are used, the patient often informs the medical attendant that, during the night, a clear discharge, like water, took place from the ear, leading the practitioner to suppose that caries exists; but this frequently arises from the injected fluid passing through a *small* ulcerated opening in the membrana tympani, into the cavity of the tympanum, and which gradually drains off from the tympanum during the night, owing to the favourable position in which the head is placed for a lengthened period.—[See case, p. 133.]

It has been mentioned that suppuration occurs in the tympanum in a short time, if inflammation be not checked. When once suppuration has commenced, it *rapidly* increases in quantity, and soon completely fills the tympanum, producing intense agony, from its pressure against a highly inflamed membrane, the pus being unable to escape through the Eustachian tube. It has also been stated, that when allowed to accumulate, it, at an uncertain time, either suddenly bursts out through the Eustachian tube, or the membrana tympani gives way, allowing of the exit of this fluid, and giving instantaneous relief to the unfortunate sufferer; but that very frequently, when allowed to accumulate to this extent, some of the pus is compressed into the mastoid cells, they become inflamed, themselves pour out pus, and from their delicate structure, absorption speedily ensues, constituting that formidable disease, caries.

Why then should we allow a fellow creature, to suffer perhaps the most dreadful pain that flesh is

heir to, when by an operation (if from its simplicity it may deserve that name) we can at once appease the pain, and generally prevent the occurrence of caries? It should, therefore, be laid down as a rule never to be deviated from, that as soon as the practitioner feels persuaded there is matter in the tympanum, he should puncture the membrana tympani, to allow of the escape of the collected matter; thereby ameliorating the sufferings of the patient, and possibly preventing the destruction of the internal ear.

Among the consequences of inflammation of the lining membrane of the tympanum, may be mentioned loss of the ossicula auditûs, their connexions with each other and with the tympanum being destroyed, they pass out through the external meatus. Inflammation of this lining membrane sometimes occasions permanent thickening of the membranæ fenestræ vestibuli et cochleæ, and these tissues have in some few instances been converted into bone.[9] The membrana tympani, which is so frequently lacerated when under distension, usually unites a few days after the cessation of the discharge.

If the case should have been more severe, the ossicula may have been lost, the mastoid cells may have suffered, caries having taken place; this may extend to the internal ear, when the whole or part of the petrous portion may be absorbed; the membranes becoming inflamed in which the brain sympathizes, abscess then takes place, and death speedily follows.

The ossicula auditûs generally come away before caries of the mastoid process or petrous portion has occurred. The malleus and incus are much more easily displaced than the stapes, nor do they appear

[9] Valsalva.

to be of the same importance. The whole of the ossicula have come away, and hearing has remained. A scrofulous child had suppuration of the internal ear, with loss of the whole of the ossicula, without injury to the sense of hearing ;[4] but generally, if the stapes be lost, deafness follows. When the ossicula are lost, and the immediate connecting medium between the external and internal ear is destroyed, patients hear better when the middle ear is filled with water. Saunders says, "I have two or three patients at present who are in the habit of syringing their ears: they can distinctly perceive light sounds whilst the injected fluid remains, but on its escape again become deaf.[5] In that particular form of inflammation caused by syphilis, the ossicula frequently come away.[6]

When the tympanum has been destroyed, fungous excrescences frequently spring up, sometimes remaining concealed in the tympanum, at other times making their appearance in the meatus, and occasionally even protruding. The application of the sulphate of zinc will generally check their growth, and sometimes even effect their removal.

*Otorrhœa*, from οὖς, ὠτος, the ear, and ῥεώ, I flow, is, as its name implies, a flowing from the ear: this discharge is secreted by the lining membrane of the tympanum, and of the meatus externus ; and may be either purulent or mucous, and sometimes mucopurulent; it is not necessarily attended with pain.

"In the Clinique of the Hôtel Dieu there was a man, æt. 68, who had otorrhœa *without pain* for thirty years. He had paralysis of the right side of the face. He

[4] Med. and Phys. Journal, vol. liv. p. 519.

[5] Saunders on the Ear, London, p. 35.

[6] Bell on Lues Venerea.

died with all the signs of apoplexy. On examination, the tumour below the mastoid process was found to consist of a congeries of small encephaloid tumours, and to be connected with the fungus of the ear, the internal portion of which was, for the most part, destroyed, and the dura mater which covered it softened, and surrounded by thick purulent matter, in which the facial and auditory nerves appeared to terminate, so that their further course could not be traced. The parietes of the right lateral ventricle, and the lower portion of the middle lobe, were greatly softened; and on the basis cranii, the substance of the brain was changed into a grayish brown fluid, which communicated, by means of a perforation of the cerebral membranes, with the encephaloid tumour of the ear."[7]

Otorrhœa may be caused by catarrh, bathing, the exanthemata, fever, erysipelas, otitis, porriginous inflammation of the lining membrane of the meatus, lepra, strumous tubercles, fungoid or encephaloid tumours, blows, foreign bodies, stimulating injections, caries, and syphilis.

Cases.—Joseph Odin, aged 23 years, had been in bad health for some years, and shown symptoms of phthisis. In 1834 he was attacked with lancinating pain in his right ear. In two months the pain was somewhat relieved by a scanty white purulent discharge, which ever afterwards continued. From the beginning of the attack he was deaf, and two scrofulous swellings appeared under his maxilla a year ago. On the 1st of January, 1837, he felt more than ordinarily severe pains in the ears; the purulent discharge almost entirely ceased. He had pains in his forehead, with some transient swelling. In a few days he was affected with paralysis of the muscles of expression of the right side of his face, and was admitted under M. Chomel, on the 13th of January. The only treatment adopted was the making two caustic issues in the neck. In this state he was

[7] See Lancet, p. 478. 1828-9.

attacked by smallpox, of which he died on the 7th of February.

On examination, the brain was found to be perfectly sound. Towards the base of the pars petrosa was observed, for the extent of two square lines, a whitish yellow spot under the dura mater. At the point corresponding to this stain, there was observed some solid matter, friable, of a dull white colour, and resembling a *tuberculous* deposit. It was lodged in the temporal bone, which it had penetrated to the depth of three or four lines. The walls of the cavity of the tympanum were found to be red, spongy, and moistened with purulent matter. Though there was no caries or necrosis, the small bones were destroyed, and the tympanic membrane also was gone. A second *tubercular* mass was found, entirely filling the internal auditory canal, for nearly four lines. The trunk of the facial nerve, although unaltered in structure, was found strongly compressed between this tubercle and the bone. The auditory nerve was destroyed, but the fifth pair offered no appreciable lesion."[8]

Mr. Travers has seen one case of medullary tumour of the internal ear. The deformity was excessive, and the sufferings of the patient very severe.[9]

Chronic otorrhœa is frequently met with in scrofulous children; and in these cases the discharge usually comes from the meatus only, the glands being in a state of chronic inflammation. The discharge is almost always mucous, but occasionally, in severe cases, it is muco-purulent. It will generally run its course until the age of puberty, in spite of remedial means being adopted; sometimes it stops for a short time, and then returns. But generally about the fourteenth or fifteenth year the discharge gradually becomes less and less, and is at last altogether suspended.

[8] Medical Gazette, vol. xx. p. 284.

[9] See Lancet, p. 624.

Discharge from the ear may be the result of inflammation, fungus, polypus, caries, and abscess, of the brain. Suppurating glands, or an abscess may discharge, by the external ear, simulating otorrhœa.

Itard mentions having seen an enormous parotid gland disappear during the night, by a very abundant discharge from the meatus ; and on making pressure over the region of the parotid, the discharge flowed abundantly from the ear.[1]

Otorrhœa is sometimes found connected with disease of the spinal column,[2] and some have even thought it occasionally pathognomonic of that disease ; but these cases are always involved in a good deal of obscurity ; it is also sometimes found in connexion with nasal polypus.[3] Otorrhœa may attack at all ages, and may continue for an unlimited time, even fifteen, twenty, or thirty years.

It is better not to interfere with this discharge from the ear ; if suddenly checked in children, it frequently causes skin diseases, swelled glands in the neck, inflamed eyes, and sometimes brain affections.

Itard mentions a case where an injection of linseed oil suppressed suddenly otorrhœa in an infant, who died a few days after in convulsions.[4]

In adults, if discharge from the ear, particularly if from the internal ear, be from any circumstance *sud-*

[1] Itard, vol. i. p. 212.

[2] See Abercrombie on Diseases of the Spinal Marrow, p. 43. Edinb. Med. and. Surg. Journal, vol. xiv. See also the case of John Baynes. mentioned p. 151.

[3] For a fatal case of nasal polypus, where the patient had suppurative discharge from both ears, see Trans. of the Med. and Phys. Society, Calcutta, vol. ii. p. 307.

[4] Itard, vol. i. p. 222.

*denly* stopped, head symptoms immediately commence. The danger is of course increased, if the otorrhœa has continued a long time.

Sir Benjamin Brodie says, "I once attended a young gentleman, who had always been from his earliest youth remarkably dull and listless. He had a discharge from the ear, and as long as that discharge continued, things went on very well. This discharge, however, one day stopped; he died very soon afterwards, and on examining his body after death, an abscess as large as an orange was found in one of the lobes of the cerebrum; and a small aperture through the temporal bone, leading to the meatus auditorius externus, was also discovered, through which the matter had been discharged. This aperture had been stopped up, and the patient had died from the collection of matter pressing upon the brain. But such cases as this are rare; one, however, somewhat similar to it, has been in the hospital, under the care of Mr. Hawkins, and after death abscess in the brain was discovered.[5]

"A soldier, æt. 24, was admitted for fever, from which he appeared to be convalescent. When just about to leave the hospital, he observed a slight discharge from the right ear, without any pain or buzzing (*bourdonnement.*) This discharge, at the end of a few days, became thicker, and a little sanguinolent; the membrana tympani was gone, which was accounted for by the patient stating that in his youth he had been very subject to these sort of discharges. At the end of sixteen days the patient left the hospital without permission, got drunk, and was brought back by the corps de garde next morning. He complained of excessive pain in the head, principally in the temple; the discharge was entirely suppressed; he became worse, and on the twenty-sixth day from the commencement of the attack he died. On inspection the following day, the sinuses were gorged with blood, the dura mater was detached from the bone throughout the whole extent of the right temporal, and part

[5] See Lancet, p. 348. 1832.

of the occipital fossæ, and in the same situation was found about a spoonful of serum, almost yellow. This same portion of the dura mater was covered upon its internal surface with a false membrane, or rather a lining (*couche*) of very thick pus; the arachnoid was much thickened, and very distinct from the pia mater, which was also covered with a thick puriform matter. In the left lateral ventricle there was about an ounce of thick serum. There was no other apparent lesion of the auditory apparatus than the destruction of the membrana tympani; and a good deal of viscid mucus in the mastoid cells."[6]

Valsalva mentions the case of a man who had a discharge of blood from the ear, in consequence of a blow on the head; purulent discharge then took place. Sometimes the discharge stopped, when the brain became oppressed; he was always relieved upon its recurrence. Upon inspection after death, the brain was found much diseased.[7]

A girl, æt. 14, who had been subject to otorrhœa for nearly three years by exposure to cold, had this discharge suppressed. Headache soon came on, gradually became more violent, and, at the expiration of three weeks, was first seen by Dr. O'Brien. At that time she had all the symptoms of acute inflammation of the brain and membranes, as delirium, red face, wild and suffused eyes, with contracted iris and small pupil; pulse 120, hard, small, and irregular. Depletion was actively adopted, and a large blister was applied to the nape of the neck, with poultices over the ear, &c. The symptoms, although at first checked, subsequently increased; she became comatose, had several convulsions, and died on the fourth day after being first seen.

On inspection, the integuments of the neck immediately behind the affected ear were of a dark-green colour, apparently in a state of incipient mortification; this blackness extended from the base of the skull behind the ear, more than half way down the neck. The pia mater was much inflamed, only a small quantity of fluid in the ventricles; the

[6] Itard, vol. i. p. 233. [7] De aure humanâ.

choroid plexus and lining membrane highly vascular. There was a large abscess over the petrous portion, the matter being of a greenish colour, of an intolerable odour. This matter was in contact with the petrous bone, the dura mater having been destroyed to the extent of half a crown. Immediately over the spine of the petrous bone and curve of the carotid artery, the bone was carious, so that in this way the abscess communicated with the external muscles.[8]

John Baynes, aged 18, of his Majesty's ship Fylla, was admitted into Haslar Hospital on the 8th of August, 1813, with inflammation of the right ear, with purulent discharge, without fever. In a few days *the discharge ceased*, by the use of purgatives and *topical lotions*. On the 13th he complained of acute lancinating pain, confined chiefly to the top of the head, pulse 100, hard, with other symptoms of pyrexia. V. S. ad ℥xvi., and a purgative.

14th. He had espistaxis during the night; headache relieved, but not removed; tongue furred. 16th. Symptoms continuing, V. S. and purgative repeated. 17th. On shaving the head there was a diffuse swelling over the whole of the right parietal bone, upon which he had received a blow twelve months previously, which stunned him, but produced no further inconvenience. V. S. repeated. 18th. Symptoms increased, delirium, the tumour of scalp puffy and painful on pressure; an incision of five inches in length was made down to the bone; a small quantity of pus issued; he lost twenty or thirty ounces of blood from some divided arterial branches, which much relieved him. 19th. Slept a good deal during the night, countenance improved, delirium lessened. 20th. Symptoms increasing, a purgative given, and blister applied to the neck. 21st. Convulsions during the night: paralysis of left arm, and retraction of the right angle of the mouth; mild delirium at intervals; bowels open. 22nd. Passed a restless night, without convulsions; pulse nearly natural; trifling aberration; complains of headache. The pericranium

[8] For full particulars, see Trans. of King's and Queen's College of Phys., Ireland, vol. ii. p. 309.

detached on each side of the incision, and the bone white, upwards of two inches being deprived of its pericranium. The trephine was applied, the dura mater was covered with highly fetid pus, some of which escaped during the operation. The symptoms were somewhat mitigated, paralysis less: but on the 27th he passed a restless night with delirium; there was much pain extending along the whole course of the spine. He suffered intense pain in the back when attempting to move. He continued in this state two or three days; his powers became gradually exhausted, and he expired on the 3rd of September.

On dissection the pericranium was detached from the whole of the superior part of the right parietal bone. There was a considerable quantity of purulent matter between the dura mater and bone. The petrous portion of the right temporal bone carious, the dura mater detached, with a small circular ulceration of about two lines in diameter, allowing of the communication between the cranial cavity and that of the ear. Considerable adhesions of various portions of the membranes. On examining the spine, a quantity of pus was found between the medulla spinalis and its membranes.[9]

Astringents, which ought *rarely* to be used, are highly dangerous when there is pain in the *head;* and if these injections be persevered in, the brain suffers, and death generally follows.[1] This renders the *quack specifics* so dangerous, as they are either composed of astringents, stimulants, or sedatives; each and all being decidedly injurious, when introduced into the tympanum, especially under such circumstances.

A girl had discharge from the ear; a *quack* (*charlatan*) injected into it an oily liquor, which caused considerable pain; inflammation succeeded, and she

9 For full particulars by Dr. Denmark, see Medico-Chirug. Transact. vol. v. p. 24.

1 See a case published by Mr. Swan, Edinb. Med. Journal, vol. xvii. p. 410. 1821.—Also many cases mentioned in this treatise.

died delirious.[2] Garlic infused in oil of almonds, and coloured by alkanet root, was a celebrated remedy for deafness.[3]

Nothing is more common, when discharge is taking place from the ear, than to order these astringents; frequently without inquiring into *any* of the circumstances of the case. Whilst writing this thesis, I went to a public charity, with the *purpose* of seeing the treatment adopted in these cases. A woman presented herself, with purulent discharge from the external ear, which was of two weeks' standing; she complained of extreme pain in the *head;* she was ordered *instantly* an injection of the sulphate of zinc. I was unable to obtain any information respecting her subsequently.

In otorrhœa never use stimulating injections, for their presence has often produced violent inflammation of the tympanum, and even of the membranes of the brain, which has terminated in the death of the patient. In otorrhœa you can never be certain what disorganization has taken place in the internal ear, and therefore no one is warranted in injecting into it such dangerous agents. Purulent otorrhœa may continue for a length of time in a healthy person without caries; but in a weak and delicate or scrofulous subject, disorganization proceeds very rapidly; the discharge is always more offensive when caries is present, and it stains a silver probe yellow.

In treating otorrhœa, when it occurs in children, and comes under the observation of the practitioner soon after its accession, whether it arise as the sequelæ of the exanthemata or from any other cause, blisters may be applied behind the ear, or upon the nape of

[2] Dict. des Sciences Méd. tom. xxxviii. p. 45.

[3] See Paris's Pharmacologia, vol. ii. p. 48, 7th edit.

the neck, and sometimes, in severe cases, alternately upon each. The application of a few leeches occasionally applied has been recommended; but it rarely happens that the children so affected can bear loss of blood, however small the quantity may be; as this disease generally occurs in those of a scrofulous diathesis. This objection to leeches does not apply to those cases, where otorrhœa is consequent upon otitis in a healthy individual; when a moderate but successive application, judiciously applied, will frequently check the discharge.

Small doses of the milder mercurial preparations with soda, and in some cases combined with a tonic, will be found highly beneficial.

Case.—Dr. Roots mentions the case of a little girl, aged eleven, who was admitted January 3rd, with otorrhœa as the sequelæ of measles. The right ear discharged six months and then ceased, but the left continued an offensive purulent discharge, occasionally mixed with blood; her general health was tolerable, but she occasionally had, though not very often, severe pain on the left side of the head. On examining the ear as well as the profuse discharge would permit, there appeared to be small granulations on the meatus externus. Dr. Roots says,—" Now I think there can be no doubt but that this was a case of inflammation of the tympanum, which had terminated in suppuration, the membrane of the meatus externus being also in a state of chronic inflammation; and being fearful that if the bony portion of the tympanum had not already ulcerated to such an extent as to denude the dura mater, yet that, at all events, the headache was referable to an increased degree of irritability of the membrane, and thus accounting for the headache, I determined to use no means for the purpose of checking the discharge, but simply directed the ear to be well washed out with warm water night and morning, the head to be shaved, blisters applied alternately to the occiput and behind the ear,

and kept open by means of the savine ointment; and the occasional application of leeches to the temple, or behind the ear, with at first gr. v. of the compound calomel pill every night, which was afterwards changed for one gr. of calomel twice a day. Mr. Tyrrell agreed with me in the propriety of not doing anything to check the discharge. Deafness and discharge continued much the same during the first month; the head was less frequently pained. Her mouth became slightly sore, and in a few days the discharge sensibly diminished. The mercury was for a time omitted, and then resumed in just sufficient quantity to keep up the influence on the mouth. Counter irritation and occasional application of leeches being still continued, by the end of February no granulation in the ear could be discovered; the discharge varied, but was infinitely less than when she came in, and by the 7th of March she could hear as well with that ear as with the right. After this, for a few days the discharge entirely ceased, but returned slightly on the blister on the occiput having ceased to discharge; it lessened immediately on the application of a fresh blister. Dr. Roots had no doubt but that she would have soon been *perfectly* well, but her mother required her services at home, and took her out on the 28th of this month.[4]

This discharge is frequently dependent upon a diseased state of the mucous membrane, (gastro-pulmonary,) and of course the object is to restore the disordered function; which is best effected by mild aperients, alteratives with soda, warm bath, gentle diaphoretics, and change of air. The ear should be *gently* washed out with a syringe twice or three times a day.

In many cases the discharge will continue in spite of all remedies, and will of itself cease at the age of puberty; in some cases, the hearing not being appreciably impaired, especially where the discharge has been owing to an increased flow of mucus; but where

[4] Lond. Med. and Surg. Journal, vol. iii. p. 558.

it has been dependent upon *acute* inflammation, and has been purulent, the tympanum and its contents become more or less injured, occasioning a greater or less degree of deafness.

In adults where this discharge has existed for many years, there can be but little chance of effecting a cure, and the principal thing to guard against is the *extension* of mischief. We have before seen how soon the brain becomes affected when the discharge is stopped, and therefore nothing should be done to arrest this discharge when it proceeds from the tympanum.

It occasionally happens that the discharge ceases all at once, and this may arise from the meatus externus being blocked up; the matter speedily accumulates and must be evacuated by breaking down with a probe the incrustations which have formed in the meatus. If dependent upon any internal obstruction,[5] warm water should be gently injected, with the hope of washing it away.

The patient should always sleep on the affected side, to allow the matter by its gravity to drain off from the ear; and the ear should be syringed with tepid water night and morning. In these cases oil should never be introduced, as it speedily decomposes. Some have recommended the habitual use of injections of sulphate of zinc, for the purpose of preventing the extension of caries; but this does not seem necessary, and by its stimulating or astringent powers may check the discharge, or exert some other baneful influences, which have been already spoken of. Mr. Burne, in his article on otitis and otorrhœa, mentions the case of an old lady, seventy years of age, who has been affected with otorrhœa from both ears, and deafness, since she had the scarlet fever in childhood, and who, by the

[5] See case by Sir Benjamin Brodie, p. 149.

daily injection of warm water, has preserved the organ from further disorganization, and has escaped the disastrous effects and premature death, which a progressive caries inevitably leads to.[6]

This case then shows, and several others have been adduced, that injections of sulphate of zinc are not necessary, to prevent disorganization in a healthy person; and should the constitution be impaired, or scrofula or syphilis have tainted the system, its use would be still more contra-indicated, inasmuch as caries spread so rapidly under such circumstances, as to prevent the possibility of knowing how far the mischief may have extended. Many surgeons have recommended injections of sulphate of zinc, nitrate of silver, pyroligneous acid, creosote, strong solutions of potash and acetate of lead, none of which should, in my opinion, ever enter the tympanum.

When suppuration has continued for any length of time, the ossicula become disconnected, and pass out with the discharge. It is sometimes advisable to paint the meatus externus with turpentine, by means of a camel-hair pencil, and this will occasionally check that discharge which arises from the mucous membrane of this passage. This is much more safe than injecting such a stimulant into the meatus, as there can be no danger of its penetrating into the tympanum. Sometimes otorrhœa may, if soon after its commencement, be cured by the application of blisters frequently repeated, or by producing crops of pustules by means of the Ung. Ant. Tart., by the local abstraction of blood, and the administration of small doses of mercury, so as gently to affect the system. When dependent upon syphilis, small doses of the Bichloride of Mercury and Sarsaparilla have been highly extolled.

[6] Todd's Cyclopædia of Practical Medicine.

When otorrhœa has been continuing for a length of time, and where the membrana tympani is gone, flies, attracted by the matter, sometimes deposit their eggs or larvæ in the meatus, some of them passing into the tympanum, where from the heat they soon become hatched, and then act as extraneous bodies; and as they increase in size the symptoms gradually become worse and worse, and if the worms be not extracted, the patient sinks from the effects of irritation; epilepsy, convulsions, &c. being produced. The presence of these worms has been denied by some, and doubted by many; I shall therefore mention several authorities.

Cases.—Sauvages mentions having put into an earthen vase many oblong and white worms, drawn from a man's ear attacked with otalgia; he saw these worms in a few days change into meat flies.[7]

Itard mentions, amongst many other cases, one where five worms were extracted from the ear of a woman by means of a pair of pincers. These worms were examined and described by M. Bertrand, Chirugien à Méry.[8]

M. Mohr, surgeon of Berlin, was consulted in the case of a boy, æt. six, who had otorrhœa, with severe and increasing pain; and, upon injecting, he saw several moving bodies which he removed from the ear with forceps. The patient in a few days recovered. "Each worm or larva was rather more than an inch long and one-twelfth of an inch in breadth; of a yellowish white colour, and composed of many soft circular portions locking the one into the other. On the head of each were two brown crooked projections, bent down-

[7] For an account of worms in the meatus auditorius, see Morgagni, Translation, vol. i. p. 180. See also Cases of Surgery by Acrel, 1778.

[8] Itard, vol. i. p. 295, et seq. See Ancien Journal de Médecine, tom. xx. Also Cooper's Surgical Dictionary.

wards, between which was found a little conical figure, called by Reaumur *dard*. This dard was not straight, as it is in the domestic fly, but curved backwards the same as the little horns, although less so. M. Mohr gave two of these larvæ to Dr. Kuntzmann, and he placed them in a little box containing some finely powdered dry earth, a small piece of meat, and a little dung. They would not touch either of the two last substances, but plunged themselves immediately into the earth. Two days after, he found them both changed into perfect chrysalides. These were brown in colour, cylindrical in figure, thin and obtuse at each end, immovable, and apparently composed of many rings. In about five days they became perfect insects, with wings spotted with gray and black; and Professor Illiger, when they were shown to him, said that they belonged to the genus *Tachina*, but that they formed a new species of that genus. This boy had been frequently in the habit of sleeping in the open air in a wood near his home, and there can be no doubt but that the eggs from which these larvæ are produced, were deposited in his ear by an insect, while he was asleep."[9]

Itard refers to Tharantanus, Volckraner, Panaroli, Kerckring, who has given five plates of these worms, Bouteille, Morgagni, Chandorey, and Leaucaud, surgeon-in-chief of the Hospital of Arles, who drew from a man's ear five worms. It is supposed that worms sometimes pass into the ear by the Eustachian tube, and indeed Andry reports a case of this kind. When these larvæ or worms are found in the tympanum, warm water should be injected; and if this does not succeed in dislodging them, a delicate pair of forceps may be employed.

*Otalgia*, (from οὖς, ὠτος, the ear; and αλγεω, I pain,) or ear-ache, is, as its name implies, a very painful affection attacking the ear. It is usually a symptom

[9] Lancet, Jan. 8th, 1825.

of inflammation of the meatus, tympanum, or Eustachian tube; and sometimes, but more rarely, it is entirely a nervous affection. This nervous otalgia has been denied by Kramer;[1] but his translator, Dr. Bennett, is opposed to him on this point.[2] The pain often first commences in a tooth, or throughout the whole jaw, and then extends to the ear, owing to the intimate communication of nerves between these two parts.

Nervous otalgia not unfrequently occurs in females during the early months of utero-gestation, and is very frequently concomitant with odontalgia, even when no caries of the teeth exists. It is often induced by a carious tooth, tic douloureux, neuralgia, rheumatism, gout, and affections of the stomach. M. Andral, in one case, found otalgia to alternate with sciatic neuralgia; and it has been frequently observed, that neuralgic pain ceasing in the ear, has commenced in the face, and shortly after has again returned to the ear.

In cases of severe otalgia, there is great constitutional sympathy, which arises from the intimate communication existing between the different branches of the fifth, such as the gustatory, the dental, and the auricular, with the sympathetic, portio dura, glosso-pharyngeal, pneumo-gastric, and accessory nerves. The diagnosis between this disease and otitis is, that in otalgia the pain comes on suddenly, often remits, and, during the intervals, the patient is perfectly free from pain; but, upon the return of the paroxysm, the pain is again excruciating; there is also an absence of throbbing; whereas in otitis, the pain gradually increases, is continued, and attended by violent sense of throbbing.

[1] Bennett's Trans. p. 149. [2] Ibid. Page 150, note.

When otalgia is a symptom of early pregnancy, little can be done but in assuring the patient that in a few weeks the pain will in all probability cease; for in this disease, as well as in odontalgia dependent upon early pregnancy, remedies seem to be of little or no avail. Still, exercise in the open air, with occasional aperients, and where there is a want of power, small doses of quinine with dilute sulphuric acid, may be administered. Change of air has sometimes been of service. Lanzoni knew a woman who became deaf four times during four successive pregnancies; after each accouchement she perfectly regained the faculty of hearing. He mentions a similar case occurring in conjunction with sciatica.[4]

Stimulating or sedative injections ought not to be employed. Never drop into the ear esssential oils, eau de cologne, æther, &c.; as, although it may sometimes be done with impunity, yet it has been productive of the greatest mischief. Some persons who frequently suffer from earache contract the habit of dropping in laudanum; this is decidedly injurious, and is not unattended by danger. In such cases I should recommend the application of hyoscyamus and marshmallow leaves, equal parts, to be applied hot; and if this cannot be procured, a hot bread and water poultice with laudanum dropped upon it. M. Itard has recommended a practice which I think may be useful in some cases, and certainly has the merit of being unattended by danger; it consists in introducing a few grains of camphor into the meatus, previously enclosed in a piece of fine cambric.

Zacutus speaks of a Spaniard who was tormented with a violent pain in the head, which deprived him

[4] Dict. des Sciences Méd. tom. xxxviii. p. 39.

of sleep. A charlatan put into the meatus a morsel of opium. The patient slept, but on awakening he had severe convulsive motions, fell into a maniacal state, and died soon after.

If dependent upon carious teeth, the tooth or *stumps* of teeth must be extracted; and if the pain be suspected to originate in the jaw, the mouth should be examined and the teeth struck, and should one in particular give pain, it should be extracted.

Case.—Fauchard, a surgeon-dentist, mentions a case of otalgia with hemicrania, which lasted several months, caused by a carious tooth. These symptoms ceased upon its extraction.[1]

If of an intermittent character, improving the general health, and administering bark, quinine, and in some cases arsenic, will be found serviceable. If it occur in common with tic douloureux, the chance of cure will be less; but the usual remedies tried in that direful and intractable disease may be had recourse to. In rheumatic and arthritic affections, warmth applied locally, and the internal administration of colchicum, are often serviceable; and in very obstinate cases small doses of arsenic may be tried. If the alimentary canal should be deranged, the practitioner must direct his remedies with reference to the particular parts affected. And lastly, when it arises, as is most usually the case, as a symptom of otitis, the remedies as advised under that head, must be *promptly* and strictly enforced.[2]

[1] Dict. des Sciences Méd. tom. xxxviii. p. 506.

[2] A rather severe plan of treatment was adopted formerly by Dr. Valentine, who was in the habit of applying a red-hot iron behind the ears upon the processus mastoideus, in otalgia inflammatoria; and he says, "I have also cauterized advantageously the

It is not sufficient in a case of earache to have relieved the pain, but it is necessary to ascertain whether *congestion* or subacute inflammation exist; and when even in doubt, the local abstraction of blood by cupping or leeches, and the application of a blister, will be with propriety prescribed.

*Caries* may occur at an uncertain time, after suppuration has taken place in the tympanum, depending upon the constitution of the patient. In many persons suppuration passes off with scarcely any injury to the ear; but, in scrofulous subjects, caries generally takes place, and runs its course very rapidly. Sometimes, though rarely, disorganization has taken place so quickly, that the accumulated matter in the tympanum, in otitis, has effected its escape through the mastoid process, caries having set in during the acute stage of the disease; whereas, in persons of good constitution, otorrhœa has continued many years without any portion of bone having been absorbed. Occasionally caries of the petrous portion of the temporal bone exists, unattended by any discharge from the meatus externus.

It is extremely difficult, in many cases, to decide whether caries does or does not exist; and very frequently we are not aware of it, until the mastoid process becomes tender upon pressure: when such is the case, and there is pain in the ear, with tumefaction and heat over the mastoid process, always suspect ulceration to have taken place; of course the opinion will be confirmed, if fluctuation can be discovered.

inward portion of the ear, with a smaller red iron slipping through a sheath, with a design of appeasing toothache." !!—*Med. and Phys. Journal*, vol. xix. p. 421.

The mastoid process is more liable to caries than the petrous portion; this may be accounted for from the entrance of pus into the mastoidal cells in otitis, when the labyrinth remains perfectly sound, and also from the extremely delicate cellular texture of which it is composed; but still it is not rare to find the petrous portion affected, and this latter is by far the more formidable disease, from its proximity to the brain and its membranes. The petrous portion generally becomes involved after the mastoid process.[3]

When caries is present, the discharge is always sanious, highly offensive, and frequently discoloured; it stains a silver probe yellow, and very often minute portions of bone become detached, and pass out with the discharge. It is very important not to allow the matter to accumulate; the patient must therefore sleep on the affected side; must syringe the ear daily with warm water; and it becomes a question, whether it is not advisable to make an opening into the mastoid cells, if there be no communication previously established; the advantage of which is, that this opening being at the most dependent part of the tympanum, the matter easily drains off.

It is very important to examine the mastoid process frequently during otorrhœa, as instances have occurred where discharge has taken place, through the mastoid process, from the cells, and has burrowed under the cervical muscles, occasioning sloughing and death.—[See case, p. 150.]

Perforation of the mastoid cells has been performed by two Swedish physicians, Dr. Jasser and Professor

[3] See two interesting cases of caries of the petrous portion, in Cooke's Translation of Morgagni, vol. i. p. 174. 1822. See Valsalva's Cases. Also Bright's Hospital Reports, Case 62, p. 117. vol. ii. part I. Mastoideal Abscess.

Hagstroem. It has been recommended by Arnemann, Riolan, Rolfincius, Lofler, Leschevin, and Heister. Morgagni did not approve of this operation.[4]

Cases.—Dr. Burn examined a man, forty-two years of age, who had recently died of otorrhœa. The brain generally was firm, presented a very vascular appearance, and the membranes particularly so, especially in the neighbourhood of the diseased bone. He believed there was no part of the dura mater absorbed, so as to admit matter to enter between it and the arachnoides. Matter, however, had found its way from the mastoid cells to between the dura mater and the skull. There was a small quantity of it in that situation, in the neighbourhood of the ear. Great pain had been experienced in this case over the mastoid process, and considerable enlargement of the parts covering it. Mr. Callaway had seen the case, and he (Dr. B.) believed it to be that gentleman's opinion, that if another such case should present itself to him, he would not hesitate to trephine.

It appears that the man had paralysis of the left cheek, (the diseased side,) and a large tumour in the neighbourhood of the mastoid process. Sixteen years previously he had been thrown from a cart, at which period the pain in the head commenced. A discharge soon took place; stimulating injections were used, by which the discharge was arrested, and from that moment the pain increased to such an extent, that Mr. Callaway was obliged to revive the discharge by the introduction of probes; the pain gradually subsided, and the discharge continued without much pain for a very long period. The pain latterly became most excruciating. Mr. Callaway made a free opening into the mastoidean tumour; a fœtid discharge followed. He then introduced a probe, and broke down the mastoid cells; he carried the probe through them into the internal ear, from which a second evacuation took place, which seemed to give great relief. Sir Astley Cooper was requested to see him, and it was

[4] For case of trepanning the mastoid process, see Memoirs of Medical Society, vol. iii. p. 549. Also, Journal de Médecine, 1793.

thought that the trephine should be applied, The man was in great agony; a day or two passed away; another consultation was held; but, in the interim, the patient suddenly became comatose and died. Mr. Callaway had seen another case of this kind, which proved fatal; the internal ear was destroyed, together with a very considerable portion of the cerebrum.[5]

Itard mentions the case of a soldier, who took cold from mounting guard during cold and wet. He had otitis, and subsequent discharge, which continued sixteen days, and then stopped. He immediately suffered more pain than previously, and became much more deaf; injections were used, but procured no relief. He then felt lancinating pain in the mastoid process for eight days, when a dark-coloured tumour, extending three or four inches under the scalp, made its appearance. This was opened with a bistoury, and a thick and abundant flow of purulent matter followed, which came principally from the interior of the mastoid process, the cells having been destroyed. The pain ceased as soon as the opening was made, and the matter had a free issue. In the midst of this disorganization of part of the ear, the sense of hearing still retained something of its integrity, as the patient heard nearly as well on this side as on the other. Exfoliation took place spontaneously; and three months after the operation he left the hospital.

It is by no means rare, when caries of the mastoid process has been the effect of an *accidental* inflammation, that, the constitution being good, it may be confined to this part, and never spread to the internal ear; but when it has arisen from *constitutional* predisposition, or has been excited in an unhealthy person, the whole ear soon becomes involved, in which even the squamous portion may participate.[6]

Acrel, amongst his surgical cases, relates an instance

[5] Lancet, p. 317. 1828-9.

[6] See No. 946, xxii. G. Prep. Edinb. Coll. of Surgeons.

where a piece of bone became detached in the tympanum, which he discovered by introducing a probe. A short time after its removal, the otorrhœa, which had continued some time, stopped, and the patient recovered.[7]

In the Hunterian Museum, London, is a preparation, showing a detached piece of the petrous bone, surrounded by caries. It is not yet numbered, but was shown me, with some other preparations of the ear, not yet added to the collection, through the kindness of Mr. Clift.

Unfortunately there are but too many cases on record of caries of the petrous portion occasioning inflammation of the membranes and brain, and terminating only in the death of the patient;[8] and our museums are seldom without many specimens of this ravaging and extensive disease.[9]

[7] Cases of Surgery, by Acrel. 1778.

[8] For description of the sphacelated appearances of the brain, and the destruction of the pia and dura mater, with caries of the petrous portion, &c., see Valsalva de aure humanâ. Also, Abercrombie on Diseases of the Brain. Edinb. 1829. Also, Bright's Hospital Reports. London. Case 63. Scrofulous tubercles, with purulent discharge from the ear. Case 64. Fungoid tumour in the brain in disease of the ear, with purulent discharge. See also three interesting cases, dissected by Mr. Syme. 1. Case of abscess in the cerebellum, with chronic purulent discharge from the ear. [p. 331.] 2. Case of suppuration of the right anterior lobe of the brain, with chronic discharge from the ear, terminating in a tetanic affection. [p. 332.] 3. Case of extensive suppuration of the cavities of the petrous portion of the temporal bone, with chronic discharge from the ear. [p. 333.] For full account see Edinb. Med. and Surg. Journ. vol. xvii. See Cases by Dr. Abercrombie, Edinb. Med. and Surg. Journal, vol. xiv. p. 265. Also, Cases by Itard, tom i. p. 236, et seq. jusqu'au f. 281.

[9] See Preps. Lond. Coll. of Surgeons. Also No. 947, xxii. G. Edinb. College of Surgeons. Also some valuable preparations in the Musée Dupuytren, at the Ecole Pratique, Paris.

As caries of the petrous portion continues, the dura mater, in contact with it, inflames, separates from the bone, becomes discoloured, and pus is often deposited between it and the bone, or between it and the brain. The brain, sympathizing with this membrane, becomes itself inflamed, and abscess takes place, which may or may not discharge by the ear; when there is a free exit for this pus, the unhappy sufferer usually survives longer than when the matter is locked up in the brain.

Neuralgia and paralysis of the face, with conjunctival inflammation, frequently occur, independently of any disease of the brain, produced by a lesion of the portio dura. For this important fact we are indebted to Sir Charles Bell.[1]

It ought to be constantly borne in mind, that whenever caries of the petrous portion exists, brain symptoms may be daily expected. Large collections of pus sometimes form under the pericranium in cases of severe otitis, leading one to suppose that mastoideal abscess has taken place. The free evacuation of matter will speedily relieve the patient, and very frequently, in the course of a few days, the discharge ceases, the mastoid process remaining perfectly sound.

Cases.—In the case of a gentleman, sixteen years of age, where a large quantity of pus was found between the brain and its membranes, the dura mater adhered to the base of the skull, except over the petrous bone, where it was black and sloughy. The petrous bone itself was carious, black, and

[1] For an account of five cases of partial paralysis of the face, connected with lesion of the portio dura, by Mr. Shaw, see Medico-Chirurg. Trans. vol. xii. p. 112. See Sir Charles Bell's Exposition of the Natural System of Nerves, p. 133, and seq., and 149-50.

crumbling, and contained fœtid pus. The auditory nerve looked healthy. In this case there had been no delirium, but continued drowsiness, from which, however, he was easily roused.[2]

Otorrhœa, with abscess in the brain.—Ellen Britain, a woman of spare make and relaxed tissue, of regular habits, and employed in needle-work. Her health, till about a fortnight from the time of her death, had been uniformly good; she was then rather suddenly seized with violent *headache*, most intense pain in the right ear; chilliness then came on, which in a short time amounted to actual rigors; these were succeeded by flashes, and the usual symptoms of pyrexia. The pain in the ear now increased, and there was for several hours an oozing of blood from the meatus. The next day a thin ichorous discharge, from the same situation, was established. Her febrile symptoms rapidly increased, and on admission her aspect was that of a person labouring under fever of a low type: expression languid and anxious, lips and cheeks dully suffused, eyes heavy, pupils dilated equally, pulse frequent, feeble, and regular, respiration somewhat hurried, tongue dry, brown, and fissured, teeth covered with a dark sordes. She is in a state of semi-stupor, with occasional muttering; but when roused, which she easily is, answers questions correctly, though tardily. She complains of severe pain in the head, particularly on the right side. There is a thick, fœtid, purulent discharge from the ear; there does not seem to be any deafness; she can stand, but does not attempt progression. There is no paralysis, either of motion or sensation, but general muscular rigidity. When moved into bed, the limbs, instead of falling about, are stiff and extended. There is morbid sensibility over the whole cutaneous surface, a mere touch occasioning distress; evacuations passed in bed, apparently unknown to her. She gradually sank, and died on the evening of the 23rd, sensible to the last. She had not slept

[2] See Med. Trans. of College of Physicians, Lond. vol. v. p. 210.

since her admission. She could not trace her illness to any blow or injury to the head, and had never previously experienced any cerebral symptoms.

Lydia Ward, No. 11. Dr. Cholmeley. April 21, 1837. Reported by Mr. Aspland.

*Examination post mortem.*—Softening of the brain, disease of the petrous portion of the temporal bone, and the internal ear. Arachnitis, &c.

Ellen Britain, æt. 23, admitted into Lydia Ward, No. 11, on the 21. 4. 37, under the care of Dr. Cholmeley, and died on the 23. 4. 37. Case in Clinical Society's book. Physician's patient. Female. Vol. i. p. 98.

On the removal of the calvaria, the external surface of the dura mater presented no unusual adhesion or extravasation; but, on making an incision through it, a considerable quantity of puriform secretion of rather dark, yellowish appearance, and somewhat fœtid odour, was evacuated; the latter was most considerable towards the posterior part. The dura mater was softened, and of a somewhat sloughy appearance, and easily broken down, in a small space over the petrous portion of the temporal bone on the right side. The arachnoid membrane over the superior surface of the convolutions did not appear much altered, either in thickness or transparency, although that lining the base was thick, opaque, and universally coated with lymphatic deposit. The brain was well developed, the convolutions were somewhat firm, and did not appear softened on the superior surface; but on the inferior surface, over the petrous portion of the temporal bone, on the right side, was a considerable portion of the brain softened and formed into an abscess, which contained about an ounce of puriform secretion, which latter had a fœtid odour, and was of a dark yellowish appearance, and mixed with serum. The abscess itself appeared to be about the size of a five-shilling piece; had penetrated deeply into the substance of the brain; and its contents were somewhat mixed with blood. The portion of brain surrounding the abscess was soft, and much increased in vascularity. The surface of the petrous portion

of the temporal bone, where the brain lay in contact with it, appeared of a somewhat dark colour, and, on sawing into it, the inner portion of the petrous was increased in vascularity, and even in some parts ulcerated; the secretion was fœtid and puriform, and the mucous membrane completely destroyed, and the membrana tympani ulcerated nearly through. Some of the bones of the internal ear were destroyed. (&c.)[4]

In cases where otorrhœa has existed for some length of time, pus has been found in the brain, without any traces of communication between it and the ear being discovered, no caries of the petrous portion existing; so that there can be but little doubt, that extreme irritation and inflammation of the internal ear, is of itself sufficient to induce inflammation and suppuration of the brain.[5]

Dr. Alison has communicated to me a case where abscess was found in the brain, consequent upon disease of the ear attended with discharge. The petrous portion was sound, consequently there was no communication between the matter of the ear and that of the brain. Dr. Alison has a drawing of the brain of this patient.

We often find irritation of the brain consequent upon teething;[6] often inflammatory suppuration, depending upon the condition of the mucous membrane in fever; and nothing is more frequent than to find discharge from the ear, dependent upon gastric de-

[4] From Inspect. Book, No. 11. M. p. 41. Guy's Hospital.

[5] See a case where no communication was detected between the disease of the brain and that of the ears. In the cavity of the brain were three ounces of pus.—Lancet, No. 149, vol. x. p. 460. See also Dr. Burn's case, where matter was found between the bone and the membranes, no communication existing, p. 165.

[6] Bright's Hospital Reports, part I. vol. ii. p. 43.

rangement:[7] showing how great a sympathy exists between the brain, the ear, and the gastro-pulmonary membrane.

There is a great sympathy between the ear and other organs of the body; thus a sudden grating or scratching noise "sets people's teeth on edge," arising from the connexion of the chorda tympani with the fifth nerve.

The celebrated Bayle always fell into convulsions on hearing the fall of water from a pipe.[8] Rousseau states that he knew a woman who could hear no kind of music without being thrown into convulsive laughter. Tissot also relates the case of a person in whom the sound of music brought on epilepsy.

"There are phenomena which show that the organs of vegetative life are affected by certain sharp sounds, and which can only be explained by the connexion of the chorda tympani with the branches of the glosso-pharyngeal nerve, distributed to the tympanum, and of the sympathetic. Paullini[9] relates a case of a man who invariably vomited on hearing music; and Pechlin[1] makes mention of a person, in whom the mechanical irritation of the external ear caused vomiting. It is also well known that persons of weak nerves sometimes become faint by the tunes of the harp; and there are several instances on record of the respiratory and urinary organs being affected by a similar cause.

As the ear is connected with the sympathetic, it not unfrequently happens that in primary affections of the abdomen this organ also suffers. This can only be

7 Bright's Hospital Reports, part I. vol. ii. p. 109.

8 Esprit des Journaux, Nov. 1793.

9 Observ. Medic. Cent. 4 obs. 71.

1 Obs. Physico-Medic. lib. ii. obs. 45.

explained[2] by the connexion of the sympathetic nerve with the glosso-pharyngeal. Sard[3] mentions the case of a person with an ulcer at the bottom of the stomach, who complained of a pain extending from the stomach to the left ear.

"Difficulty of hearing and complete deafness are sometimes produced by affections of the abdomen. To this cause belongs the periodical deafness which comes on with spasms of the abdomen, and intermittent fever, and again disappears."

A rather unpleasant effect was produced upon the Gascoign knight by music: "Cui phormingis sono audito vesica statim ad urinam reddendam vellicabatur." Certain sounds, and particular sorts of instruments, are peculiarly disagreeable to some ears.

From violent blows or falls upon the head, sometimes a large quantity of blood is effused into the tympanum, remaining there and coagulating. The membrana tympani is not always lacerated; and Sir Astley Cooper, in a case of this kind, punctured this membrane, and after a discharge of blood, and subsequently of matter, which continued ten days, the hearing was gradually restored. Sir Astley supposes that the blood, if allowed to remain, may become organized, and so obliterate the cavity of the tympanum.—[See p. 183.]

In scrofulous persons, the tympanum, as well as the

[2] De Nervi Sympathetici Fabricâ et Functionibus, p. 137.

[3] Dissert. de raro ventriculi abscessu in Haller. Collect. Diss. Pathol. vol. iii. p. 128. See Tiedemann's and Treviranus's Zeibschrift für Physiologie, vol. ii. part I. p. 273. Lancet, vol. xii. p. 712. 1826-7.

labyrinth, is sometimes filled with caseous matter: in such cases there is generally perfect and permanent deafness. When the membrana tympani has, from any cause, been destroyed, wax sometimes passes into the tympanum in a soft state, and subsequently hardens, producing irritation and some degree of deafness. In such cases, an injection of warm water or warm oil has been found efficacious. The tympanum has, in cases of apoplexy, been found full of blood.

Valsalva saw a man who died a few days after an attack of apoplexy, with paralysis of the left half of the body, and who, after death, passed by the mouth blood furnished by the Eustachian tube. The ventricles of the brain were filled with blood, much more on the right side than on the left; the posterior part of the right ventricle was lacerated, and the ear of the same side was filled with blood.

*Membrana tympani.*—Inflammation and ulceration of this membrane may take place, and the whole of it may in consequence be removed by absorption. Inflammation of the membrana tympani is almost invariably the consequence of an extension of inflammation of the lining membrane of the meatus externus, or of the tympanum; it being rarely the exclusive seat of inflammation, except when induced traumatically, or by violent sounds. The inflammation may be either chronic or acute. Inflammation may cause thickening of this membrane, as is not unfrequently found after bad cases of small-pox, or any other skin disease penetrating the meatus; and in these cases hearing becomes considerably impaired. Inflammation is not unfrequently produced by the application of stimulants, as eau de cologne, &c. This membrane has been

found converted into bone,[4] and has been said to arise from old age, but this is certainly not very frequent.

Some suppose that the membrana tympani may be lacerated during sneezing, or violent fits of asthma or coughing, from air being suddenly forced through the Eustachian tube into the tympanum. It is frequently lacerated by the reports of artillery, or other loud noises. Kramer believes that the membrana tympani can never be lacerated by the reports of artillery,[5] an opinion directly opposed to the practical experience of our army and navy surgeons.

If the report be not sufficiently loud to lacerate this membrane, it may nevertheless cause temporary or even permanent deafness, which will be treated of hereafter. Sometimes hearing is impaired for only a short time after a loud noise, first attended by ringing of the ears,[6] and subsequently by tinnitus.

A smart box on the ear has been known to lacerate this membrane; which is probably occasioned by the air in the meatus being driven with violence upon it. Sir Astley Cooper has given a plate of a lacerated membrana tympani, the effect of a box upon the ear.[7] It is very frequently lacerated by an incautious and ignorant use of the probe; it is occasionally ruptured in removing extraneous bodies; and is an inevitable

[4] Haller, Prælectiones Academicæ.

[5] Bennett's Trans. p. 143.

[6] The ringing which accompanies a very intense sound is caused by the compression of air against the membrana tympani. The same effect may be produced by exhausting the Eustachian tube. —*Wollaston.*

[7] See Sir A. Cooper's plates of ruptured memb. tymp. Phil. Trans. 1801, p. 435.

consequence when discharge passes from the tympanum by the external meatus.

The membrana tympani is more frequently lacerated by *unexpected* reports, than merely by loud noises, and this I think may be accounted for by persons opening the mouth when anticipating a loud noise; the consequence of which is, that the excited vibratory undulations pass by the mouth through the Eustachian tube into the tympanum, and press upon the inner side of the membrana tympani, at the same time that other undulations penetrate the meatus, and press upon the membrana tympani externally; thus explaining it precisely in the same way as this membrane is poised under ordinary circumstances. When this membrane is lacerated, it is frequently attended with hæmorrhage from the ear and throat.

The membrana tympani is much more frequently diseased than is generally imagined. Kramer mentions, that out of three hundred patients, thirty-five had chronic inflammation; and in twenty-eight of these it was partially destroyed, of which the practitioners who had previously attended the patients were not aware.

"In examining the membrane in different subjects, the parts were found frequently in a more or less morbid state. In one instance the membrane was found loaded with blood-vessels, was less transparent than usual, and was united by a close adhesion to the point of the long process of the incus. In another instance there was a preternatural ossification adhering to it, at a small distance from the handle of the malleus."[8]

[8] Croonian Lect., Sir E. Home. Phil. Trans. part I. 1800.

From whatever cause inflammation of this membrane may arise, leeches should be applied; and if symptoms should require it, the antiphlogistic treatment must be prescribed. If this inflammation be not checked, thickening takes place; and where the inflammation has been severe, or the constitution bad, ulceration. When ulceration of this membrane once commences, it generally proceeds very rapidly. It is frequently caused by an extension of ulcerative disease of the lining membrane of the meatus.

Case.—Mr. Ebenezer Smith has published a case, where the meatus were frequently subject to superficial ulceration, which on the left side spread inwards, until an opening was effected in the membrana tympani. In four days, one-fourth of the whole membrane, at the antero-inferior segment, was eaten away; the membrana tympani looked dull, and very vascular, around the handle of the malleus, as well as about its edge and the integuments; slight uneasiness in the tympanum was complained of. During this rapid ulceration, hearing as quickly diminished, and in three days the clearest and strongest sounds were with difficulty appreciated, either by the naked ear or by hearing tubes. The right membrana tympani was entire, but the corresponding Eustachian tube continued closed, and the hearing on that side was gone. In this case, after employing catheterism, astringents, &c., Mr. Smith tried the effect of mercury; in seven days the gums were sore, immediately upon which the power of hearing improved, and he observed the edges of the ulcerated membrana tympani white and approximating, so as to narrow the aperture.—"In six weeks *the ulcer was replaced by a delicate white membrane*, resembling the original membrane, except in apparent strength, stretching across the entire site of the aperture." The power of hearing became equal to what it had been eight months previously; but in the course of three months, ulcerative action recurred, and the valuable little new creation of membrane was rapidly absorbed. Mr.

Smith did not consider it prudent to hazard the patient a second time to the effects of mercury.[9]

The membrana tympani rarely gives way in the centre, from the pressure of accumulated matter in the tympanum, but generally at one of its edges; in a few days, if the discharge cease, this membrane again closes. Valsalva performed several experiments on the membrana tympani of dogs; he ruptured this membrane and dilated it, and in a few days killed the animals, and found no traces whatever of the injury; and could not even discover the cicatrices. If the discharge continue a long time, and especially if the ossicula auditûs have come away, then the whole of this membrane becomes destroyed; and it is only in very rare cases that an artificial membrane is formed;[1] but occasionally such membranes are produced, either in connexion with, or internal[2] or external[3] to, the membrana tympani. In speaking of false membranes covering the membrana tympani, Kramer seems to doubt whether they *ever* exist, and supposes that Fabricius Hildanus is the only person who has seen such a membrane. He imagined that Duverney was deceived, (who observed it in an adult,) by a partial abrasion of the membrana tympani.[4]

9 For more full particulars, see p. 183, Bennett's Translation.

1 See Mr. Smith's case p. 177. Itard mentions two such cases.

2 Valsalva found a false membrane which covered the base of the stirrup, and excluded the hammer and anvil. Morgagni found membranes intersecting each other, and occupying the whole tympanum. See Mémoire de l'Academie des Sciences de Paris, 1703; and Prix de l'Academie de Chirurgie, tome iv. in 4to.

3 Saunders has seen a false membrane form in the meatus after the destruction of the membrana tympani, and his extracting it did not seem materially to diminish hearing. See also M. Maunoir's case, p. 202.

4 See Bennett's Trans. p. 146.

In the treatment of these cases of ulceration of the membrana tympani, slightly affecting the system with mercury seems to be the only remedy we possess, and fortunately it is one in which we can with a tolerable degree of confidence trust. I therefore entirely disagree with Kramer, who says, "that salivation can never be indicated for any disease of the ear as such."

Its good effects are well shown in several cases detailed in this essay; as otorrhœa with chronic inflammation of the tympanum;[5] ulceration of the lining membrane of the meatus externus, as well as of the membrana tympani,[6] &c. Mercury is also specially indicated, when inflammation attacks the inner ear, and where it would be unsafe to exercise depletion.

An aperture in this membrane does not apparently diminish the power of hearing,[7] and indeed it may be almost entirely lost, and yet partial hearing remain;[8] formerly it was believed that deafness inevitably followed its destruction. When lacerated to any extent, near the attachment of the malleus, the patient is said to be unable to distinguish low or grave sounds.

Cases.—Sir Astley Cooper mentions the case of a medical student, who had lost the whole of one membrane, and the other only partially; he could hear better with the *former*, in which no traces of the membrane could be found. His ear was susceptible of musical tones, for he played well on the flute, and had frequently borne a part in a concert. He also sang with much taste, and perfectly in tune.

His slight degree of deafness was always increased by his

[5] Page 155, case of Dr. Roots, where the discharge sensibly diminished upon the mouth becoming sore.

[6] Page 177, Mr. Smith's case.

[7] Phil. Trans. Sir A. Cooper, 1801, p. 435.

[8] Ibid. p. 438. Two cases.

catching cold, which seems to have arisen from an accumulation of wax, as, after he had been deaf some time, a sudden fit of coughing forced hardened wax from the ear, by the air rushing through the Eustachian tube, and his hearing was instantly restored. He suffered considerable inconvenience from bathing, unless his ears were guarded with cotton. When this precaution was neglected, the water, as he plunged in, by rushing into the interior parts of the ears, occasioned violent pain, and brought on a deafness, which continued until the water was discharged; but he had acquired the habit of removing it, by forcing air from the mouth through the ear.

When the finger is pressed upon the meatus, a noise similar to that of distant roaring of the sea is produced; this arises from the air in the meatus being compressed upon the membrana tympani. In this case no such sensation was produced, since the air met with no resistance, but passed out through the Eustachian tube. He had the power of moving the auricular muscles, and when he was addressed in a whisper, the ear was seen immediately to move, but when the tone of voice was louder, it then remained altogether motionless.[9]

Valsalva found, in a woman who had only suffered from dulness of hearing, the membrana tympani on each side destroyed by ulceration. On the one side all the ossicula were lost, except the base of the stapes; and on the opposite side the incus was dislocated from the stapes.

Vieussens has observed a similar case.

Deaf persons generally hear acute better than grave sounds;[1] they can therefore understand women and children more easily than men. It has often been ob-

9 Phil. Trans. 1800.

1 Grave sounds are not heard by persons whose membranæ tympani have been destroyed. *Itard.* For a curious case of congenital deafness, where partial hearing was subsequently gained, *grave* sounds were heard *better* than acute. See p. 121, Dict. des Sciences Méd. t. xxxviii.

served, that persons much in the company of the deaf acquire shrill voices. Acute sounds are perfectly audible, when the membrana tympani is drawn inwards, while grave sounds cannot be heard; this may be shown by closing the mouth and nostrils, and attempting to inspire, when the tympanum will be exhausted, and the membrana tympani drawn inwards. The same effect is produced in descending in a diving-bell, and those frequently accustomed to do so, acquire the habit of yawning, which forces air into the tympanum, and equalizes the pressure upon the membrana tympani.

To ascertain whether there is an aperture in the membrana tympani is not always easy ; in some cases it being difficult to get the rays of light to fall upon this membrane. It may, however, generally be seen by allowing the rays of the sun, or the reflected light of an argand lamp, to fall upon it: when in a healthy state it has a *tendinous* appearance, and when there is an aperture it appears as a *dark* spot.[2] When inflamed it has a *dull brown* aspect, and numerous red vessels can be seen passing in every direction.

Accumulation of cerumen, of scurfy or purulent matter, a preternaturally curved meatus, thickening of the lining membrane, or enlargement of the ceruminous glands, a superabundance of the pili auriculares, all these may prevent an inspection of the membrana tympani. There are many surgeons, who have been in practice for a number of years, who have *never seen* the membrana tympani. If there be an opening, the lips and nostrils being closed, air passes out of the external meatus when forced from the mouth.

[2] See Sir Astley Cooper's plates of ruptured membranes of the tympanum. Phil. Trans. 1801. p. 435.

The diagnosis may be further assisted by placing the finger gently upon the meatus, when, if perfect, a low rumbling noise will be heard. Although simple, this will be found a very excellent mode of diagnosis. The rumbling noise is never heard when the membrana tympani is absorbed. If the aperture should be of any size, water and smoke will pass from the mouth, through the external meatus.

The inconveniences attending an imperfect membrana tympani, in addition to the defective hearing, are, that water may pass into the tympanum during washing or bathing, causing a painful deafness and tinnitus, which generally goes off in a few days. Such patients are particularly sensitive of cold draughts of air, which often cause excessive pain in the tympanum. Wax may pass in while in a semi-fluid state, afterwards hardening, and occasioning much uneasiness. It has been found under such circumstances in the tympanum, by Ribes and Chaussier.[3] Insects may also enter the tympanum, giving rise to considerable irritation. To prevent any of these unpleasant occurrences, wool should be worn in the meatus, whenever the membrana tympani is wanting.

If *certain* that the membrana tympani be sound, and that no aperture exist, there can be no harm in using gently stimulating injections for diseases of the meatus; but the very presence of these diseases frequently excludes the examination of the membrana tympani; and therefore, as a general rule, it is far better to apply caustic and stimulating remedies by means of a camel-hair pencil, rather than running the risk of inflaming the tympanum, and possibly the

[3] Dict. des Sciences Méd. t. xxxviii. p. 30.

internal ear, by the accidental entrance of any acrid substance into the tympanum.

Relaxation of the membrana tympani has been by some considered as one of the causes of deafness. It is sometimes necessary to puncture this membrane when the Eustachian tube is impervious, as in these cases the air only being admitted through the meatus, and not through the Eustachian tube, it becomes convex internally, and deafness more or less complete is the result, probably arising from the vibrations having no space in which to undulate. This operation will be more fully spoken of, under diseases of the Eustachian tube.

It is also sometimes necessary to puncture it in cases where, from a severe blow or fall upon the head, blood extravasates and coagulates in the tympanum; if this operation be not performed, the patient will remain perfectly and permanently deaf. Itard has performed this operation where the membrana tympani was much thickened, and the patient, who had been previously deaf, was instantly restored to hearing. He has also proposed, in some cases, to wash out the tympanum by means of injections through this opening in the membrana tympani.[4] In one case, where extravasation of blood had taken place into the cavity of the tympanum, Sir Astley Cooper punctured the membrane, and some blood passed out, which continued to discharge for ten days, during which period the hearing was gradually restored. He says, "I have formerly known instances of permanent deafness from this cause, and I think it not improbable

[4] Tom. ii. p. 223 and 157.

that the blood thus effused has become organized, and continued to fill the cavity of the tympanum.[5]

When required to puncture the membrana tympani, in consequence of blood having extravasated and coagulated in the tympanum, or from matter being pent up in that cavity, it is not necessary to make either a large or a circular opening, the object being merely to allow the contents to drain off, which being effected, the membrane usually unites.

A common sharp-pointed silver probe is generally used, taking care to introduce it in that portion of the membrane anterior and inferior to its attachment with the malleus; or a sharp-pointed bistoury sliding through a canula might be preferred: this would cause considerably less pain if the membrane was much inflamed, as it always is when much pressed upon by an accumulation of purulent matter in the tympanum.

When a permanent opening is requisite, as in obliteration of the Eustachian tube, then a larger and a *circular* piece of membrane should be removed, as it is well known that this shape offers a very considerable impediment to its reunion.[6]

*Cerumen.*—Hardened wax sometimes entirely fills the external meatus, and very often, in old persons, small portions of wax remain at the upper or tympanal extremity of the meatus externus, acting in a great measure as extraneous bodies, and when in very large quantity occasioning pain, even during the movements of the lower jaw. "In the bodies of almost all old people there is found, in the innermost part of

[5] Phil. Trans. 1801.

[6] For further information respecting perforating the membrana tympani, see page 204

the meatus auditorius externus, a firmly attached lump of indurated ear-wax, which in old age acquires a disposition to crystallize, partly in an earthy form. The ear-picker only scratches off its outer surface. This lump is the cause of the dulness of hearing, which occurs slowly in healthy old people."[7] Morgagni has found the cerumen of the hardness of stony matter.

It is a frequent cause of deafness, and from its pressure upon the lining membrane of the meatus and membrana tympani, sometimes occasions inflammation, suppuration, and even exfoliation. Kramer says, respecting hardened wax producing ulceration of the membrana tympani, "that it is not only unfounded on experience, but is opposed to all experience." At the same time, he admits that, after having removed such concretions, there was a partial *redness* of the membrana tympani.[8]

This deafness may be partial or complete, depending upon the quantity of hardened cerumen; in these cases the ticking of a watch is distinctly heard, when placed between the teeth; thereby forming a certain diagnosis between this disease and insensibility of the acoustic nerve.

When there is much wax, there can be no difficulty in detecting it, and when a smaller quantity is present, an examination in the sun's rays, or by a powerful argand lamp, can seldom fail to discover it. The gentle introduction of a probe is also a good test, as, if it touch the membrana tympani, exquisite pain is felt; whereas if it reach only wax, the patient is not sensible of its presence.

Diminished secretion of wax is often the first sign

[7] Professor Authenrieth of Tubingen.

[8] Bennett's Trans. page 145.

of incipient disease of the internal ear; and is generally observed in deafness dependent on insensibility of the acoustic nerve. Kramer says, "Deviations in the quantity and quality of the cerumen are generally unimportant attendants on other diseases of the ear, but very seldom exist independently, and then exert no important influence on the function of the organ.[9] Deficiency of cerumen will of itself cause deafness, and this disease is termed "*dry ears.*"[1] Upon moistening the meatus with oil, hearing is instantly restored, and remains perfect so long as its moisture continues; proving at once the cause of the deafness. In such cases soft soap has been recommended, which not only keeps the meatus moist, but acts as a gentle stimulus.[2] The application of blisters behind the ear, and the rubbing in of antimonial ointment, has been highly recommended in these cases. Some have advised the local application of turpentine.

It is not uncommon to find several members of the same family subject to inflammation of the meatus, attended with discharge, which irritates the meatus and external ear, producing an erysipelatous inflammation, with diminished secretion or even suppression of cerumen. Injections of warm water several times daily, and improving the general health, with the application of the Ung. Hyd. Nitratis as soon as the inflammation is subdued, will generally effect a cure; but the disease is very likely to recur upon the least exposure to cold.

The cerumen itself may be vitiated, and is some-

[9] Bennett's Trans. page 94.

[1] Med. Gazette, Feb. 1834.

[2] Bell's Anatomy. Edinburgh, 1776. p. 362.

times of a dark-brown, or even of a green colour; in these cases syringing the ear frequently, and painting the meatus with a solution of the nitrate of silver, will in a very short time correct this secretion. There is always an increased and very abundant secretion of cerumen on the cessation of inflammation of the internal or external parts of the ear.

Persons who bathe sometimes complain of dulness of hearing, with ringing buzzing noise in the ear; this is frequently dependent upon a layer of wax, while soft, having been deposited upon the membrana tympani, and subsequently hardening; it may also arise from a small quantity of water being detained in the meatus between two layers of wax, or when the membrana tympani is unsound, from water passing into the tympanum. Syringing the ears two or three times with warm water, or with soap and water, will remove this unpleasant sensation.

For injecting the ear, care should be taken in choosing the syringe, which should not be small, as, although no force should be used, yet moderate power is frequently necessary. A syringe capable of containing two fluid ounces, will be found the most serviceable for washing out cerumen from the meatus. Some persons have recommended a size capable of containing only two or three drachms,[3] but this is manifestly too small for such a purpose. It is important to have a short nossel, as the body of the syringe then forms a *guard* to prevent its entering too far into the meatus. Complicated instruments have been invented, but a common syringe with a short nossel will effect every purpose. It is convenient for those not wishing to increase the number of their instruments, to have a

[3] Buchanan's Illustrations of Acoustic Surgery, p. 19.

meatus shield fitted to an ordinary two or three ounce syringe. The nossel should not be so large as to completely fill up the meatus, otherwise the pressure might be too great, and laceration of the membrana tympani might take place, if the superabundant fluid could not pass out through the meatus. The piston should be pressed upon but feebly at first, and, if necessary, may be gradually increased. If the injection cause *pain*, it should be immediately discontinued. It has been found that warm water dissolves the cerumen more readily than oil; but it has been recommended to drop a small quantity of oil into the meatus, the evening previous to injecting. It may be necessary to inject several times before the whole of the wax is washed out.

In cases of caries, especially if this disease exist in the petrous portion, a small common syringe may be used, and *no force* must be employed, and nothing but simple tepid water should ever be injected under such circumstances.

Many persons are in the habit of injecting stimulating and narcotic liquids in various diseases of the tympanum. Of such a practice I do not approve, and know it to have been frequently productive of mischievous effects. At the same time, I think it right to add, that many medical men highly advocate the employment of sulphate of zinc injections, in Otorrhœa, especially in recent cases.

*Polypus.*—When discharge from the ear has continued a long time, it is not rare to find polypus: in these cases, the membrana tympani is generally entirely lost, and the polypus grows from the walls of the tympanum. Its situation is very various, being sometimes found at the entrance of the meatus, and at

other times quite concealed. It is occasionally, though rarely, attached to the membrana tympani. It is liable to be mistaken for granulations; which are often of great size, especially when the tympanum has been destroyed.

Case.—Professor Cooper excised a round, smooth tumour, growing from the *membrana tympani*, to which it was attached by means of a long pedicle. It nearly filled the meatus, and was attended with a discharge: the nitrate of silver was applied. In a few weeks it grew again; and it was once more removed with the same result. Mr. Cooper intended to twist it off at the next operation; but it was attacked with inflammation, and sloughed away.[4]

Polypus has a very deep-red and shining appearance, bleeds profusely when punctured, which causes no pain. Polypus ought never to be extracted by forceps, as much injury may be in this way done: the shape, size, and situation must determine the instrument to be employed. It is generally better to tie polypus: but, whether tied or excised, the stem or root should always be cauterized with the nitrate of silver. Polypi sometimes bleed a good deal when extracted. Buchanan says, "I have seen a patient lose nearly five ounces of blood from the ear, after the operation."[5] Polypus very frequently returns, and sometimes becomes fungoid.

When *granulations* fill up or sprout out from the meatus, the application of the sulphate of zinc will generally check their growth; or it may be necessary to introduce sponge tents, previously dipped in a solution of the nitrate of silver.

[4] See Cooper's Surg. Dict. 7th edit.

[5] Illust. of Acoust. Surg. p. 76.

*Inflammation of the Eustachian tube* often takes place in those subject to sore throat: hence it so frequently occurs in scarlet fever and syphilis. It is particularly met with in cases of chronic inflammation of the fauces, with relaxation of the uvula. The Eustachian tube, in the healthy state, conveys mucus from the tympanum into the throat; but when inflamed this tube closes, and the inflammation may spread along it into the tympanum, which becomes, in consequence, filled with a morbidly acrid fluid, of itself increasing the irritation, and leading to that mischief which so rapidly occurs in these cases when neglected. When the Eustachian tube is inflamed, there is great pain in mastication and deglutition; the patient is unable to force air into the tympanum, when the mouth and nostrils are closed: there is constant noise in the ear; the tympanum is generally more or less involved; and if the inflammation run high, the external meatus becomes painful upon pressure. The patient is unable to judge of the pitch or tone of his voice, and speaks in an unusual, and generally very loud key.

Cases.—An eminent music-master, after catching cold, found a confusion of sounds in his ears. Upon strict attention, he discovered that the pitch of one ear was half a note lower than that of the other; and that the perception of a simple sound did not reach both ears at the same instant, but seemed as two distinct sounds, following each other in quick succession, the last being the lowest and weakest. This complaint distressed him for a long time; but he recovered without any medical aid.[6]

I had, in consequence of a cold, a very slight pain in my

[6] Phil. Trans., 1800. See also two other cases.

left ear: on sounding the regular notes of the piano-forte, $C^3$ and $C^4$ were much louder than the others; and the loudness was much increased by placing the hand over the left ear. When it was pressed close, or when the Eustachian tube was closed, the intensities of all the notes were equalized.[7]

The antiphlogistic treatment must be prescribed, which must be regulated according to the severity of the attack. When concomitant with cynanche, inflammation sometimes runs so high, as to terminate in gangrene, when the Eustachian tube rarely escapes, and permanent deafness is the result. Therefore every precaution must be taken to prevent the increase or extension of inflammation, when it exists. The emetico-cathartic plan of treatment will be found highly beneficial in most cases. Gargles should be constantly used; and in some cases it will be advisable, as soon as the more acute inflammation has subsided, to inject warm water into the Eustachian tube, as it frequently happens that this tube becomes filled up with thick mucus, which, if allowed to remain, keeps up irritation, and, in the course of time, permanently obliterates this canal.

Case.—Richard Evans, aged 35, who, from cold, became deaf, and continued so for many years, died of small-pox; and Mr. Wathen says, "I took that opportunity to examine the Eustachian tube of each ear, and found them both stuffed quite full of congealed mucus, which was observed by two gentlemen of the profession present. This was the only visible cause of his deafness, the other parts appearing in their natural state.[8]

[7] Mr. Wheatstone. Quarterly Jour. of Science, Lit. and Art. p. 72. 1827.

[8] Phil. Trans. vol. xlix. p. 215.

It not unfrequently happens that this inspissated mucus is suddenly expelled, attended by a loud snapping noise, with immediate restoration of hearing. Grapengiesser injected the Eustachian tubes of a congenitally deaf and dumb person, and concreted matter followed at various successive periods; the boy obtained partial hearing.[9]

Obstruction of the Eustachian tube takes place from inflammation, erysipelas, enlarged tonsils,[1] inspissated mucus, polypus in the posterior nares; from adventitious deposits after bad cases of ulcerated or syphilitic sore throat, especially if sloughing have existed. To ascertain whether the Eustachian tube is obstructed, desire the patient to close the mouth and nostrils, and then force air from the mouth into the ear, when, if this tube be free, an unpleasant pressure will be experienced upon the membrana tympani. Should any doubt still exist, it may at once be cleared up, by the introduction of a small bougie through the posterior nares into the Eustachian tube. Obstruction of the Eustachian tube may be temporary or permanent. When it is completely obliterated, nothing can be done. Some have suggested the dangerous practice of perforating from the pharynx into the tympanum.

[9] Dict. des Sciences Méd. tom. xxxviii. p. 120.

[1] Kramer cannot conceive how swollen glands can have any effect in closing the Eustachian tube.—*Bennett's Translation*, p. 237.

A yeoman had an abscess above the left side of the uvula; when this was stopped with lint, he became deaf in the left ear: hearing was instantly restored when the lint was removed.

A gentleman had lost his hearing by a polypus reaching from the posterior nares to the uvula.—*Valsalva*, cap. v. p. 90.

If the tonsils be large, and press upon the pharyngeal opening of the Eustachian tube, they must be removed by excision or ligature: the latter is the more preferable and less dangerous operation. In those cases of chronic inflammation of the fauces, so frequently met with in delicate persons, the application of a strong solution of the nitrate of silver, by means of a sponge, will very frequently remove this troublesome complaint. This was the plan of treatment first suggested, and so successfully adopted, by the late Mr. Vance, who met with so unfortunate a fate.

In recent cases of partial obliteration and thickening of the mucous membrane, even when adventitious deposits may have taken place, mercury, so as to affect the system, will sometimes cause absorption of these deposits.[2] Iodine has been highly recommended in these cases; it is particularly useful in chronic en-

The membrana tympani of each ear was punctured for obliteration, produced by ulcers, with perfect success.—*Phil. Trans.* 1801.

Hippocrates noticed that in a quinsy of the fauces the patient became deaf, by its compressing and closing the Eustachian tube.—*Coac.* 11. n. 35.

In a case where the tonsils were much enlarged, occasioning deafness, Sir Astley Cooper punctured the membrana tympani with perfect success.—*Phil. Trans.* 1801.

A man, twenty years of age, while fighting, received a blow on the throat, and immediately became deaf.—See *Mémoires de l'Academie des Sciences*, 1705.

[2] Of all the symptoms of lues venerea, none prove more obstinate, nor are less acted upon by mercury, than deafness. A certain degree of deafness, indeed, produced by venereal ulceration or swelling at the opening of the Eustachian tube in the throat, is sometimes relieved or even removed by mercury.—*Bell.* Edinburgh, 1797. vol. ii. p. 412.

largement of the tonsils, and in ulcerated pharynx dependent upon syphilis, even when gangrene has commenced; its action is evident in a few hours; I have seen ulceration checked, and ulcers assuming a healthy appearance, within twenty-four hours after its administration.

It has been mentioned that one of the effects of inflammation of the tympanum and Eustachian tube is an increased quantity of mucus, some of which frequently becomes inspissated, and completely fills up this tube, thereby causing deafness. Monsieur Guyot, postmaster at Versailles, endeavoured to remedy this defect on his own person, and having relieved himself, submitted his operation to the Academy of Sciences. He proposed injecting the Eustachian tube, by passing the instrument through the mouth; an operation which required no small degree of address in performing. M. Petit first proposed, and Mr. John Douglas first demonstrated, the possibility of passing the nossel of the syringe through the nose into this tube; and Mr. Wathen acknowledges himself indebted to Mr. Douglas for his knowledge of this operation.

Mr. Wathen says, "I first introduced my probe, a little bent at the end, through the nose, into the tubes of several dead subjects; and having thereby acquired a facility, I did the same on a person that was very deaf, and on whom all other means had proved ineffectual. No sooner had I withdrawn the probe, than he said he could hear much better. This success excited my further endeavours, so that I had pipes of different sizes adapted to a syringe; I have since injected the tube in the following manner with success."

The pipe is made of silver, about the size and length

of a common probe, and a little bent at the end ;[3] this being fixed to an ivory syringe, full of liquor, (viz. a little mel rosarum in warm water,) must be introduced between the ala and septum of the nose, with its convexity towards the upper part of the aperture of the nares, and thus continued backwards and a little downwards, till it comes near the elliptic orifice ; then its convexity is turned towards the septum, by which the inflected extremity enters the tuba Eustachiana with ease ; the liquor is then impelled through it into the tube, by which the sordes, if any, being diluted, is washed out and regurgitates through the nose or mouth, or both, with the injection ; and, if the quantity be large, may be seen." Mr. Wathen then mentions six cases, where all were benefited, and some completely cured, who had been previously exceedingly deaf.[4] This operation has been performed and recommended by Douglas, Cleland, Wathen, Sabatier, and Leschevin. Bell, Portal, and Trucy, have thought it next to impossible to inject the Eustachian tube through the nose, on account of the irritability of the Schneiderian membrane.

I believe all persons who inject the Eustachian tube still adhere to the method adopted by Mr. Wathen, which requires some little practice, but may be soon acquired ; it is at once obvious that the most easy and direct channel to this tube is through the nose, as a reference to the *subject* will at once indicate. The

[3] The catheter used by Kramer is at an angle of 144 degrees ; that recommended by Boyer has an angle of about 136 degrees. For information respecting the introduction of instruments into the Eustachian tube, see Itard ; also Traité des Mal. Chirurg. tom. vi. p. 391 ; and Dict. des Sciences Méd. tom. xxxviii. p. 108.

[4] Phil Trans. vol. xlv. p. 216.

principal difficulty in introducing the tube will be found to arise from the extreme irritability of the Schneiderian membrane. The silver catheter is now almost universally used by those surgeons who inject the Eustachian tube; although Deleau in his practice prefers a flexible catheter, the disadvantage of which is the extreme pain caused on withdrawing the stilet. M. Deleau has proposed injecting condensed air into the tympanum through the Eustachian tube, which has been somewhat extensively practised upon the Continent.

[It has lately been much advocated by some of our own countrymen; and since this thesis was written, has been rendered but too public in consequence of its injudicious application.[5] That the air acts on the tympanum as a very powerful stimulus is at once evident, from the numerous cases of inflammation which have been caused by its injection. It will require the sanction and experience of honest men, before we can admit of contradictory results to those obtained by M. Itard and others, who have not found it of use in a single case.]

A directly opposite mode of treatment has been adopted by Dr. Darwin: "he applied a cupping-glass, fitted with an exhausting syringe, over the ears of three persons who were very hard of hearing. The irregularity of the mammoid process made it necessary to put two or three circles of wash-leather, dipt in oil, around the helix of the ear. On working the air syringe, the external ear swelled and became red; but at length the patient complained of pain in the internal ear, and the air was re-admitted. One of these three patients heard considerably better immediately

[5] See p. 246.

after the operation, and received permanent advantage; the others received neither benefit nor disservice.[6]

Where injections do not succeed in dislodging the inspissated mucus, it is sometimes advisable to pass a small bougie or catgut into the Eustachian tube, not with the view of dilating, but simply breaking down the coagulated matter. Fine harp-strings form very good bougies, and that particularly recommended by Kramer is the small E string. It is to be introduced in the following manner: first pass into the Eustachian tube a common canula, such as is used for injecting; then take the harp-string and pass it through the tube. The operator should know the length of the string, and should be careful not to pass it up the Eustachian tube more than one inch and a half. Great care should be taken not to pass this bougie farther into the Eustachian tube; although this is somewhat at variance with the advice of Kramer, who recommends that it should be passed *up to the membrana tympani.*[7] He also says, "If the gut be thrust still farther forwards, *so as to pass between the handle of the malleus and the incus, and to the membrana tympani beyond*, the acuteness of the sensation increases up to the moment when, accompanied by a lancinating pain, the membrane itself is touched."[8] It is difficult to conceive how such a practice could be persisted in, without doing considerable damage to the membrana tympani, and also to the ossicula, considering their delicate connexions and the brittle material of which they are composed.

The strongest advocate for catheterism that I have

[6] Phil. Trans. vol. lxiv. p. 353.

[7] See Bennett's Trans. p. 201.

[8] Ibid. p. 202.

met with is Kramer, who condemns the English for not practising this operation. That we are to blame for not having more frequently adopted this use of bougies, I am free to confess; and I feel convinced that in many cases it would be of essential benefit; but it is not so much worthy the attention of the practitioner, as the now almost neglected, but more simple and safe operation of Mr. Wathen, which, in most cases, would prevent the necessity of having recourse to the use of bougies. Why this operation has been so long neglected, I am at a loss to conceive, except that by some its difficulties may have been considerably exaggerated.

All instruments for dilating the Eustachian tube are exceedingly injurious, and I believe are never employed by British practitioners. The mechanical dilatation of strictures of any part of the body often produces much mischief, and I am happy to find that this plan of treatment is daily becoming less popular. The seat of stricture in the Eustachian tube is generally in the cartilaginous portion. It is very rare to find only one tube obliterated, but generally both are similarly affected. The stricture may be only partial, and in such a case, hearing will be only correspondingly impaired; but when the tube is completely obliterated, there is almost perfect deafness.

Case.—Sir Astley Cooper has seen one instance of a stricture in the tube, which, although it did not entirely obstruct the passage of the air, yet rendered it extremely difficult. "To enable himself to hear, the gentleman who was the subject of this disease, was under the necessity of forcing air from the mouth into the cavity of the tympanum, which pushed the membrana tympani towards the meatus; then pressing gently upon the ear, he forced out a part of the air which the tympanum contained; thus giving the membrane

liberty to vibrate, and producing an immediate increase in the power of hearing."[1]

To Sir Astley Cooper is due the honour of having relieved, by a simple operation, persons labouring under this previously incurable deafness.[2] "The deafness to which I allude, is that which arises from an obstruction of the Eustachian tube; and the operation consists in puncturing the membrana tympani. The tympanum of the ear is formed like a drum; and as a drum will produce very little sound unless air be admitted by a hole in its side, so, in the usual state of the ear, the membrani tympani cannot perform its office, if air has not free access to the cavity of the tympanum. The air thus essential to hearing, passes from the throat to the ear by the Eustachian tube, so that the membrana tympani is placed between two portions of air, the one contained in the meatus, the other in the cavity of the tympanum. Accordingly, if the Eustachian tube becomes obstructed, the air confined in the tympanum being unable to yield, the membrana tympani must cease to vibrate, and thus sound being no longer conveyed to the interior parts of the organ, a permanent deafness must ensue."[3]

If patients can distend the membrana tympani when closing the mouth and nostrils, then it is improper to puncture this membrane, as it is a *proof* that air can pass into the tympanum. It is also useless to puncture it, if the patient cannot hear the ticking of a watch when placed between the teeth, as this shows

[1] Phil. Trans. 1801, p. 440.

[2] Cheselden was the first to propose the operation, although I believe he never performed it.

[3] Phil. Trans. p. 438. 1801.

the nerve to be insensible. When this operation was first introduced, surgeons, eager to try anything to cure deafness, punctured the membrana tympani in every case submitted to them; and, finding it to fail, began to place no confidence in it. But if the cases be properly selected, there is every chance and hope of a favourable result.

In speaking of perforating this membrane, Kramer says,[4] "The single case in which Itard was induced to puncture the membrana tympani, simply on account of thickening of the membrane, is the only one in which the operation afforded any good results to incite to imitation in similar cases." And again,[5]—"So that I must repeat, that, with the exception of the single successful case recorded by Itard, no other is known, in which the operator was on good grounds induced to puncture the membrana tympani; and that the thickening of this membrane, unaccompanied by any other disease of the ear, invariably affords the only true indication for its perforation.

Several successful cases have been mentioned, and others have been referred to, which at once convince that this operation *has been*, and still *may be*, useful in other cases, *besides* those of simple thickening of the membrana tympani: and it is but charitable to suppose that Kramer was unacquainted with these cases, when he ventured upon the voluntary assertion just mentioned.

Cases.—Sir Astley Cooper has published a selection of *four* successful cases, of which I shall transcribe one. "Mr. Round, of Colchester, consulted Dr. Baillie respecting his

[4] Kramer, Translation, p. 156.
[5] Ibid. p. 158.

son, Mr. John Round, aged seventeen, who had laboured from his birth, under such a degree of deafness, as would have incapacitated him from engaging in business. Dr. Baillie having satisfied himself that there was no nervous defect in the ear, referred him to me.

" I found that this gentleman had been born with an imperfect state of the fauces, which rendered him incapable of blowing his nose; that the Eustachian tubes had no openings into the throat, and therefore that he was unable to force air from the mouth into the ear. The auditory nerves, however, were perfect; for he could distinctly hear the beating of a watch, if placed between the teeth, or against the side of the head; and he never had perceived any buzzing noise in his ears. I therefore advised him to submit to the operation of perforating the membrana tympani, to which he cheerfully consented. The moment this was done, a new world was opened to him; and the confusion produced by the number of sounds which immediately struck his ear, made him sink upon a chair, almost in a fainting state.

" From this state he recovered in about two minutes, and finding that his hearing was completely restored on the one side, he wished the operation to be performed upon the other; which was immediately done, with the same happy result, and without his experiencing the same confused sensation as before. Near two months after the operation, I had the pleasure to receive an assurance from him, that he had suffered no relapse nor any inconvenience from the opening which I had made, and that his hearing continued perfect."[6]

The two following cases are important, as, in each instance, the perforation of the membrana tympani effected a complete cure.

The subject of Monsieur Maunoir's observation was a man aged 40, who had lost his hearing in consequence of a

[6] Phil. Trans. p. 442. 1801.

chronic affection of the fauces, which had completely obliterated the Eustachian tube. On perforating the right tympanum with a small trochar, he remained some time stupid, and then exclaimed, " Au nom de Dieu, Messieurs, ne criez pas, vous me faites mal!" although the bystanders were speaking in a low tone of voice. In eight days this excessive sensibility ceased. The left ear was then perforated without any effect. Twenty days after the second operation, his hearing was very little diminished; but there only remained a very small hole in the right tympanum: to prevent it from shutting up, it was perforated anew, not without effect; but, on examining the left ear, it was discovered that the tympanum was hid by a *false* membrane, which alone had been perforated in the second operation. M. Maunoir removed it entirely with a pair of forceps, and then perforated the real tympanum, which, it is remarkable, was followed by the same astonishment and excessive sensibility to sound as the first operation.

The subject of Dr. Celliez's case was a lady, 59 years of age, subject to catarrhal affections, but who had lost her hearing twenty-two years before, during an acute disease. The one tympanum was no sooner pierced, and the trochar withdrawn, than she exclaimed, " J'entends!" and requested the surgeon to speak lower. The other tympanum was perforated at the same time, and hearing was restored, but, at first, with too great a degree of sensibility. Dr. Celliez thinks he has improved on the operation of Sir Astley Cooper, by using a curved trochar, and of a considerably larger size, as the chance of the perforation healing up is lessened; and, by perforating the tympanum at its lowest and most anterior edge, there can be no current of air, and there is less chance of any hæmorrhage.[7]

Dubois punctured the membrana tympani four times without success.[8] Mr. Saunders, by puncturing

[7] Edinburgh Medical Journal, vol. i. p. 382.

[8] Nosograp. Chirurg. t. ii.

this membrane, instantaneously restored a patient to hearing, who had been deaf thirty years, syphilis having attacked and destroyed part of the palate. Paroisse restored a young man who had been deaf eight years, from obstruction of the Eustachian tube.[9] And in the cases of Hunold and Michaelis, two-thirds of those operated on succeeded.[1]

It is proper here to add, that some cases, at first benefited by puncturing this membrane, gradually relapse into their former state of deafness; nor would this seem entirely dependent upon a closing of the membrana tympani, to which it has been referred;[2] but I think it more probable that it arises from a more or less complete insensibility of the acoustic nerve, induced by the unaccustomed stimulus, to which it is so suddenly exposed; and I should therefore suggest, that a person subjected to such an operation should at first be guardedly kept from any noise, even that of persons talking, and that the ears should be instantly plugged with wool, previously dipped in oil, so that the tympanum may gradually become accustomed to the presence of air. At the expiration of a few days, this discipline may gradually be relaxed; and the patient will, I conceive, under such circumstances, be placed in the best possible position for the success of such an operation.

[9] Opuscules de Chir. p. 309, 8vo. Paris, 1806.

[1] Dict. des Sciences Méd. t. xxxviii. p. 6.

[2] Richerand has proposed effecting an opening in the membrana tympani by the application of the nitrate of silver; thinking that the edges would be less likely to unite under such circumstances. —*Nosog. Chirurg.* t. ii. p. 132. éd. 2. Leschevin recommmends the same practice.

The membrana tympani should never be punctured while in a state of inflammation, as the operation will be very painful, and ulceration may be the consequence. The part selected should be the anterior and *inferior*, underneath the manubrium of the malleus: the operation is perfectly safe, owing to the ossicula being placed at the superior part of the tympanum. It has been recommended that the trochar should be rather large, and, after the puncture is made, should be turned round several times;[3] the head must be held firmly by an assistant.

The best instrument for puncturing this membrane, with which I am acquainted, is that recently invented by M. Fabrizi, an Italian, and manufactured by Mr. Weiss of the Strand. [See plate.] Its object is to make a *circular* opening, the divided portion of the membrana tympani, fixed by the spiral wire, remaining within the canula. It is simple in its construction, and consists of a canula, into which slides a spiral wire, somewhat resembling that of a corkscrew. It is to be used in the following manner: Pass the canula with the spiral wire down upon the inferior part of the membrana tympani, retain it there with the left hand, being careful not to press too firmly upon the membrane; then, with the right hand, take hold of the small handle which revolves the spiral wire, and turn it from right to left, being what is usually called turning the *wrong way*. The instant the membrane is perforated, is sensibly felt by the operator. The wire is now no longer to be turned; but by its handle the instrument is to be retained in its situation; then gently revolve the canula, which

[3] Buchanan.

has a cutting edge, from *left* to *right*, when a circular portion of the membrana tympani, corresponding to the diameter of the canula, will be cut out, and at the same time drawn into the canula and held fast by the spiral wire.

*Tinnitus aurium* is frequently met with as a symptom of other diseases of the ear: it is also found as an affection *sui generis*. It is known by a variety of indescribable sounds; some patients complaining of tingling, hissing, whizzing, buzzing, throbbing noise, or as of the retiring waves upon a shingly beach, roaring of the sea, buzzing of insects, rustling of the wind, &c. They may with advantage be divided into the grave and acute sounds. It sometimes occurs in one ear, at other times in both; the power of hearing being often unimpaired. It may be produced by whatever opposes free, or excites undue circulation of the blood; thus, in running, when the heart is beating violently, the blood is heard rushing into the ears. A man at the Hôtel Dieu, who had aneurism at the superior part of the external carotid, which was much diminished by compression, which he himself effected, complained only of a *stunning* noise in the interior of the ear.[4] It is frequently produced by an irregularity of the circulation of the blood through the brain, caused either by increased action of the heart, or by excessive loss of blood, and is often found with partial deafness, in cases of congestion attended with dull, heavy pain in the head, preceding apoplexy; and is not unfrequently induced by the suppression of accustomed

[4] See a curious case, p. 65, Abercrombie on the Intellectual Powers, 7th ed. 1837.

discharges. When arising from increased arterial action, congestion, or suppressed evacuations, the noises are heavy, throbbing, and dull, and are *synchronous* with the pulse, seldom intermit, and are aggravated by warmth, stimulants, and the horizontal posture. In these cases, unless immediate danger be apprehended, it is unadvisable to order general depletion ; but a continued and regular action upon the bowels, seems to give the most certain and permanent relief. It sometimes arises from an opening in the membrana tympani, from an excess or deficiency of cerumen, or from thickening and consequent diminution of the calibre of the Eustachian tube ; from catarrh, and enlargement of the tonsils, the effect being an unequal distribution of air through the tympanum. It is often met with in cases of disordered stomach, where the eyes are affected with muscæ volitantes. It occurs, also, in cases of deafness, dependent upon insensibility of the acoustic nerve, and is a most troublesome symptom, as it unceasingly disturbs the patient. It frequently arises from an altered function of the nerves, and is often induced by the depressing passions, and excessive profluvial discharges, and is much complained of by hypochondriacs, dyspeptics, and hysterical females, whose imagination sometimes converts these noises into *whispers*, proving a source of great disquiet, and amounting, in some instances, to a complete hallucination. In these cases, attention to the general health, with change of air and scene, and directing special attention to the discharges, are the chief indications to be attended to. Local applications appear to be useless, inasmuch as the affection is consequent upon an enfeebled state of the whole nervous system. It is very

frequently found occurring after mental depression; in which cases, there is generally palpitation, and *swimming* of the head. The bare mention of this last symptom frequently sets the lancet to work; this practice of course only increasing the disease. Mild aperients, with James's powder, and very gentle tonics, with change of air and scene, will be found the best plan of treatment in such cases.

In the treatment of this disease, the cause must first be ascertained: whether it arises from a too free or impeded circulation, or from any gastric or nervous affections; and, lastly, whether functional or organic. It would be useless for me to mention the various ways in which this treatment should be carried out, as it must be at once obvious. Blisters behind the ears do not seem to be of the least benefit; but the local application and internal administration of belladonna has been highly recommended in those cases dependent upon an altered function of the nerves.

Sir Gilbert Blane states, "That in two cases of tinnitus aurium, which fell under his observation during the past winter, a cure was effected by belladonna. In the first case, which occurred to a lady rather advanced in life, the sensation was so distressing, that she requested, if it could not be removed, something might be administered "to make her sleep for ever." Belladonna was applied externally to the ear, and, after a short time, the relief was complete, and has since remained permanent. The other case, was in the person of one his Majesty's household, who compared the noise "to the rushing of winds, the roaring of cataracts, the discharge of fire-arms, and everything that was most distracting." A third of a

grain of belladonna was given internally three times a day, and in three days the patient had entirely recovered from this distressing symptom.[5]

## ON DEAFNESS.

Deafness may arise from a variety of causes: it may be the result of acute inflammation, or caries, with partial or complete destruction of the ear; it may be caused by sudden fright, severe mental affliction, general want of tone of the system,[6] sympathetic

[5] Lond. Med. Gazette, vol. i. p. 797.

[6] "There was made an experiment, the 20th of May last, at Udine, at the house of Signor Griffoni, by the transfusing the blood of a lamb into the veins of a spaniel, of a middle size of that kind, thirteen years old, who had been altogether deaf for above three years, so as what noise soever was made, he gave not any signe of hearing it. He walked very little, and was so feeble, that, being unable to lift up his foot, all he did was to trail his body forward. After the transfusion practised upon him, he remained for an hour upon the table, where he was yet untied; but, leaping down afterwards, he went to find his masters, that were in other chambers. Two days after, he went abroad, and ran up and down the streets with other dogs, without trailing his feet as he did before. His stomach also returned to him, and he began to eat more and more greedily than before. But that which is more surprising is, that from that time he gave signes that he began to hear, returning sometimes at the voice of his masters.

"The 13th of June he was almost quite cured of his deafness, and he appeared, without comparison, more jocund than he was before the operation. At length, the 20th of the same month, he had wholly recovered his hearing; yet thus, that when he was called, he turned back, as if he that had called him had been very

affections of the uterus, loud and unexpected noises, blows, or any external violence upon the head, organic disease of, or tumours pressing upon, the brain; or tumours situate in the internal ear, compressing the acoustic nerve;[1] or it may arise from a gradual want of power in the acoustic nerve, resembling the condition of the optic nerve in some cases of amaurosis; it is often found in fever; and occasionally comes on suddenly, as a precursor of apoplexy. It is caused by excrescenses or concretions blocking up the meatus or tympanum; or from an enlarged or contracted meatus externus. It sometimes arises without any apparent cause either before or after death. Some have referred it to an inflammatory state of the minute branches of the glosso-pharyngeal nerve, distributed on the tympanum; others to anchylosis of the ossicula, relaxation of the membrana tympani, or even paralysis of the muscles of the ossicula! It has been caused by a powerful sternutatory.[2]

Case.—In 1830, during the Revolution, a man was taken to the Hôtel Dieu, with paralysis of the organs of sight, smelling, and hearing, on the right side of the face, the consequence of a ball, which traversed the face in an oblique direction, and made its appearance beneath the integuments, a little below the mastoid process, on the right side. The paralysis continued at the end of six months.[3]

far off. But that hapned not alwayes; in the mean time, he heard alwayes when he was called."—*Phil. Trans.*, vol. iii. p. 481.

[1] Itard. Bonet. Thoman. &c.—See Copeland's Medical Dictionary. See also p. 218.

[2] Dict. des. Sc. Méd., t. xxxviii.

[3] Lond. Med. and Surg. Journal, vol. v. p. 157. See also Dict. des Sciences Med., t. xxxviii. p. 123.

This disease is not unfrequently induced by irregularity or cessation of the catamenia, especially when the brain is in that torpid condition, with headache and sense of weight, so generally met with under such circumstances.

A girl, æt. 17, had amaurosis and deafness, in the first instance, consequent upon cessation of the catamenia, but the cerebral symptoms continuing after the uterus had assumed a healthy action, remedial means, such as mercury, purgatives, antimonials, iodine, cupping, leeches, seton, strychnia applied to a blistered surface, and mercurial ointment behind the ear; nitrate of silver and turpentine applied to the meatus, and last of all cajeput oil; the employment of all these remedies only slightly benefited the amaurosis, when, from breaking a stick with difficulty across the patella, inflammation and suppuration of the bursa took place, and a profuse discharge continued for three or four weeks, *with very great benefit to her sight and hearing.* The knee healed, and as she still had a noise in her ears, resembling the rattling of carriages, Dr. Fosbroke ordered, in addition to a seton, a double issue in one of the muscular depressions of the right shoulder. Her hearing shortly became quite restored, although she still had noise in the ears, and her sight was getting clearer and better.[3]

In such a case the object is to bring the uterus into a healthy state, and improve the general health. It is impossible to lay down any general rules, but the treatment must depend upon the particular symptoms which present themselves in individual cases.

Loud and *unexpected* noises sometimes at once produce deafness; and the antiphlogistic treatment,

[3] Lancet, p. 918. 1834-5. See Remarks by Abercrombie, Edinb. Med. and Surg. Journal, vol. xiv. p. 326. Case iii.

which should always be prescribed after these exposures, will, in a few days, frequently restore the patient to hearing, but sometimes the deafness remains permanent. Artillerymen, blacksmiths, and the blasters in mines often become deaf; and this seems to be dependent upon defective energy of the acoustic nerve, from having been so frequently *over excited.* In those cases where the disease has come on *gradually,* there is little hope of ever regaining the power of hearing.

Deafness is sometimes dependent upon a want of power of the acoustic nerve, it being similarly affected as is the optic nerve in amaurosis; being, in fact, an *insensibility* of the acoustic nerve, sometimes improperly called *paralysis* of the *nerve.* It is caused by the depressing passions, or whatever induces deficiency of tone in the system. When arising from this cause, it comes on gradually; the least thing which agitates, impairs the hearing; persons so affected hear better in society, but, when under this excitement, frequently complain of pulsations in the ear with tinnitus aurium; there is generally a diminished secretion of wax. They hear better in a carriage, or whenever there is an *unaccustomed* noise; hence persons living in the country hear very well when first visiting London, but after a few weeks, when the noise ceases to act as an extra excitant, the same good effect ceases. Sauvages mentions the case of a young woman, who had always a drum beaten before she could hear; and another case, of a bell-ringer, who only heard whilst the bells were ringing. And Dr. William Holder, speaking of a young gentleman who was born deaf and dumb, says, "For so long as I beat a drum, fast and loud by him, he could hear those who stood

behind him, calling him gently by his name, (which he understood,) having learned to speak and pronounce it among other words; and when the drum ceased he did not hear the same persons, when they again very loudly called him by his name."[4] These persons generally hear better on a clear, fine day, than during dull, heavy, and wet weather. This deafness usually comes on so insensibly, that the person thus affected is rarely the first to discover it; but the friends find themselves obliged to repeat their questions and answers; and it is by them the patient is generally first informed of this diminution of hearing. As soon as one ear becomes deaf, a person involuntarily employs the other, and, from the absence of the usual stimulus and regulation, the affected ear soon becomes altogether useless. The impaired function of the one, does not necessarily in the least affect the other ear; in this respect differing from affections of the eye.

Almost all deaf persons contract the habit of opening the mouth, when listening to conversation, and M. Richerand supposes that the depression of the lower jaw expands the meatus;[5] but it seems much more probable that it affords a more ready passage for air through the Eustachian tube, as, during the extension of the lower jaw, the pharyngeal extremity of the Eustachian tube becomes dilated.

Deafness in fever is not uncommon; it is usually considered a good sign, as it indicates a diminished sensibility of the brain. I have, however, observed a case where deafness having continued six days, the

[4] Phil. Trans. vol. iii. p. 665. May 18, 1668. See also Derham's Physico-Theology.

[5] See Copland's Translation, p. 289, 2d ed.

hearing suddenly returned, and the patient died a few hours after. The deafness usually disappears as the patient convalesces; should it still continue, it must be treated according to the peculiarities of the case, it being useless for me here to repeat what has been previously given in detail.[6]

Attempts have been made to classify the different degrees of deafness, and that first adopted by Rosenthal seems the best.

1. *Deafness.*—Surditas, κωφωσις, in which the faculty of hearing articulated sounds is completely annihilated.

2. *Hardness*, or difficulty of hearing.—Dysœcia, Δυσήκοος, in which this faculty is so diminished, that articulated sounds cannot be heard without the assistance of a particular apparatus.

3. *Alteration*, or *diminution* of hearing.—Paracusis, Παρακουψ, in which the faculty of hearing articulated sounds in the natural way, is imperfect for want of precision.

There have been several other subdivisions; but these are sufficiently minute for all practical purposes. There is, however, a disease, yet to be mentioned, which has been called *Hyperacusis*, υπερακουψ, or *exaltation* of hearing. It is a very rare affection, and is usually a symptom of disease of the brain, indicating an increased sensibility; it is met with also in cases of high hysteria, hypochondriasis, phrenitis, and mania. In these cases, besides paying attention

[6] For a case of fever of nine weeks' duration, accompanied with deafness, attended, during the last six weeks before death, with a copious fetid discharge from both ears, see Trans. King's and Queen's Coll. Phys. Ireland, vol. ii. p. 299.

to the *head* symptoms, wool may be placed in the ear, to diminish the intensity of vibration; and it is very probable that belladonna, which exerts so powerful an influence in cases of tinnitus, may prove beneficial in this disease.

The treatment of deafness, dependent upon affections of the acoustic nerve, has been avoided by most writers on the diseases of the ear; I, therefore, could not presume to give any but very general directions upon this head.

If the deafness arise from any organic disease of the acoustic nerve, or from tumours compressing it, at its origin, or during its passage, nothing can be done.

If arising after apoplexy, deafness sometimes is permanent, but many cases have occurred where the hearing has been completely regained. The treatment adopted for the prevention of subsequent attacks of apoplexy, will be the most proper for the local congestion, which has been found to exist in persons who have died under such circumstances. It would be advisable also to apply leeches for several successive periods, around the mastoid process.

Case.—In December, 1838, a patient, while in the Royal Infirmary, Edinburgh, with paralysis, was seized with an attack of apoplexy, for which the antiphlogistic treatment was successfully prescribed. This man remained quite deaf with one ear for upwards of a fortnight after the apoplectic attack, when he very gradually began to regain his hearing. At the expiration of a month he left the Infirmary, his hearing with the affected ear being still imperfect.

Deafness sometimes remains after convulsions in children, induced by the irritation of teething, or by worms in the alimentary canal. The cause of irrita-

tion having been removed, gentle aperients, with alterative doses of a mild mercurial, and the application of one or two leeches behind the ear, will generally remove this affection.

In cases of congestion, caused by suppressed discharges, whether natural or habitual, as suppression of the catamenia, or periodical or continued hemorrhoids, the insensibility of the acoustic nerve is generally accompanied with headache, languor, giddiness, tinnitus, sometimes momentary insensibility, and not unusually a numbness of the external ear, together with other parts supplied by the fifth nerve, probably the consequence of pressure upon the origin of the trigeminus, or perhaps of congestion of the neurilema itself. The treatment in these cases is at once obvious—to restore the discharges, or, failing in this, to substitute an artificial discharge, its utility being well shown in the Case, p. 210.

A moderate but *continued* action upon the bowels should be regularly maintained, and an issue should be established. It was in such cases that Mr. Saunders benefited patients labouring under deafness, by repeated doses of calomel and sulphate of magnesia, and the constant application of blisters. Some have preferred placing counter-irritants at a distance from the ear, hoping thereby to divert the local arterial action; while others invariably place them in the immediate neighbourhood of the affected part. It is impossible to lay down any general rules for the treatment; and hence the necessity of a regularly educated practitioner undertaking the charge of diseases of the ear, which are always more or less connected with other derangements of the system.

In some cases it may be necessary to abstract a

large quantity of blood, which will alone relieve the patient; and a similar practice on another person might be attended with bad, if not with dangerous, consequences.

The symptoms previously described sometimes occur from the sudden recession of the exanthemata, and the retrocession of gout; in such cases the object would of course be, to cause determination of blood to the surface generally, by the various modes of treatment laid down in all elementary works. When produced by the depressing passions, or existing in persons whose whole nervous system is deranged, the treatment must at first be general, the object being to establish the general health. It is in these cases, when the strength is improving, that the employment of strychnia by the endermic method will be found so successful. Galvanism may also be tried, as it has been of decided advantage in some cases. [See pp. 245, 8.] It is also a good plan, first suggested by Itard, to enclose a piece of camphor in fine cambric, and introduce it into the meatus; this being repeated as soon as the camphor has evaporated. It is by no means rare in these cases to have relaxed tonsils, and the employment of stimulating gargles will be doubly advantageous. Gargles, and especially the injection of water into the Eustachian tube, are much neglected; and I feel convinced that were they more frequently employed, especially after cases of scarlet fever, that deafness would not be of so frequent an occurrence.

Moxas are not now generally employed in Great Britain, and, so far as my observation has extended, I must confess, that I have never seen a greater degree of benefit derived from them, than is usually produced by blisters; and the terror and pain caused by the former,

would require a very decided superiority, to induce us to substitute it for the latter, more gentle, but perhaps not less certain in its good effects. In whatever way artificial wounds are established, whether by seton, issue, or moxa, the intention is the same.

*Morbid alterations in structure, and congenital malformations.*—In examining the ears of persons who have laboured under deafness, various parts have been found as the seat of disease.

The lining membrane and even the bony part of the meatus externus and the membrana tympani, may be absorbed; or the Eustachian tube wanting or obliterated; the tympanum, mastoid cells, and labyrinth, may be more or less destroyed by caries. The whole of the ossicula are sometimes lost; the tympanum, and even the labyrinth, filled with granulations or depositions varying as to consistency. The membranes of both fenestræ, either ulcerated or thickened, shrivelled and hardened, and sometimes converted into bone; the diameter of the bony foramina themselves occasionally found enlarged.

Scarpa considers the membrane of the fenestra rotunda (cochleæ) to act the same part to the cochlea, as the membrana tympani does to the tympanum; and states, that this window diminishes in diameter and even becomes obliterated in old age.[7] I believe Cotunnius also found the fenestra rotunda obliterated; and M. Lobstein has seen it exceedingly small. The stapes has been observed firmly united to the fenestra vestibuli;[8] it has also been seen without

[7] See Obs. Anat. de Struct. Fenest. Rotund. 1772. [8] Valsalva.

its crural branches, being composed of one column, resembling the columella in birds. The whole of the ossicula have been found anchylosed,[9] the malleus incus[1] and stapes have each been wanting, and sometimes all have been absent in the same subject.[2] The handle of the malleus has been found broken off;[3] the ossicula have been seen only one-third their normal size, and also twice as large as usual.[4]

The whole or part of the petrous portion may be denuded; matter sometimes being found between the bone and dura mater, or between the dura mater and brain, and also in the brain itself. Sir Charles Bell has found in a man who had been deaf many years, and who was killed by a fracture of the skull, the cells of the temporal bones filled with matter, and a thin greenish fluid lay betwixt the temporal bone and the dura mater. He has since found caries of the petrous portion from this cause fatal.[5] Itard has mentioned several such cases. The brain and membranes are sometimes of a yellow colour in the neighbourhood of the petrous portion.

Tumours may have pressed upon the origin of the acoustic nerve, or throughout some part of its course, or the nerve may itself have been lost in the general mass of disease.

Case.—A case is related in the Sepulchretum, of a steatomatous tumour being developed betwixt the cerebrum and

9 Ruysch.

1 Mersanni. Bonet. Sepulch. tom. i. sect. 19.; and Epist. ad Haller tom. vi. p. 142.

2 Dict. des Sciences Méd. tom. xxxviii. p. 114.

3 Ribes. Dict. des Sciences Med. vol. xxxviii p. 30.

4 Cotunnius.

5 Bell's Anatomy, vol. iii. p. 162.

cerebellum, by which, first the optic nerves were compressed, and amaurosis produced; then the auditory nerve was subjected to compression, from which deafness resulted, and ultimately the patient died from the progressively-extended pressure. Sir Charles Bell says, "I have, however, observed, that a tumour in the vicinity of the origin of the auditory nerve, though it ran its course so as to prove fatal, had rather a contrary effect on the organ of hearing; and while the pupil of the eye remained stationary, and the man saw indistinctly, he had a morbid acuteness of hearing. This had probably been produced by the surrounding inflammation having extended to the origins of the auditory nerves."[5]

Duverney and Sandifort have found it compressed by steatomatous tumours. In a man who died of apoplexy, Drelincourt found between the brain and cerebellum a steatoma; which first caused blindness, then deafness, and finally a deprivation of all the animal functions.[6] In the University of Edinburgh is a preparation where a large tumour compressed the portio dura and portio mollis. A considerable portion of the petrous bone has been absorbed. The patient was deaf, and suffered also from paralysis of those muscles supplied by the portio dura. Dr. Alison has another preparation, where a clot of blood was extravasated near the tuber annulare, compressing the portio dura, and perhaps the acoustic nerve. In this case there was also complete deafness. The acoustic nerve has been found in a state of atrophy,[7] which is usually the *effect*, and not the cause, of

[5] Bell's Anatomy, vol. iii. p. 182.

[6] Dict. des Sciences Méd. tom. xxxviii. p. 118.

[7] In a dog, blind and deaf of the right side, the optic and acoustic nerves of the same side were yellow and wasted.—*Hoffman de Auditu Difficile.* Also Itard, tom. i. p. 393.

deafness; it has also been seen discoloured, and of a preternatural hardness. Professor Rosenthal has seen a case in which the auditory nerve was of so solid a texture, that it surpassed even the facial nerve in hardness. Arneman has mentioned the same circumstance. It has also been observed as soft as mucus in a patient who died deaf with fever.[8]

I think it unnecessary to enter more into detail, but several other morbid alterations have been observed in various cases mentioned in previous pages. The aqua labyrinthi has been found altogether wanting, this having been observed in old people; it appears also to vary as to its density.

Case.—There came into the infirmary of the Salpetrière, an aged female of 82 years; who had been so extremely deaf as to be insensible to the noise of a trumpet at her ear. She died, and M. Pinel examined the organ of hearing with great care. The membrana tympani, as compared with that of a person of the same age, but who had not been deaf, presented nothing particular; nor did the ossicula auditûs. On examining the labyrinth and semicircular canals, no traces of a fluid could be found. This phenomenon led M. Pinel to look further into the subject. On examining a number of persons whose hearing had been good before death, he invariably found the cochlea and semicircular canals filled with fluid. Some time afterwards, a female who had been deaf for thirty years, particularly of the left ear, died, and was examined by our author. The membrana tympani appeared sound externally, but on opening it, the cavity of the tympanum was found to contain purulent matter, the ossicula auditûs were partially carious, the membrane lining the cavity of the tympanum was red and inflamed, the cochlea and semicircular canals presented a similar state of inflammation, and the fenestra rotunda was

[8] Itard, tom. ii. p. 406.

eroded and open; here it was evident that the deafness was occasioned by the chronic inflammation and its consequences of the interior of the ear.

The same day M. Pinel had an opportunity of examining the internal ear of a female, 84 years of age, who was partially deaf, or, in plainer terms, "hard of hearing." In this case, the only thing remarkable was the paucity of fluid in the cochlea and semicircular canals. In another person who was deaf of the right ear, and who died scorbutic, our author found nothing particular in the interior of the left ear; while the lining membrane of the defective ear, was discovered to be thickened, opaque, and not a trace of fluid in the parts before mentioned.[9]

The internal ear has been found gorged with blood in cases of apoplexy and of severe blows in the head.

In cases of *congenital deafness* several important alterations in the structure of the ear have been observed, more especially in the most essential parts of the ear; occasionally, however, there has been no appreciable variation.

Sometimes there is an almost entire absence of the ear, not even the external auditory canal being present; and in a remarkable instance mentioned by Meckel, the whole of the labyrinth was wanting.

Case.—An infant of the Charité de Lyons, born deaf, was capable of babbling a few syllables, although not sensible of even the loudest noises. This child died of fever, and on inspection the external ear was well formed, and the membrana tympani was in its natural condition; the cavity of the tympanum was filled with a mucilaginous matter; there were no traces of the ossicula. The Eustachian tube was natural. There was a complete absence of the immediate organ of hearing; that is to say, of the vestibule, the cochlea

[9] Med. Chir. Rev. vol. vii. p. 299. See also Itard, tom. i. p. 395.

and the semicircular canals. There were no traces of the fenestræ vestibuli et cochleæ.[1]

The acoustic nerve has been found unusually small, not being of more than half its natural size. Sylvius found it remarkably atrophied, Ackermann indurated, and Morgagni entirely wanting.[2]

Case.—A gentleman who had been deaf and dumb from birth, died about the age of thirty. On inspection, the portio dura was natural, but the portio mollis was not more than half its natural size. The meatus, membrana tympani, ossicula, and Eustachian tube, were perfect; but the whole cause of deafness was found in the labyrinth. This part of the organ, consisting of the vestibulum, cochlea, and semicircular canals, was perfectly formed; but, instead of containing water, was filled with a solid caseous substance. These were the only preternatural appearances.[3]

The impression of vibration has been completely prevented from reaching the acoustic nerve, by the tympanum, vestibule, canals, and cochlea, being completely filled with caseous matter. Mr. Cline examined the head of a young man who had died of fever, and who had been born deaf, and was consequently dumb; and found, upon dissecting the organs of hearing, all the parts perfectly formed, and as usual in a healthy ear, except the vestibule, cochlea, and semicircular canals; these were filled with a substance of the consistence of cheese, instead of the fluid which they usually contain. All impression upon the auditory nerve was completely prevented.

For examining the parts contained within the pe-

[1] Dict. des Sciences Méd. tom. xxxviii.

[2] See Copeland's Med. Dict.

[3] Lond. Med. Society's Memoirs, vol. iii. p. 1. See Hoffman de Auditu Difficile.

trous portion, it has been recommended to divide the bony walls with knife and hammer; inasmuch as when a saw is used, the bone dust mixing with the aqua labyrinth, may give rise to the appearance of scrofulous deposit: I believe this was first pointed out by Mr. Thurnham.

The different parts of the labyrinth are often found to be more or less wanting; thus the cochlea has been found to consist of only one turn and a half,[4] and very remarkable deviations have been observed in the canals. The first person who noticed any alteration in the formation of the canals was Valsalva, who found one of the canals on each side tortuous, but he has made no mention of its having been impervious. It would appear that persons *congenitally* deaf and dumb have *both* organs of hearing more or less impaired; and I am not aware of a single exception, where any deviation was detected on one side, but that it existed to a greater or less degree upon the other. Imperfection in the formation of the semicircular canals, seems to be the most frequent cause of congenital deafness, and was, I believe, first *distinctly* discovered by a Swedish physician.

Case.—A deaf and dumb boy, eleven years old, who had for a long time past laboured under scrofulous ophthalmia, was seized with an affection of the lungs, from the effects of which he soon expired. On opening the body, the lungs were found in a state of suppuration, the brain was healthy, as was also the portio mollis, (nervus acousticus.) The temporal bones were carefully removed and submitted to an accurate examination. One was quite sound, and in the other the bones of the ear were found in their natural state, excepting the stapes, which was cut through on dividing the

[4] Med. and Phys. Journal, vol. xliii. p. 519.

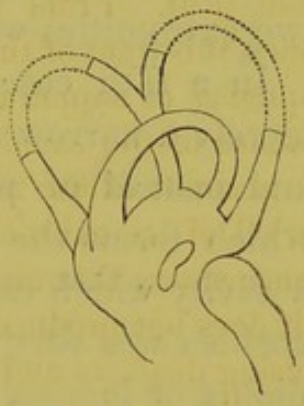
bones; the tympanum, vestibule, and cochlea, were quite sound; but no traces of the semicircular canals were to be discovered; the space usually occupied by them was filled with a cellular or parenchymatous substance, the cells of which were smaller than those of the mastoid process, and had no connexion with each other. The entrances to the canals were to be seen, but they all ended in blind sacs. From the statement of the mother, it appeared that the deceased child could hear very well till the second year, but at this period it was attacked with a violent fever, and became quite deaf. From the healthy state of the surrounding bones, this want of the canals could not be viewed as the consequence of suppuration, or of caries. But although the absence of the canals must be regarded as hereditary, still the account of the mother, that the child could hear at one period of its existence, admits of being explained. Experience shows that an important defect in the hearing, even if it does not produce complete deafness, is still capable of causing deafness and dumbness. Children may thus be prevented from comprehending articulated sounds, and giving utterance to them, but still hear very well every sound and noise; and thus it is very difficult to determine, up to the second year, whether the hearing in children be perfect.

Although several instances are on record, of the semicircular canals being wanting, still, according to the author, this is the only case where the absence of these canals has been found without disorganization of any other part of the ear.[5]

This subject has recently been more clearly and fully elucidated by Mr. Edward Cock, who has published an account of the morbid appearances of several valuable cases of congenital deafness.

[5] See Lancet, p. 40. Oct. 14, 1826. De Causis Cophoseos surdo-mutorum indagatu difficilibus connectatio brevis, quam pro Stipendio Collegii Medicœi exaratam defendere studebit.—F. C. Murer. Hafniæ. 1825. Cum tabulo lithograph. pp. 26.

These cases having been examined with so much accuracy, by so minute, so exact, and so faithful an anatomist, and forming, as they do, a more complete series of investigations, than has ever before been made by either British or continental anatomists, render them of the highest importance to the pathologist. I shall therefore take the liberty of extracting some of the more remarkable malformations and morbid appearances.



In the first case was found a deficiency of the semicircular canals; the extremities of these tubes opening into the vestibule were perfect, but the central portions were wanting. The vertical and oblique semicircular canals were both impervious at their central portions. The defective portions of the canals are traced out with dotted lines. In this case the ear of one side only was examined.

In the second case both ears were examined. On the right side the middle portions of the oblique and vertical canals were wanting. On the left side, the horizontal and vertical canals exhibited a similar imperfection. The scala tympani likewise was terminated at its larger extremity by a bony septum, which separated it from the tympanum, and occupied the situation of the membrane of the fenestra rotunda.

In a case dissected by Mr. Dalrymple, the aquæduct of the vestibule was so large as to admit the passage

of a small probe, whereas, in the natural state, a fine hair can with difficulty be introduced into the canal.[6] In another case Mr. Cock found no vestige of the fenestra rotunda on either side, the usual situation of the membrane being completely filled up with solid bone; the Eustachian tubes were remarkably large. On one side, the aquæduct of the vestibule readily allowed the passage of a large bristle; on the other side, the canal could not be traced through the bone, although its two extremities were more than usually expanded.

In a fifth case, the meatus auditivus internus was merely a narrow slit, and the portio mollis was pulpy, and instead of passing through the cribriform plate, which forms the base of the modiolus, it entered into a cavity which communicated with the vestibule. The cochlea was very imperfect, there being no scalæ, modiolus, or lamina spiralis. The anterior opening of the vertical canal was alone present, completing only half its course; there were no horizontal or oblique canals. The aquæductus vestibuli was wanting. On the right side, a similar appearance was observed; the fenestra rotunda could hardly be said to exist; the aquæductus vestibuli was large enough to admit a small probe.

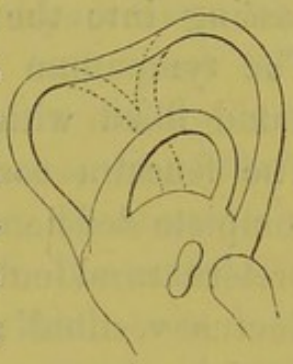
In the sixth case there was no cochlea.

In the eighth case, Mr. Cock found, on the right side, that the scala tympani, when traced from the fenestra rotunda, took half a turn round the modiolus, and terminated in a blind extremity. The scala vestibuli made a third of a turn, and opened into a cavity forming the rest of the cochlea, the base of the cochlea being alone perfect. The petrous bone seemed like an

[6] Med. Chirug. Trans. vol. xix. London.

extension of mastoid cells, which were filled with muco-purulent fluid.

On the left side, the vestibule had only four openings for the semicircular canals instead of five; that which is common to the posterior extremity of the vertical and the superior extremity of the oblique, being deficient. On tracing the vertical canal from its anterior opening it was found to terminate, not by returning to the vestibule, but by becoming continuous with the upper part of the oblique canal, which latter opened below as usual. The cochlea was much the same as on the right side.[7]



A somewhat similar malformation of the semicircular canals has been described by Mr. Thurnham, who, on examining the ears of a boy aged thirteen years, who had been the subject of congenital deafness, found the horizontal semicircular canal of the right side imperfect, in about the outer third of its extent; there were no traces of sacculus nor utriculus vestibuli, nor of membranous semicircular canals. In the left side no utricle nor sacculus was met with; there were, however, very minute gelatiniform membranous semicircular canals. The osseous semicircular canals were complete on this side.[8]

By an analysis of eleven cases dissected by Mr. Cock, it will be seen that the subjects examined all died with strumous diseases. The petrous portions were generally malformed, sometimes the bone being

[7] For full account of these interesting particulars, see Guy's Hospital Reports, No. 7. Oct. 1838.

[8] See p. 197, Med. Chirug. Rev. 1836.

so deficient as to barely cover the internal cavities, whilst in others there was a preternatural osseous development; vascular granulations more or less completely obliterating the cavity of the tympanum, enveloping the ossicula auditûs, and sometimes penetrating the mastoid cells, Eustachian tube, and even passing into the labyrinth by the fenestra cochleæ. The tympanum and mastoid cells were occasionally found filled with thick tenacious or caseous matter. The fenestra cochleæ filled up by bone; partial or complete deficiency of the spiral canals of the cochlea, preternatural enlargement or absence of the aquæductus vestibuli; a greater or less deficiency of the semicircular canals. The auditory nerve, although frequently healthy, was occasionlly harder and smaller than natural.

I shall rest content with having merely mentioned these very interesting facts, without attempting to account for the causes of the deafness, and for full particulars must refer to the papers written by Mr. Edward Cock. It is only recently that this important subject has been properly investigated, and although in a *few* instances of congenital deafness no appreciable malformation has been detected, yet in most, remarkable deviations have been found, which I believe *have never been observed, except in those who have laboured under congenital deafness.*

## DEAF DUMBNESS.

Deafness from birth, and consequently dumbness, is much more frequent than is generally supposed. In Eastern courts it has been usual from time immemorial

to retain a number of mutes. These are not only employed to amuse the Monarch, but also to instruct his pages in an art to us little known, of communicating everything by signs, lest the sound of their voices should disturb the sovereign. The mutes are also the secret instruments of his private vengeance.[9]

In Great Britain, in 1830, the total population was 21,000,000. The number of deaf and dumb was 13,650. In England there are only eleven institutions set apart for their reception![1] In Russia, where there are more than 28,000 deaf and dumb, there are only two institutions.[2] In the Duchy of Brunswick, in 1835, the proportion of deaf and dumb was 1 in 2,026, being 125 in number, of whom 60 were males, and 65 females. In Prussia the proportion of deaf and dumb is 1 in 1,426.[3]

The number of deaf and dumb for all Europe is as high as 1 in 1,537 and of these not above one in twenty-four have the means of instruction.[4] In France one in four possess the necessary tuition.[5]

It has been calculated that in every million of souls in the German empire, one hundred are deaf and

9 Edinb. Med. Journal. vol. vii. p. 61.

1 In the year 1818, thirty-six men were discharged from the army, being incapacitated by deafness. See Mr. Marshall on Enlisting, &c.

2 For full statistical account, see an extract from the Gazette Médicale, p. 83. Lond. Med. and Surg. Journ. vol. v.

3 For further particulars, see Forbes and Connolly's Rev. vol. iii. p. 255.

4 For an article upon the comparative view of the Foreign and British institutions for the deaf and dumb, see Quarterly Journ. of Foreign Med. vol. i. p. 314.

5 Medical Gazette, vol. xii. p. 263.

dumb; of these only thirty in every hundred are supposed to be capable of being taught, the rest being too young, too old, or too much diseased in other parts, besides the organ of hearing. Boys born deaf, are said to be more numerous than girls. The director of the school at Vienna (Mr. May) stated this difference to be in the proportion of four to one.[6] This seems opposed to general experience, and I do not think any inference can be drawn from such a statement; as the report was taken from the numbers of a *school*, and not of a particular *tract* of country. It is completely nullified by the *exact* statistical account of the deaf and dumb in the duchy of Brunswick. [See p. 229.]

We must not regard all cases of the deaf and dumb as congenital, inasmuch as they may have been deprived of the sense of hearing, during very early childhood, either by accident, fever, measles, &c., and deafness frequently arises during dentition.

It is not uncommon for persons in the same family to be born deaf, but they are always of the same sex. Kramer mentions the circumstance of healthy parents having five daughters and six sons. The sons were all born deaf, and the daughters without exception heard perfectly well.[7] A physician resident at Marseilles, knew a family consisting of six children; the first was born deaf, the second heard perfectly; the

[6] Edinb. Med. Journal, vol. vii. p. 63.

[7] Bennett's Translation, Lond. 1837. p. 295.

It is a curious fact, that white cats with blue eyes are said to be always deaf, and that should the mother produce a litter of kittens, and any of them have a single speck of colour on their fur, they as invariably possess the usual faculty of hearing, but if perfectly white they are then invariably deaf.—See Magazine of Natural Hist. No. 2.

third was born deaf, and so on alternately. The father and mother both enjoyed perfect hearing.[8]

Instances are known of deaf and dumb persons marrying and having children possessing their senses quite perfect. Deafness is *said* to be hereditary, but I have not been able to find a single case mentioned, of deaf and dumb parents producing deaf and dumb children, but several instances are known, of one and even both parents being dumb, and producing healthy children, who have had their senses unimpaired.

Although persons born deaf and dumb often have their nervous sensibility much impaired, yet instances are not wanting of considerable intelligence, quickness, tact, and ingenuity being present. Intelligent deaf and dumb persons have sometimes supplied the want of hearing by observing, and in the dark feeling, the motion of the lips; and have even carried on a conversation by merely placing their hands upon the chest of the person addressing them. They have been known to play on musical instruments, by having some part of the sounding body in connexion with the teeth.

Cases.—A deaf and dumb girl occupied in sewing in a room near the street-door of the house, always gave notice when any one opened or shut this door. A bell was attached to it, that on every motion, made sufficient noise to be heard distinctly in the next room; but as, with the exception of this noise, no shock or agitation could be perceived, the phenomenon appeared to Pfingster somewhat surprising. Wishing to know what the girl really experienced, he rang the bell loudly without opening the door; she did not seem to perceive anything. He then had the bell made silent, whilst a person very cautiously opened and shut the door, which

[8] Dict. des Sciences Méd. t. xxxviii. p. 39.

was done so gently, that he himself did not perceive it; but the little girl immediately gave notice that some one had come in. On reflecting on these circumstances, he was led to consider, that the chair on which she sate, communicated to her body, a certain agitation which made her conscious of the motions of the door.

Another deaf person possessed the sense of touch in a still more delicate degree. This, a little girl, lay in the same chamber with the servant of the house, with whom she had every evening long conversations about her toilette or other subjects, after the lights were extinguished. She lay on her side, and placed her hands on the chest of the servant, who lay on her back; and thus was enabled to discern the discourse of the latter. Pfingster, desirous to see himself this singular mode of intercourse, persuaded the two girls to engage in conversation in his presence; and he perceived that, when the deaf girl had placed her hands on the breast of the other, she could repeat correctly almost all the words the latter had pronounced.[9]

Bishop Burnet, in speaking of a deaf and dumb girl, says, she can hold conversation whole days, with those that can speak her own language. I could understand some of her words, but could not understand a period, for it seemed to be but a confused noise. She knows nothing that is said to her, unless she seeth the motion of their mouths that speak to her, so that in the night, when it is necessary to speak to her, they must light a candle. Only one thing appeared the strangest part of the whole narration. She hath a sister with whom she hath practised her language more than with any other: and in the night, by laying her hand on her sister's mouth, she can perceive by that, what she saith, and so can discourse with her in the night.[1]

[9] See Med. and Phys. Journal. vol. xliii. p. 519. Pfingster, Vieljachrige erfahrung ueber die Gehoerfehlier der Saubstummer. Kiel. 1802. p. 32.

[1] Derham's Physico-Theol. ninth ed. 1737. p. 114.

Itard mentions the case of a Spaniard who, at the termination of an acute illness, became deaf by the obstruction of the Eustachian tube; and who heard the tones of a guitar with much pleasure, when its handle was placed in the mouth. So also the piano has been played and heard, by forming a connexion between it and the teeth.

Persons entirely deaf are sensible of the *thrill* or vibration produced by a powerful organ; which impression is doubtless received through the nerves of touch, bearing an analogy to the way in which insects, and perhaps even fishes, become sensible of external vibratory undulations. It has been before mentioned, that the nerves supplying the ears of some fishes, are not special nerves of hearing, but branches of the fifth. [See p. 56.] All persons must be aware of the peculiar external sensation produced by the organ, the vibratory undulations being felt by every part of the body, more especially when in contact with solid substances.

I may here perhaps mention, that I think it possible that the defective formation of the internal ear, so frequently observed in cases of congenital deafness, may be the consequence of violent, grating, or peculiarly disagreeable sounds, impressing the mother during the early months of gestation; if such were really the case, it would strengthen the opinion previously advanced, that different parts of the labyrinth were intended to appreciate particular sounds.

Thus accounting for congenital deafness may at first sight appear very improbable, but will cease to be so, when we consider that different portions of the body are altered in form, and sometimes even are altogether wanting, in consequence of painful impres-

sions made upon the mother during the early months of pregnancy. Without multiplying facts, how often has a woman, so circumstanced, been horrified on beholding a revolting malformation of the limbs, of the external ears, or of the face, and her infant, when born, has exhibited almost the exact representation of the painful image, which had so inopportunely presented itself.

A distinction ought to be drawn between cases of congenital deafness and those which have arisen subsequently to dentition; as in the former, although not necessarily, yet generally there is an alteration of structure,—a malformation; whereas, in the latter, it may be dependent upon a want of tone or power of the acoustic nerve. Of course, if the internal ear be destroyed by caries, which is sometimes the case in very early life, there can be no hopes of ever restoring the power of hearing.

There are four ways of communicating instruction to the deaf and dumb: by *writing*, *manual speech*, or *dactylology*, *vocal speech*, and the *explanation* of the *meaning* of *words*.[2]

In France, a man who it was subsequently proved feigned deaf dumbness, when upon his trial for some offence, was requested to put in his statement in writing; in which he declared he had been deaf and dumb from birth, but had received his education in some public institution. An intelligent instructor of the deaf and dumb was summoned, who negatived the man's assertion, by affirming that had he received his

[2] See Instruction of the Deaf and Dumb. Watson, London. 8vo. 1809. Sicard, Cours d'Instruction d'un sourd muet de naissance, 8vo. Paris, 1813. 2nd ed. Encyclop. Méthodique.—Arts et Metiers, tom. v. 4to. Paris, 1788.—Sourds Muets.

education in a deaf and dumb asylum, he would have spelt by *sight*, and not by *ear*, several of his words having, unfortunately for himself, been mis-spelt. The man was found guilty.[3]

In a deaf and dumb establishment, a selection ought to be made, of those requiring to be taught to articulate, and others who are to receive symbolical education. The comparative advantages of symbolical or articulate language, declares itself decidedly in favour of the latter; for, generally speaking, an individual deaf and dumb, can only converse with his immediate relations or instructors, when he depends upon his fingers, because few other persons are acquainted with the necessary signs: whereas, could such a person talk even imperfectly, yet the circumstances are numerous in which he might be placed, where this articulate language might be of the greatest utility.

It is not in my power here to say anything respecting language, but shall merely pass by with observing that each articulate word is a different modification of sound. The origin of language has been attributed to Divinity; and the variety of tongues has been considered as the effect of the confusion of Babel. We know that various nations speak different languages, and that even various counties have their peculiar dialects; and that these differences are so great in some parts, as to be almost unintelligible to persons inhabiting the same country. The language now spoken is very different to that used a hundred years since; words are constantly changed, and, as new ob-

[3] I have quoted this from memory, having forgotten exactly where I received the information; but in the main point of the case, I am sure I am correct.

jects present themselves, ingenuity is set to work to find new names. Some have supposed language to be an imitation of the various natural and artificial sounds; and this is seen exemplified to the present day in savage life. Thus, the Otaheitans called a gun, a *tik*, *tik-bou*, imitating the cocking and report of the object; and voyagers have described many similar instances.[4]

Music is universally allowed to be artificial; of which there cannot be the least doubt. It is difficult to say to what extent animals or birds are capable of communicating their ideas to each other: that they possess such a power, no one can doubt, as is proved by a hen-turkey calling her young ones by the particular note *koe-ut*, when danger is near, as when a hawk is in the air: the young ones immediately hide themselves; and whenever they subsequently hear the note *koe-ut*, be danger near or no, they immediately run to a place of protection. The sentinels of rabbits, to warn the warren of danger, thump their paws violently upon the ground. A hen, with her various *clucks*, trains her young,—they perfectly understanding her various notes, whether of satisfaction, fear, or displeasure; and, upon the advance of any danger, a particular note from the hen, brings the chickens instantly around her: nor does it seem that this power of communication is confined to her own species, inasmuch as she is just as capable of educating ducklings. Some have supposed that the singing of birds is acquired, and have instanced, as their proofs, that a nightingale, brought from Italy, and placed in Scot-

[4] There is an elaborate article upon this subject, in the American Phil. Trans., vol. iii.

land, ceases to sing; and, again, if a nightingale be hatched under any other bird, it never possesses the power of singing. Persons wishing to educate singing birds, take care to have a bird with a good note for the instructor. The barking of dogs is thought to be artificial; for those first discovered at Juan Fernandez never barked at strangers; but when they became acquainted with European dogs, they soon learnt their habits.

I cannot treat of the various sounds entering into the English language, but suffice it to say, that they are *twenty-six* in number; of which twenty-one are *laryngeal*, and five *oral*. The former are extremely diversified in their *expression*, dependent upon the various movements of the fauces and mouth, while the sound is passing out from the larynx; the latter are formed in the mouth, and are not susceptible of the slightest variety of tone.

Although there are so many more cases of deaf and dumb than is usually believed, yet absolute deafness is more rare than is generally credited. M. Itard allows one-fifth of those presented to him as deaf, to be so. Kramer states, that out of 300 deaf persons, 104 were found to be incurable; being about the proportion of one to three; 188 were completely cured or relieved; 8 only, under treatment, were not benefited; 140 were cases of erethitic nervous deafness, of which 14 had been already electrified when they were submitted to his care: all appeared to have been made worse by it, though at first it seemed occasionally as though the electrical treatment would improve their condition;—in all, the erethismus and tinnitus were increased.

It seems well established that, by paying great

attention, a deaf and dumb person, if educated while young, may be taught to speak very tolerably; quite sufficiently to be well understood; and I imagine the best plan is, that the dumb child should be educated with children of his own age, and should constantly watch the movements of their mouths, when naming particular objects, and should be made to imitate these motions *immediately*. And, in order to render this more easy, a mirror should be suspended before the dumb child, in order that, by placing his own mouth in the same positions as his infant instructor had previously done, the chances of failure might be less. In Trezel's case, M. Magendie says, "Perhaps he would never have overcome this difficulty, if recourse had been merely had to his organs of hearing; but an appeal was likewise made to his sight.[5] In order that this plan should be fully carried out, the child must not be taught, nor even allowed to make, any signs; but must always endeavour to ask for each individual necessity.[6] It is most essential that the pupil be treated with the greatest kindness and encouragement.

The first person who taught the dumb to speak, was a Spanish Benedictine monk, of the convent of Sahagun, in Spain, who died in 1584,[7] and upon whom the following epigram was written: "Petrus Pontius, Mo-

[5] Edinb. Journal, vol. i. p. 358. See also p. 241. For an account of teaching deaf and dumb to speak, see Phil. Trans. vol. v. p. 1087, (No. 61,) by John Wallis.

[6] For some remarks on the importance of exercising the facial muscles and nerves in cases of deafness, see Joseph Swan, on the Physiology of the Ear.

[7] Gall and Spurzheim. Préface, p. 38. Anat. et Physiologie du systéme nerveux en général. Paris, 1810.

nachus Sancti Benedicti, amicus meus, qui, res mirabilis! natos surdos docebat loqui."[8]

Juan Pabbo Bonnet also appears among the first who undertook the art of instructing the deaf and dumb.[9]

Speaking instruments, such as might be used by the deaf and dumb, have been invented, but have only partially succeeded. Kratzenstein and De Kempelen seem to have been among the first to construct such machines, which may more correctly be called vowel pipes. One of the professors at Cambridge has recently made some improvements upon their invention.

The Abbé Mical, a celebrated French mechanician, constructed two collossal brazen heads, which are said to have uttered not only words, but entire phrases. He submitted these masterpieces of his ingenuity to the Academy of Sciences, in July 1783; but being disappointed of the reward, which, on the recommendation of the Academy, he had expected from the Government, he broke them to pieces.

From *habit*, medical men think that because an unfortunate being is born deaf, that therefore he must necessarily be dumb, and be incapable of exercising the laryngeal muscles; but this does not appear to be the fact, inasmuch as even the congenitally deaf and dumb have been taught to speak, so as to be able

[8] De Sacra Philosophia. Valles, 1588. See an exceedingly interesting article in the Edinb. Encyclopædia. See an interesting paper on the Elements of Written Languages, with an Essay on the Mode of Teaching the Deaf and Dumb.—*Amer. Phil. Trans.* vol. iii. p. 262.

[9] Redution de las lettras y arte para ensennar a ablas los Mutos. En Madrid, par Francesco Abarca de Angulo, 1620. 4to.

to enter into conversation; of which the facts are exceedingly numerous.

A cure ought *always* to be attempted, and that at the earliest moment at which deafness is detected; and children so affected should mix with others *not* deaf, and no symbolical education should take place until all chances of cure are gone. Just as the difficulty is greater in teaching a strange language to an old than to a younger person, so also is the difficulty proportionate to the age, in educating the deaf and dumb. If such patients do not improve in hearing before puberty, there is very little chance afterwards; but still, if capable of distinguishing the slightest sound, they should be subjected to a systematic exercise, to enable them to compare different sounds; for it is not unreasonable to suppose that the ear is as capable of being improved by exercise, as are other organs or impaired functions of the body; thus we find in blind persons, that the sense of hearing becomes exceedingly accurate and acute, as is particularly exemplified in the following case, mentioned by Darwin, in his Zoonomia. "The late blind Justice Fielding walked for the first time into my room, when he once visited me, and, after a few words, said, 'This room is about twenty-two feet long, eighteen wide, and twelve high;' all which he guessed by the ear with great accuracy."

This was the idea which first led M. Itard, now more than twenty years ago, to try on twelve deaf and dumb persons a series of exercises and experiments, the result of which was, to restore, without operation or treatment, six of them to speech and hearing.

"M. Itard had recourse at first to the most penetrating sounds, to stimulate the sense of hearing: he

accomplished this by striking on a large bell, which he had suspended in the room; he diminished every day the intensity of the sound, either by removing the patient farther from the bell, or by striking it less powerfully. When he perceived that the hearing was becoming dull again, he suddenly roused it by one or two very powerful sounds; and, passing immediately to weaker, had the satisfaction to find his patients as sensible to them as they had been before. At a later period, in order to keep up the excitability of the organ, M. Itard made the bell vibrate near the patient's ear, and gradually removed it, without rendering the sound more intense. By these means he increased and kept up the susceptibility of perception, till sounds were heard at the distance of twenty-five feet, which could not be perceived at more than ten feet when he began. These experiments were performed in a long, narrow corridor: the patients were placed in a line, and along the wall was marked the point, at which each ceased to hear; thus forming an exact scale or register of their progress.[1]

"His next endeavour was, to make them sensible of a sort of rhythm; he first used a tambour, then a flute, teaching them to judge of their distance, direction, and repetition. They were also taught to distinguish sounds from each other, and to imitate them; in a word, to call the functions of the larynx into operation; and this appears to have been the greatest difficulty."[2]

[1] An acoumêtre has been invented by a German of the name of Wolke; this has been subsequently improved upon by Itard.—*Traité*, &c., t. ii. planche 1, fig. 1.

[2] For more complete account, see Lond. Med. Gazette, vol. ii. p. 139.

It will be unnecessary for me again to mention the treatment of deafness, arising from any of the numerous causes previously described.

It has been proposed by Deleau to force condensed air into the tympanum; and a child who had been deaf and dumb from infancy was restored to hearing by this forcible injection of air into the tympanum through the Eustachian tube.[1]

M. Itard has in this way operated on no less than 120 patients for congenital deafness, from three to ten times each; and, unhappily, this mode of treatment was of no essential benefit in a single instance. He considers the production of pain in the internal ear, consequent upon this injection, a proof that the Eustachian tube is not obstructed. Although no material benefit was derived from the treatment in a single case, yet, in a few, a certain degree of amelioration was procured, while the pain lasted.[2]

This injection, or air douche, sometimes produces inflammation, and even suppuration. This occurred in seven cases to M. Itard. [Even death has occurred *during* its injudicious application,[3] and, in many instances the most alarming symptoms have been produced,[4] even though considerable care may have been taken.] Various gases and æthereal vapours have been injected into the cavity of the tympanum, but, I believe, with no better success than that of air. In Deleau's case, mentioned by Magendie, of the boy

[1] Edinb. Med. Journ., vol. xxv.

[2] Ibid, vol. xxix. p. 425.

[3] Med. Gazette, July 13, 1839.

[4] Med. Gazette, p. 616, July 20, 1839. In the same Journal, Mr. Savage refers to five cases, which have come under his cognizance, where perfect deliquium was caused, remaining for several hours, p. 619.]

Claude Honore Trezel, ten years of age, he was unable to hear the most violent noises, or the loudest explosions. He did not know how to blow his nose. It appears that air was not *alone* injected in this case, but that water was forced into the Eustachian tubes, being, in fact, a repetition of Mr. Wathen's injection. As soon as hearing commenced, he was capable of blowing his nose.

It occasionally happens that hearing occurs spontaneously in persons who have been previously deaf and dumb; and I think it possible that, in these cases, the Eustachian tube may have been impervious; and from some circumstance, such as cold, sub-acute inflammation is set up, and the membrana tympani ulcerates; the same effect being produced by nature, as has been so ingeniously performed by art.

Cases.—The Mémoire de l'Academie des Sciences, of the year 1703, presents an example of this kind, which happened to a young man at Chartres, 24 years old, "who, to the great astonishment of all the town, began speaking all of a sudden. He explained that, three or four months before, he had heard the sound of bells, and had been very much surprised with this new and unknown sensation. There was afterwards a sort of water that passed out of his left ear, and he heard perfectly with both his ears. He continued for three or four months hearing, without saying anything of it, repeating to himself the words that he heard, exercising himself in pronunciation, and in the ideas attached to words. At last he thought himself in a state to break silence, and he maintained that he could speak, though it was still but very imperfectly."[5]

A young man, born at Nantes, deaf and dumb, when

[5] Magendie's Physiol. (Tr. Milligan.) 1831.

28 years of age, had perfectly gained his hearing, and spoke well, although no remedies had been adopted.[6]

I believe the following case of Itard's to have been deafness arising from an obstructed Eustachian tube, somewhat similar to the case mentioned by Sir Astley Cooper, [see p. 204,] and I think that the *perforation of the membrana tympani*, and not the injection, was the cause of cure.

Case.—A young person deaf and dumb from birth, about 15 years of age, was cured of his deafness by Doctor Itard, by means of injections thrown into the tympanum through an opening made in the membrana tympani. The young man heard first the sound of the neighbouring bells; at that instant he felt a very lively emotion; he had even headache, vertigo, and dizziness. The next day he heard the sound of the small bell in the room; twenty days afterwards he could hear the voice of persons speaking. He was then extremely delighted, nor could he be satisfied with hearing people speak. "His eyes," says Professor Percy, "seemed to search for the words, even on our lips." His voice was soon developed; he formed only vague sounds at first: some time afterwards he could stutter some words, but he pronounced them imperfectly, in the manner of children. It was some time before he could pronounce compound words, and those containing a number of consonants. They caused him to hear a *hurdy-gurdy* (vieille organisée) without preparing him for it; he was then observed to tremble, turn pale, and seemed on the point of falling into a syncope; he next showed all the transports occasioned by a lively and unknown pleasure, &c. This young man was unfortunately soon cut off by disease.[7]

[6] Considérations sur les Sourds Muets de Naissance, par M. Le Bouvyer Desmortiers. For the account of a cognenitally deaf and dumb person, who unxpectedly obtained his hearing and speech when 17 years of age, after a violent fever, see Phil. Trans. vol. xxv. p. 1469. (No. 312.)

[7] See Magendie's Physiolog. [Tr. Milligan.] p. 153. 1831.

Electricity and galvanism have been much extolled by continental physicians for the cure of deafness, whether congenital or dependent upon the various nervous affections; but in Britain, the cases are very few which have been benefited by their application. Kramer says, "The English physicians have not afforded us any certain practical information on this question, nor do they appear among the inquirers into the efficacy of galvanism and mineral magnetism as a remedy for deafness."[8]

It appears that attention was given to this subject some years since, with benefit in a few cases; but like many other remedies, because it did not effect every thing that could be wished, it has been latterly almost entirely rejected; but there can be no doubt, from the facts which have been published, that in some cases, where there is not organic disease, this remedy offers a very fair chance of cure. After having examined the subject with some degree of attention, I find few cases have been benefited by the action of electricity; but *galvanism*, if we may credit the accounts, would seem to have been more efficacious.[9]

Galvanism has been much advocated by Sprenger and Volta,[1] the former of whom is reported to have cured upwards of forty cases.

[8]Bennett's Translation, London, p. 44. 1837.

[9] See Lond. Med. and Phys. Journ. vol. vii. p. 243, 247, 531; vol. viii. p. 255, 324, 526; vol. ix. p. 133, 134, 142, &c.; vol. x. p. 61, 333.

In many of these cases no benefit was derived. Dr. Grapengiesser had nine successful cases, and Dr. Quensel found four cases decidedly benefited by the application of galvanism.

[1] Edinburgh Med. Journal, vol. ii. p. 425. 1806. See also Journal Economique, Janvier, 1767.

The Abbé Nollet was opposed to electricity,[2] Itard and Deleau think it has no beneficial action on the ear, and Kramer has found it worse than useless, as it has sometimes done positive harm. In speaking of patients who had been electrified, he says, "They all appeared to have been made worse by it, though at first it seemed occasionally as though the electrical treatment would improve their condition. *In all, the erethismus and the tinnitus were increased.*"[3] I have myself known it render hearing less perfect, from its injudicious application.

Mr. Wright, in speaking of electricity, says, "In deafness occurring after the use of mercury, electricity produced by attrition should not be omitted. Many cases of this kind I have relieved, some very speedily; others, after considerable perseverance, have only been partially or not at all relieved." Mr. Wright also particularly recommends it in those cases where persons having been exposed for a length of time to a draught, are troubled with coldness of the affected side, with numbness and apparent tinkling sound on rubbing the face.[4]

Mr. Wilson mentions a single instance, in which he had cured deafness of seventeen years continuance, by means of electricity, but he acknowledges that he tried similar experiments on six other deaf persons without success. Mr. Wesley has known hearing given by it to a person who was born deaf. Dr. Antonius de Haen, in his Ratio Medendi, cited by Dr. Priestley in his Hist. Elect. vol. i. p. 485, informs us that it has been of some use in cases of deafness.[5] The Abbé Nollet

[2] Encyclopédie, art. Electricité. 1755.

[3] Bennett's Translation, p. 43.

[4] See Lancet, p. 88. 1831-2.

[5] See Rees' Cyclopædia.

undertook a journey to Italy for the purpose of visiting the different experimenters by whom much had been published. He repeated the experiments in their own presence; and though he found that in particular cases, such as diseases of the eyes, the *ear*, and the head, and in some instances of paralysis, the patients had found considerable relief, yet he was convinced that in other instances the effects were greatly exaggerated, &c.[6] Haller tried it on one of his relations for twenty days, and found so little benefit as not to have patience to continue. MM. Poma and Rainaud tried it in four cases without any success.[7] Amongst other means which have been employed, may be mentioned mineral and animal magnetism; the former is said to have been once successfully applied by Klarich.[8] Hagstroem tried animal magnetism upon a patient he thought likely to be benefited by it, for three months without any success.[9]

To apply electricity or galvanism to an ear, where there is great local congestion, preternatural excitement, inflammation, or an obstructed Eustachian tube, would be the height of absurdity; but by selecting proper cases, such as the following, related by Magendie, or when dependent upon any of the functional derangements, more especially of the nerve, these electrical agents may become a powerful remedy, in the hands of an experienced person.[1]

[6] See Edinburgh Encyclopædia.

[7] Journal de Médecine. Nov. 1787. See Dict. des Sciences Méd. t. xxxviii. p. 124.

[8] Dict. des Sciences Méd. t. xxxviii. p. 125. Kramer, p. 50.

[9] Journal de Médecine. 1793.

[1] Hearing is said to have been restored by a sudden flash of lightning. [Mason Good.] See Bresl. Samml. 1718. p. 1541.

Case.—At the meeting of the Royal Academy of Sciences, Paris, M. Magendie gave some details respecting the case of a young Polish officer, who, at the battle of Astrolenka, when charging a battery which was at that moment firing cannon balls, was thrown down without receiving wound or contusion upon any part of the body, when, having remained in a state of insensibility for nearly half an hour, it was found that his hearing, speech, and taste were gone.

After having been treated by leeching and revulsions without success at Vienna, and by strychnia in the endermic method at Trieste, he came to Paris, where M. Magendie, to relieve his deafness, had recourse to the galvanic currents in the following manner. One of the wires of the pile was applied over the chord of the tympanum, and produced immediate effects, the patient experiencing a loud buzzing in the ear. The sense of taste commenced to be re-established at the third application, which to the anatomist and physiologist is a remarkable fact, and throws light upon the origin of the chord of the tympanum, and the use of the fifth pair of nerves.

After seven or eight applications, the patient heard the sound of a drum, and afterwards church bells, and then of house bells, and finally of the human voice. M. Magendie thinks it essential that there be established an immediate contact between the nerve and conducting wire, and that might be accomplished without difficulty, for the chord of the tympanum is the only nerve which creeps towards the exterior. With respect to the other nerves, we might readily, after a little practice, accomplish our object by penetrating their traject with a needle, to which the conducting wire is to be applied.[2]

With respect to the *Medico-Legal* difficulties affecting the deaf and dumb, I must be very brief. The almost impossibility of making them comprehend some points, and the possible misapprehension of others, added to the not unusually low tone of intellect,

[2] Lancet, vol. ii. p. 526. 1835-6.

must impress every one with the extreme difficulty of deciding how far they are responsible for their actions, and how far they are capable of managing their own affairs; and it is a question worthy of very serious consideration, whether Government ought not in some way to superintend the affairs of the deaf and dumb, in the same way as the Lord Chancellor directs the interests of the insane.

"A person born deaf, dumb, and blind, is looked upon by the law as in the same state with an idiot, he being supposed incapable of any understanding, as wanting all those senses which furnish the human mind with ideas." If he subsequently become, or in the original *grow* deaf, dumb, and blind, not being *born* so, he is decided to be *non compos mentis*.[3]

Cases.—A most extraordinary case occurred in the person of James Mitchell, who was born blind, deaf, and dumb. This afflicted boy was accustomed to amuse himself by striking vibrating substances against his teeth, and more particularly with a musical snuff-box which excited his wonder, astonishment, and delight. The membrane of the tympanum of each ear was punctured by Sir Astley Cooper, with no benefit.[4]

An American girl was afflicted with the triple calamity of blindness, deafness, and dumbness, having lost the senses of sight and hearing by the violence of a typhus fever, at the age of four years. She exhibited considerable sagacity, was much attached to her family and infant sister, and often passed her hand and mouth over the eyes of the child, in

[3] Blackstone, vol. i. p. 304, 5.

[4] For full particulars of this exceedingly interesting case, see Edinb. Med. Journ. vol. ix. p. 473.

order to ascertain whether it was crying, and soothed its little distresses with all the assiduity of a talkative and musical nurse.[5]

In England and Scotland, if a deaf and dumb person have sufficient understanding to comprehend the nature of an oath, he may be received as a competent witness.[6] *Education* seems essential for a proof of guilt, or rather *responsibility*, against a criminal who is deaf and dumb.

Case.—On the 1st of July 1807, Jean Campbell, alias Bruce, was charged with murdering her child, by throwing it over the Old Bridge of Glasgow. Her counsel, Mr. M'Niel, objected to her trial, because she had been deaf and dumb from infancy, and would not allow her to plead to the indictment, until it was *explained* to her that she was at liberty to plead *guilty* or *not guilty*. Upon it being found that this could not be done, the case was dropped, and she was dismissed from the bar *simpliciter*.[7]

In the accompanying case of Campbell's, there can be but little doubt, that she would have had to stand her trial, had her education been sufficient to make her comprehend.

The deaf and dumb are remarkably irritable and passionate, are not easily conciliated, and exhibit a strong dislike to strangers.

Lunatics not unusually become more or less deaf,

5 Tilloch's Phil. Mag. vol. li. p. 129.

6 See trial of William Bartlett, January Sessions, Old Bailey, 1786. Also Alison's Practice of Criminal Law of Scotland, p. 359 and 436.

7 Beck's Elements of Med. Jurisp. p. 477. See also Causes Célèbres du xix. Siècle, vol. iv. p. 193.

and are often exceedingly tormented by ringing in the ears.[8] The ear would indeed sometimes seem to be specially affected, inasmuch as persons so unhappily afflicted, often suffer principally, from the *supposed* unearthly whispers or anomalous sounds, with which they are harassed, frequently inciting and encouraging them to self-destruction.

Deafness, dumbness, and imbecility, are by no means unfrequent amongst the Cretins, varying as to degree; some being able to hear but imperfectly, and to utter inarticulate sounds, while others are capable of understanding and pronouncing a few words.

Deaf dumbness may be assumed, either by beggars wishing to excite the sympathy of the charitable, or by persons desirous of avoiding military or naval service; and it is not always easy to determine whether the case be real or feigned.[9] It is worthy of recollection, that if a person has ever learnt to speak, and possesses the power of moving the tongue, his dumbness cannot be real.

These impostors have sometimes been detected, by suddenly and unexpectedly putting a question, as, How long have you been deaf? and they have also been exposed by firing off a pistol suddenly; this might be done with more effect when the person is asleep. The discharge of otorrhœa has been simulated by introducing honey into the meatus, or by using cantharides, and subsequently introducing rancid

[8] Haslam on Madness.

[9] See the case of M'Keon of the 7th Dragoon Guards, by Henry Marshall, Deputy Inspector-General of Army Hospitals. On the Enlisting, Discharging, and Pensioning of Soldiers, &c., p. 106. 1839.

oil, for the purpose of making the discharge offensive, and so more completely deceiving the medical officer.[1]

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In conclusion, I may be allowed again to remark, that because a person is presented to us as deaf and dumb, and as having been so from birth, therefore he should not be condemned to an isolated state of existence; but every such individual should be subjected to a most patient investigation, and it should be carefully ascertained whether any sound, however faint, can be heard; and should such be the case, the treatment so successfully adopted by Itard, should be most patiently persevered in, together with any other, which the peculiarities of the case, or the resources of the medical attendant, may suggest; should any improvement take place, the treatment must of course be continued; and it is only after such a trial that the medical adviser can feel satisfied that everything has been done for these most unfortunate individuals.

The following observation, extracted from the report of the commissioners appointed by the Academy of Sciences for inquiring into the treatment of the deaf and dumb, I consider to be very important:—"For we have numerous examples of children who may be called dumb, only because there requires in them, a certain effort of the ear to comprehend words, and

[1] See Todd's Cyclopædia of Pract. Med.—Art. Feigned Diseases.

rather a difficult exertion of the larynx to speak. Finding, by the employment of signs, an easy medium of communication, they neglect to exercise the ear and the organs of speech, and thus remain classed among the deaf and dumb, *when, in reality*, they are neither dumb nor deaf."[2]

Signed, DUMERIL,
GEOFFROI ST. HILAIRE.
MAGENDIE, (Reporter.)

Who can describe the pleasure experienced if, by judicious treatment, a fellow-creature be rescued from this pitiable condition? Who tell of the happiness enjoyed by one who has been the means of restoring such a hidden treasure? And yet this has happened. Persons born deaf and dumb have been restored; and the means so happily employed in those cases still remain to be applied to others; and it is to be hoped that medical men will inquire more minutely into the cases submitted to them; and by making a happy selection, and patiently employing the various means recommended, be enabled to confer an immortal obligation upon the patient, in rendering him capable of conversing with his fellow man; and when "we see their happiness increasing with their knowledge, and when the sublimity of nature is first unfolded to their opening minds, and we mark the tear starting into their eyes, we cannot but participate in the noble pleasure, and rejoice that such feelings can be theirs."

The minute parts entering into the formation of the

[2] See Edinb. Journal, vol. i. p. 358.

ear, and the *imagined* inutility of remedial means[3] in these obscure because neglected diseases, together with the extremely superficial manner, medical men while students, acquire the knowledge of its structure, and the little information they obtain respecting its pathology, all contribute to retard the progress of this department, more, I may say, than that of any other branch of medicine. But it is to be hoped, that by endeavouring to ascertain the *causes* of deafness, be they accidental or congenital; and by a closer and more accurate and minute investigation of the symptoms during life, and by carefully observing the morbid alterations or congenital malformations after death, that some more certain means of treatment will yet be devised, for restoring or improving this invaluable sense, upon which so much of our happiness depends.

The apology I have to offer for having extended this paper to so great a length, is the extreme importance of the subject—an importance which those of us who possess this sense can by no means sufficiently value. The advantages and pleasure of hearing can be only properly appreciated by those who have lost, but once enjoyed, this inestimable blessing. The benefit it confers upon society in enabling us to exchange our mutual ideas; the pleasing recollections we enjoy

[3] "Of 300 deaf patients who casually presented themselves without any selection, 104 were found to be quite incurable, incapable of being at all relieved, and with the treatment of which, therefore, I took no trouble; the proportion of these, therefore, is one to three. On the other hand, 188 were either completely cured or relieved by the treatment; whilst only eight of those who were actually put under treatment, were obliged to be left unrelieved, in spite of all the pains and care bestowed." He subsequently says, that had many of these patients applied *sooner*, their lot might have been more happy and fortunate.—*Kramer. Bennett. Trans.* p. 37.

from long past conversations; the delight we experience from the harmony of sweet sounds, or the enchantment we receive from overpowering eloquence, convince us that half our happiness is dependent upon this valuable faculty; and this indeed is not ideal, for who has not observed the individual, once happy and cheerful in his family and friends, who, from becoming deaf, lapses into a sort of melancholy, feeling that a barrier has been formed which almost entirely shuts him out from society?

THE END.

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# PLATE I.

1. Meatus externus.
2. Membrana tympani.
3. Malleus.
4. Incus, with the neck terminating in its orbicular portion, connected with the stapes.
5. Fenestra vestibuli, closed by the stapes.
6. Fenestra cochleæ, or termination of the scala tympani.
7. Vestibule with the openings of the semicircular canals.
8. Superior, or vertical semicircular canal.
9. Horizontal semicircular canal.
10. Internal, or oblique semicircular canal; a section having been made to show the *common* termination of the vertical and oblique canals, into the tympanum.
11. 11. 11. Scala vestibuli, with its two turns and a half.
12. 12. 12. Scala tympani, with its two turns and a half; both scalæ terminating in the cupola.
13. Meatus auditivus internus.
14. Eustachian tube terminating in the tympanum.
15. Chorda tympani passing through the tympanum.
16. Styloid process.
17. Portio dura.

This plate was engraved, by permission of Mr. Burgess, from a class drawing used in Windmill Street.

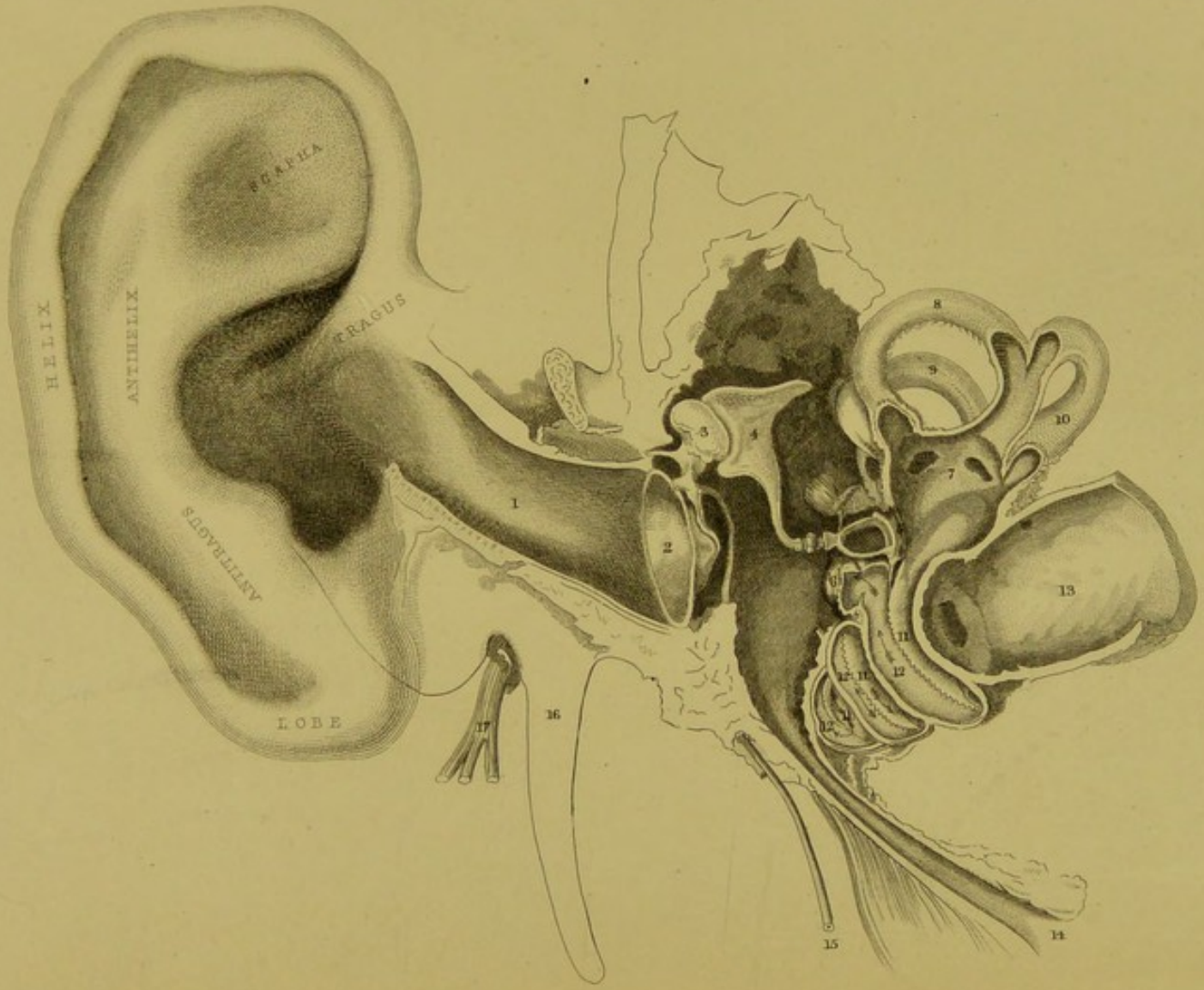
HELIX
ANTIHELIX
SCAPHA
TRAGUS
ANTITRAGUS
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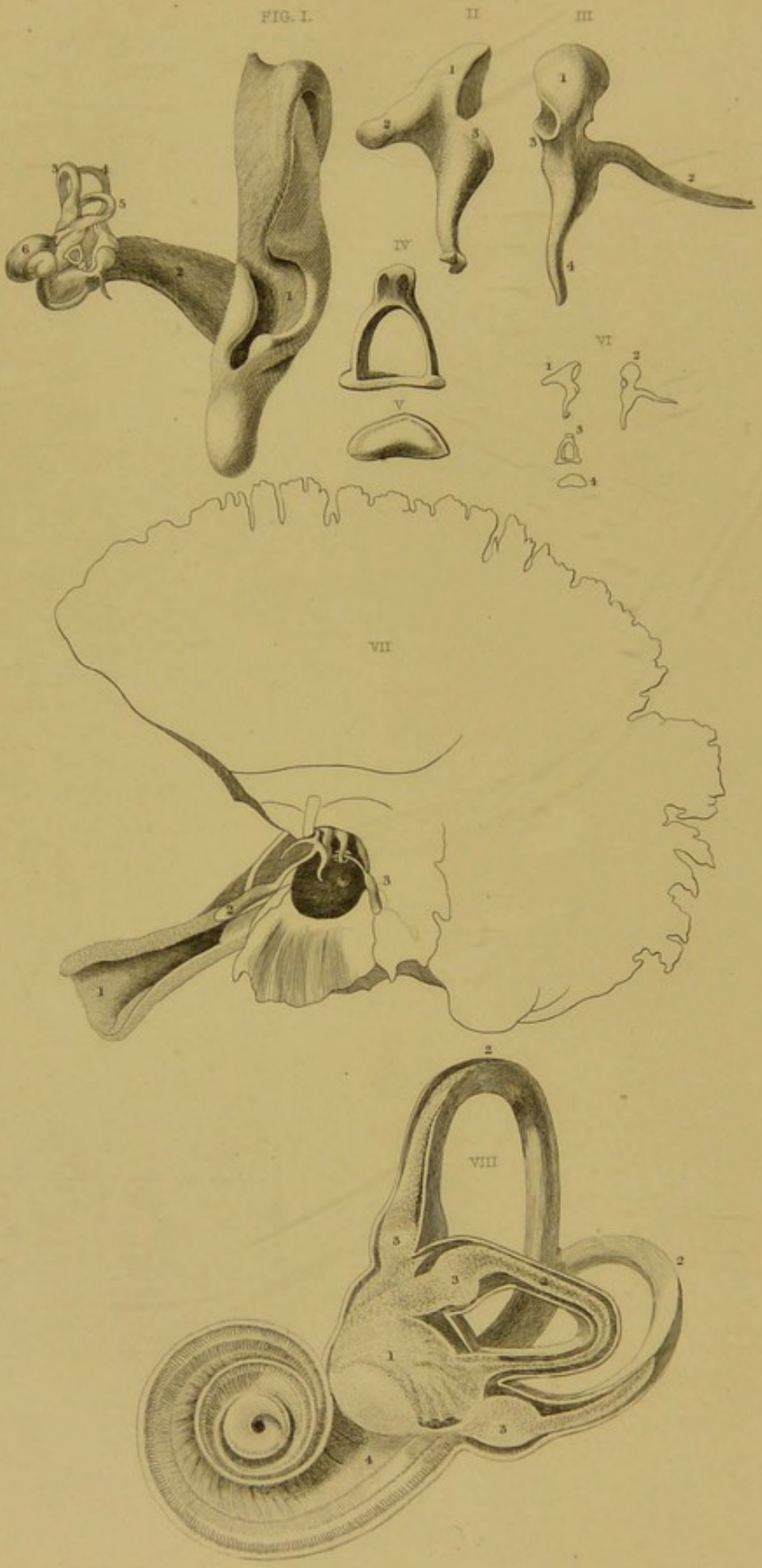
FIG. I.



# PLATE II.

FIG. I.

1. The concha of the external ear.
2. The tube of the meatus externus.
3. The superior semicircular canal.
4. The oblique semicircular canal.
5. The horizontal and smallest semicircular canal.
6. The cochlea.

The malleus, incus, and stapes are also placed in situ.

FIG. II. The Incus.

1. Its head.
2. Its short crus.
3. The articulating concavity for the head of the malleus.
4. Its orbicular process, usually called the os orbiculare, see page 17.

FIG. III. The Malleus.

1. Its head.
2. The processus gracilis.
3. Articulating surface for the incus.
4. The manubrium.

FIG. IV. The Stapes.

FIG. V. The Orbicular Process detached from the Incus, usually described as a separate bone.

FIG. VI. Natural size of the Ossicula Auditûs.

1. The incus.
2. The malleus.
3. The stapes.
4. The orbicular process of the incus.

FIG. VII. The Temporal Bone.

1. The Eustachian tube.
2. The tensor tympani.
3. The laxator tympani.

FIG. VIII.

1. The vestibule.
2. 2. 2. The three semicircular canals, each containing its proper sac.
3. 3. 3. The ampullæ.
4. The cochlea, making two and a half spiral convolutions.

# PLATE III.

FIG. I.

1. The meatus externus.
2. Membrana tympani.
3. Malleus.
4. Incus.
5. Stapes, covering the fenestra vestibuli.
6. Cavity of tympanum.
7. Fenestra cochleæ.
8. The oblique semicircular canal.
9. The perpendicular semicircular canal.
10. The horizontal semicircular canal.
11. 11. 11. Ampullæ of the semicircular canals.
12. The Cochlea.
13. The Eustachian tube.
14. 14. 14. The two turns and a half of the bony canal of the cochlea terminating in the cupola.
15. A probe introduced into the meatus externus to render it more distinct.

FIG. II. The Ossicula as connected.

1. The malleus.
2. The incus.
3. Its orbicular process.
4. The stapes.
5. The processus gracilis of the malleus.

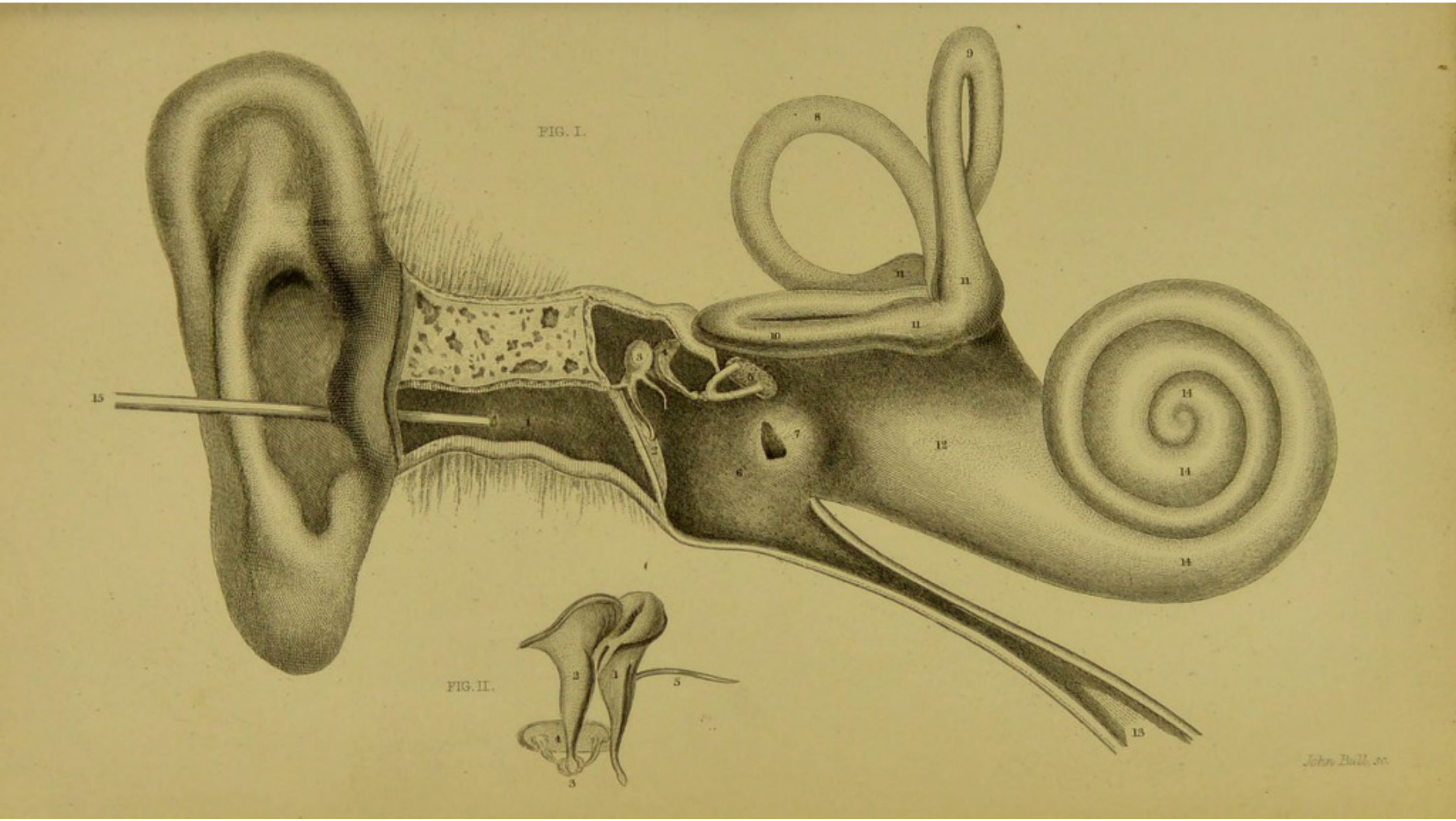


FIG. I.
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FIG. II.
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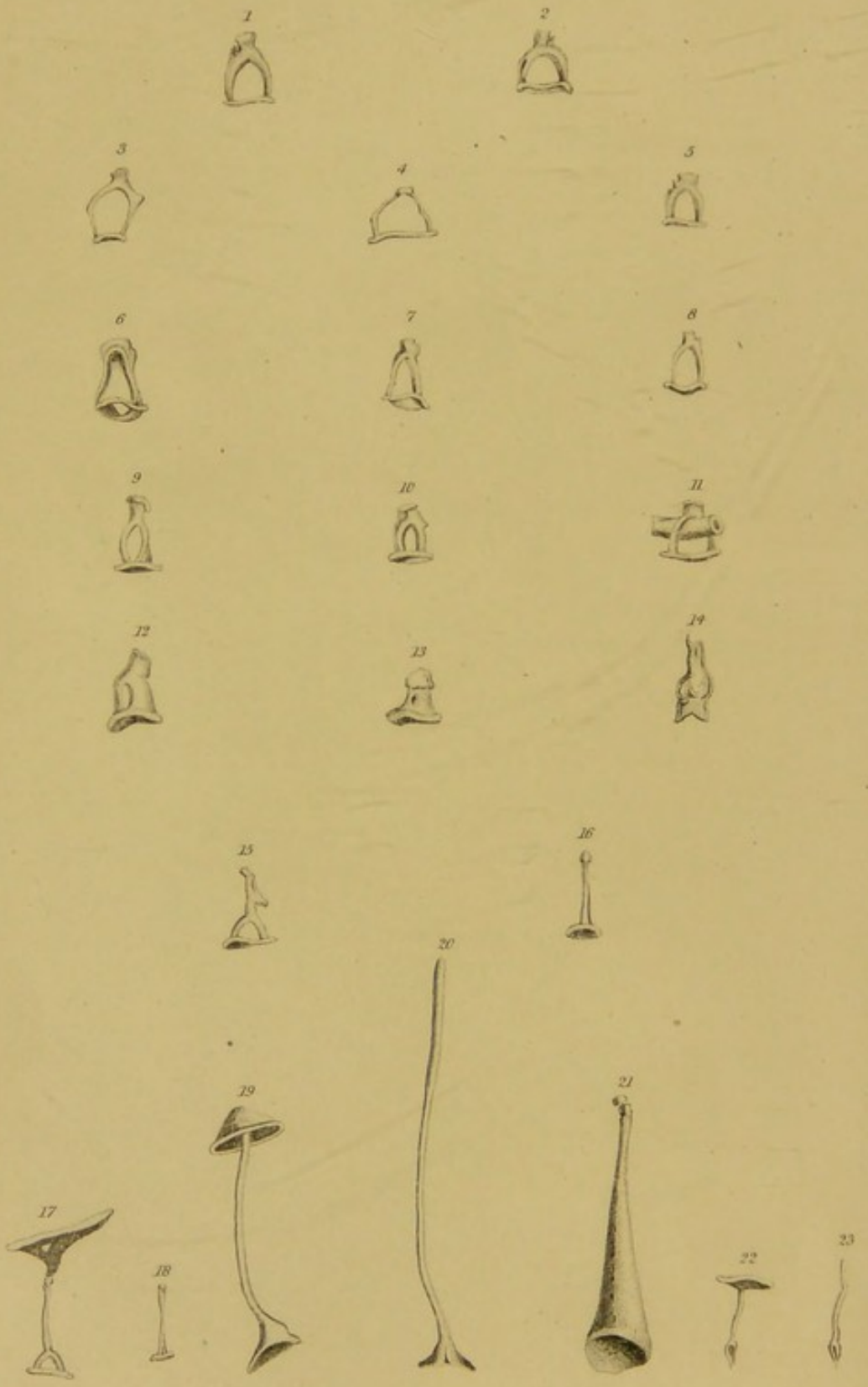


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STAPEDES AND COLUMELLÆ.

# PLATE IV.

FIG. 1. The left* stapes of a human ear magnified two diameters; presenting the curved edge of the basis, and the more elevated and pointed arch.

2. The opposite side of the same stapes, showing its rounded arch.

3. Stapes of a hedgehog, (erinaceus Europæus,) magnified four diameters.

4. Stapes of a mole, (talpa Europæa,) magnified six times.

5. Stapes of the musk ox, (bos moschatus,) twice magnified.

6. Stapes of the elephant, (elephas maximus,) natural size.

7. Stapes of the tiger, (felis tigris,) twice magnified.

8. Stapes of the dog, (canis familiaris,) three times magnified.

9. Stapes of the horse, (equus caballus,) twice magnified.

10. Stapes of the pig, (sus scrofa,) three times magnified.

11. Stapes of the marmot, (arctomys marmota,) with its pessulus; magnified four times.

12. Stapes of the seal, (phoca vitulina,) twice magnified.

13. Stapes of the porpoise, (delphinus phocæna,) twice magnified.

14. Stapes of the walrus, (trichechus rosmarus,) natural size.

15. Stapes of the kanguroo, (macropus kanguroo,) four times magnified.

16. Columella of the duck-bill, (ornithorhynchus paradoxus,) magnified four times.

17. Columella and cartilago columellæ of a goose, (anas anser,) twice magnified.

18. Columella of the Egyptian ibis, (tantalus ibis,) taken from a mummy, three times magnified.

19. Columella of a turtle, (testudo midas,) natural size, with its cartilage.

20. Columella of the gangetic crocodile, (lacerta gangetica,) natural size.

21. Columella of a turtle, (testudo coriacea,) natural size.

22. Columella and cartilage of a frog, (rana temporaria,) twice magnified.

23. Columella of a toad, (rana bufo,) twice magnified.

Taken from the Phil. Tran. 1805; vol. 95, plate iv. p. 210. See p. 45.

* The other stapedes are all from the right ears.

# PLATE V.

FIG. 1. M. Fabrizi's trochar for removing a *circular* portion of the membrana tympani.

2. The perforator removed from its sheath.

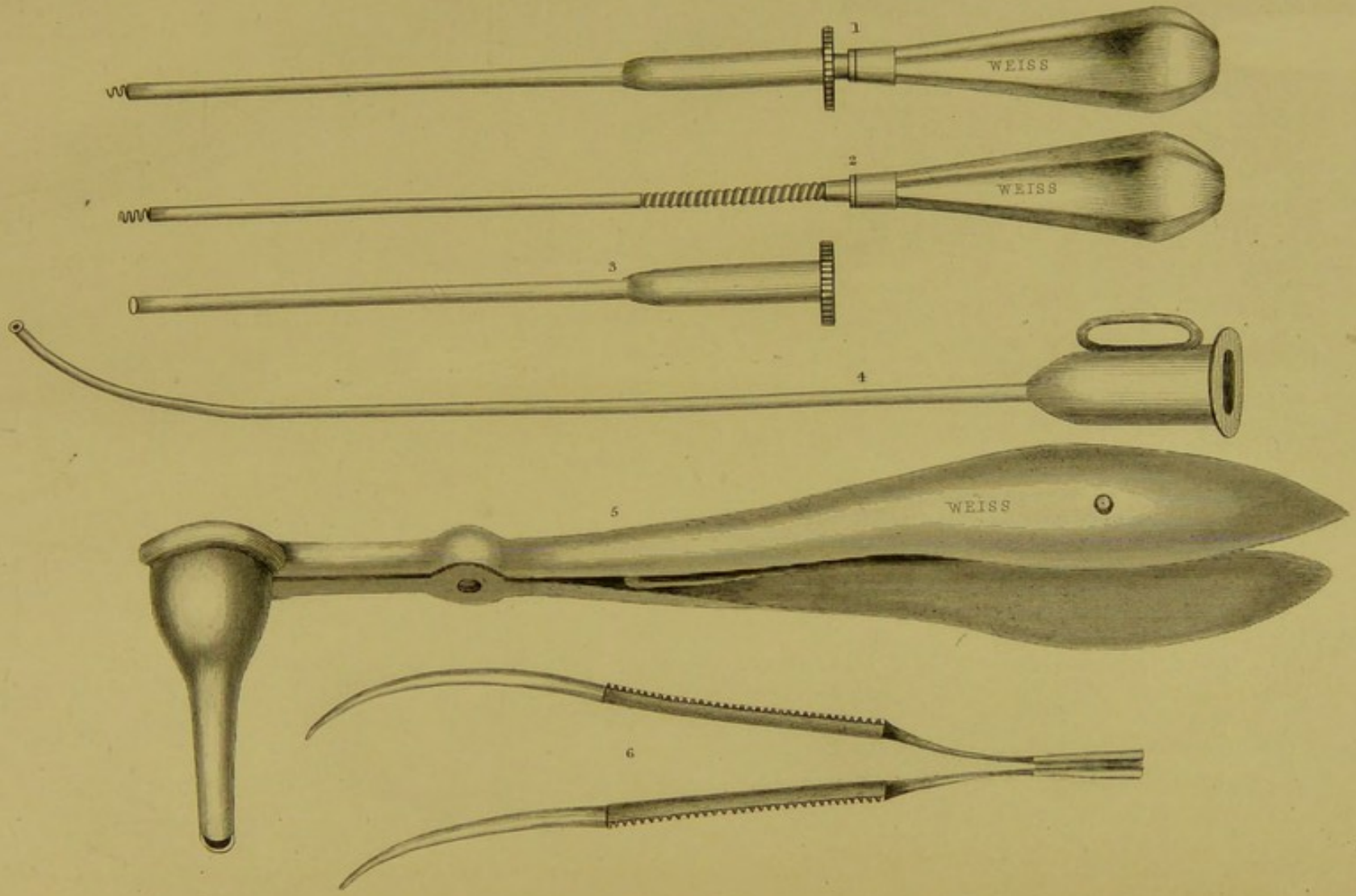
3. The sheath.

For full description, see p. 204.

4. Catheter for injecting the Eustachian tube.

5. Kramer's speculum for examining the meatus externus and membrana tympani.

6. Size and shape of forceps, frequently used in extracting foreign bodies from the meatus externus.

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# PLATE VI.

FIG. 1. The meatus externus.

2. The membrana tympani, with the manubrium of the malleus attached to its *upper* two-thirds.

3. The Eustachian tube.

4. The perforator, introduced through the meatus, and through the membrana tympani, *below* the manubrium of the malleus. The spiral portion has been magnified, so as to render it more distinct. For full description, see p. 199.

5. The membrana tympani of a patient of Sir Astley Cooper's; the only part remaining being of a lighter colour.

6. Membrana tympani lacerated by a blow.

7. Membrane lacerated in an attempt to extract a pin.

8. Membrana tympani having a fungus projecting through it; occasioning considerable deafness of this ear.

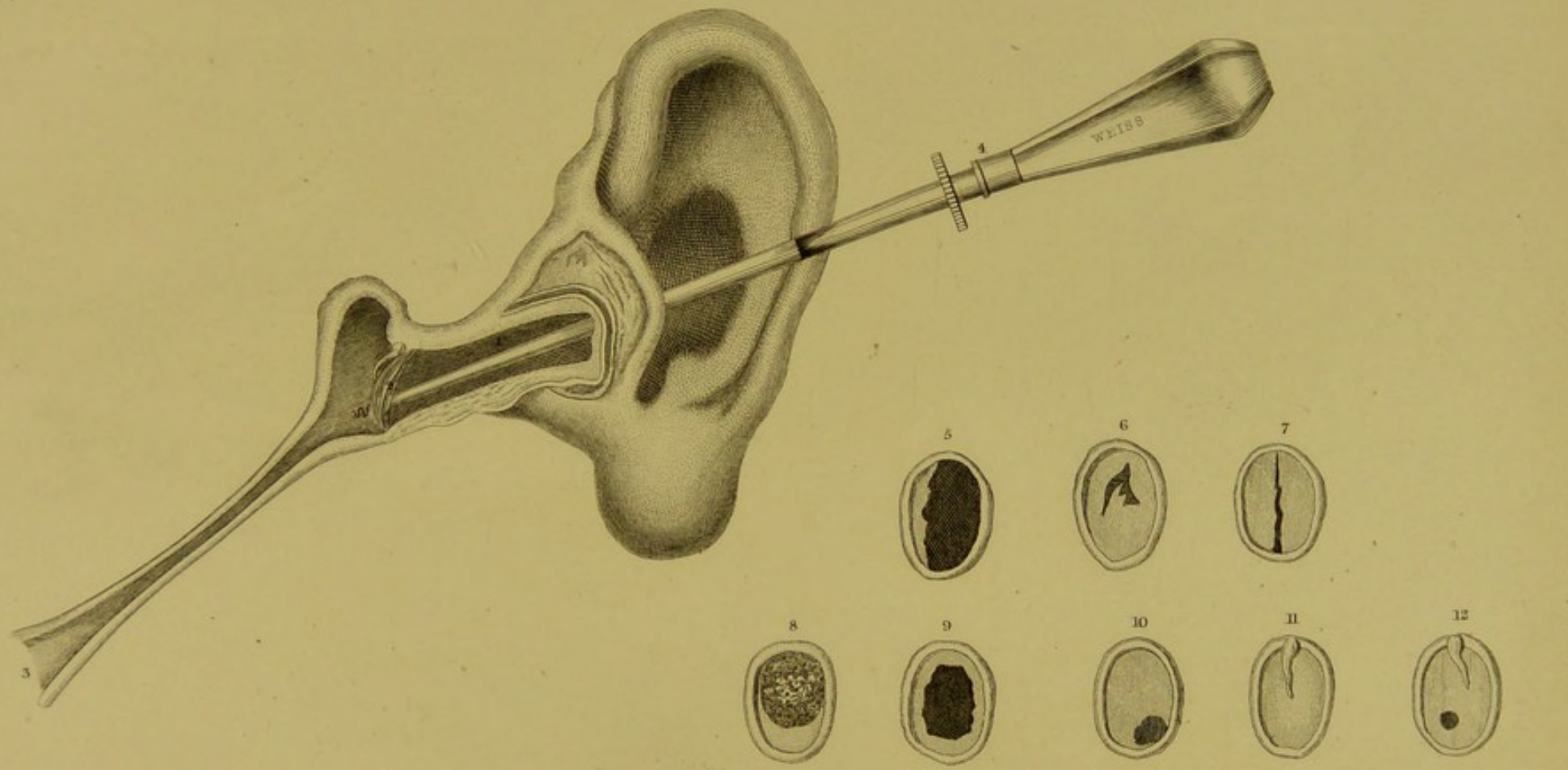
9. The membrane of the opposite side, in the same case as No. 8.

10. Membrana tympani with an opening in its inferior portion.

11. Membrana tympani in its natural state, showing the attachment of the manubrium of the malleus.

12. Appearance of the membrane after having been punctured.

Taken from the Phil. Tran. 1801; plate xxxiii. p. 450.

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