

epithelium, and contain one vascular loop. It is not yet decided whether they are constant in the fetus and newborn child or not.

Fold of Mucous Membrane Enclosing the Chorda Tympani.—Near the upper boundary of the tympanic membrane the mucous membrane of its inner surface is re-

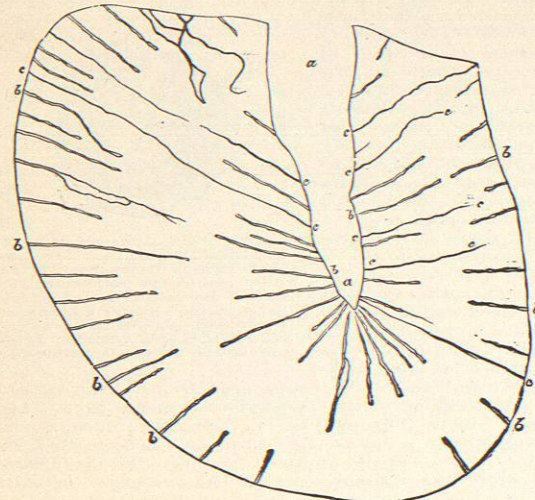


Fig. 1683.—Membrana Tympani of Dog. (C. H. Burnett.) This woodcut is from a drawing of a chloride of gold preparation made by the writer. a, a, Vacancy left by the handle of the hammer, or malleus; b, b, b, b, vascular loops; c, c, ordinary capillaries, not looped.

flected over the chorda tympani, and back again to the drum-head. This duplicature is visible in some cases from without, as a grayish line, both in front of and behind the malleus. This fold or duplicature, being adherent to the neck of the malleus, is thus divided into an anterior and posterior portion, and aids in the formation of the so-called pouches of the tympanic membrane (von Troeltsch) which will be described later.

Blood-Vessels of the Membrana Tympani.—The tympanic membrane is supplied by the tympanic branch of the inferior maxillary artery, and also by a short direct branch from the internal carotid artery, in the carotid canal. By the latter channel the membrana tympani may become engorged very quickly.

There is in the tympanic membrane of the dog, the cat, the goat, and the rabbit, a series of *vascular loops* running from the periphery of the membrane toward the malleus. A similar series of loops runs both posteriorly and anteriorly from the malleus toward the periphery of the membrane (Fig. 1683).

There is also a distribution of blood-vessels in the tympanic membrane of the guinea-pig peculiar to it. It is arranged in the form of a net, with coarse quadrangular or hexagonal mesh. In man the vascular mesh is similar to that of the guinea-pig, but much closer and with coarser vessels.

The Ossicles of Hearing.—In the tympanic cavity of mammals there are three small bones: The *malleus*, or hammer; the *incus*, or anvil; and the *stapes*, or stirrup. Anatomists of a later day have shown that the once so-called *os orbiculare*, or *os Sylvii*, does not exist as a separate bone; but that which once received this name is the *processus lenticularis* of the long process of the *incus*, which fits into a corresponding depression in the head of the *stapes*.

The *malleus*, or hammer, received its name from Vesalius, and is divided into a head, a neck, and a handle. At the junction of the handle with the neck are two important processes, viz., the short process on its outer

aspect, and the process of Rau or Folius, which passes anteriorly into the Glaserian fissure. In the fetus and the new-born child this process is about three and a half lines long, and can be removed with the malleus. After birth it unites with the under wall of the Glaserian fissure, and when the malleus is removed only a short piece of the former long process is found attached to it. This remnant attached to the malleus was all that was known of the former long bony process to the older anatomists, among whom was Folius, from whom this process has received the name of *processus Foliianus* (Venice, 1645).

In its entirety it has been called the *processus Ravii*, after Rau or Ravius, who described it to his pupils. It has also been called the *processus longus seu spinosus*. It is united to the Glaserian fissure, in adults only, by a mass of ligamentous tissue, which permits slight motion in any direction. The *head* and *neck* of the malleus project into the tympanic cavity, and are entirely free from the tympanic membrane. The rounded smooth head is directed anteriorly, and the surface which articulates with the incus is directed backward. The long diameter of its articular surface runs vertically; the short diameter horizontally. In the direction of the former the articulating surface has been said to resemble a saddle, for the surface is divided a little below the middle by a horizontal ridge, and depressed on each side of it. This articulating surface is also concave in its short diameter, i. e., from without inward. If a shallow oval basin, the long diameter of which is considerably greater than its short diameter, be placed across a ridge and then bent downward, and at the same time slightly twisted on itself, the cavity thus formed will fairly represent the articulating surface of the malleus. The neck of the malleus connects the *head* with the *manubrium*, or handle. It makes, with the head, an angle of about 135°, opening inward toward the drum cavity. There are three distinct surfaces on the neck of the hammer: a broad *inner* one turned toward the tympanic cavity, bounded in front by the process of Rau, or the long process of the malleus, and behind by the long, low, bony elevation for the insertion of the tendon of the tensor tympani muscle; an *anterior* surface, lying above the ridge running from the short process to the long process, and extending to the angle made by the head of the malleus with the neck, and separated from the posterior surface by a sigmoid ridge for the insertion of the *ligamentum mallei externum* of Helmholtz; and a *posterior* surface, which lies between the aforesaid sigmoid ridge in front, the edge of the articulating surface of the malleus above, the low, long process behind, and a line drawn from the insertion of the tensor

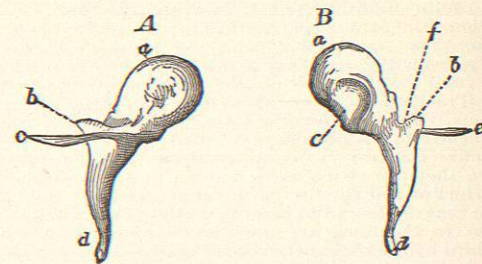


Fig. 1684.—Malleus of the Right Side. A, From in front; B, from behind. (Magnified four diameters. Henle.) a, Head; b, short process; c, long process; d, manubrium; e, articular surface for the incus; f, the neck.

tympani to the short process below. Of all the surfaces of the neck the posterior one glides most gradually into the *manubrium*.

The handle or *manubrium* of the malleus, that part of the ossicle inserted into the tympanic membrane, also has three surfaces, which may, in fact, be considered prolongations downward of those of the neck. Since all these surfaces gradually approach one another, and are united in the tip or point of the manubrium, the latter

may be said to resemble a three-sided bayonet, one ridge of which passes from the short process directly downward to the tip, and consequently is turned toward the external auditory canal. The lower end or tip of

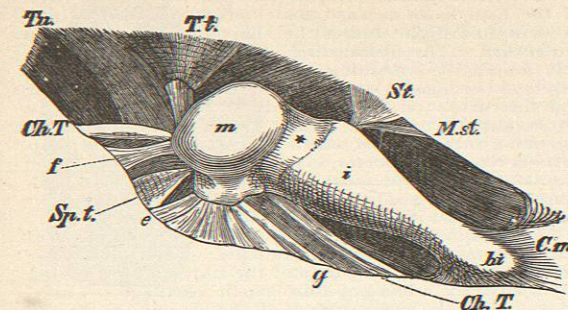


Fig. 1685.—Ligamentous Support of Ossicles seen from above. (Helmholtz.) c, g, Attachment of the ligamentum mallei externum; m, head of malleus; i, body of incus; h, posterior attachment of incus; Tu, entrance to Eustachian tube from the tympanum; St., stapes; M.st., stapedius muscle; T.t., tendon of stapedius muscle leaving the cochleariform process; Ch.T., Ch.T., chorda tympani, marking the free edge of the fold of mucous membrane, bounding the pouches; f, the upper tendinous fibres of the ligamentum mallei anterius, originating above the spina tympanica major; Sp.t., malleo-incudal joint.

the handle of the malleus is flattened into a small disc, one surface of which is turned toward the auditory canal. This spot is plainly visible as the pale, round centre of the *umbo*.

The long axis of the handle of the hammer is convex posteriorly and inward, so that when viewed from without the manubrium appears concave on its anterior and outer surfaces. This is especially marked at the lower third on the anterior surface, so that the manubrium appears curved decidedly forward near its lower end. Along the ridge of the manubrium, directed toward the external auditory canal, several small, node-like prominences are sometimes observed. These are purely physiological; but their origin is obscure.

The *dimensions* of the malleus are as follows: It is nearly 9 mm. long, its manubrium being from 4 mm. to 5 mm. in length, and its head 2.5 mm. thick. The latter is the greatest diameter of any part of the bone. The long diameter of the articulating surface of the malleus is about 3 mm.; the short diameter is between 1.5 mm. and 2 mm. In twenty cases examined by Urbantschitsch only five were found in which the *malleus* was equal in length on both sides. The malleus is held in position by four ligaments, viz.: the *ligamentum mallei anterius*, *ligamentum mallei superius*, *ligamentum mallei externum*, and the *ligamentum mallei posterius*. The *ligamentum mallei anterius* is a broad band of fibres, holding the *processus Foliianus* against the *spina tympanica major* and to be inserted along the neck of the malleus all the way from the *processus Foliianus* to the head of the hammer. A portion of it also runs from the *processus Foliianus* to the short process of the hammer below, and to the *membrana tympani* above, thereby aiding the division between the anterior and posterior pockets of the *membrana tympani*; another fold of the same ligament runs from the *processus Foliianus* downward, with a free margin, as far as the line corresponding to the insertion of the *tensor tympani* muscle. This aids in making the limiting wall between the anterior pocket of the drumhead and the tympanic cavity. The round *ligamentum mallei superius* descends obliquely downward and outward from the *tegmen tympani* to the head of the hammer. Its function is to prevent the malleus from being forced outward.

The *ligamentum mallei externum* is a very important collection of satin-like, tendinous fibres, which radiate

from the sigmoid crest on the front of the neck of the hammer, and are inserted into the sharp edge of the segment of Rivinus on the temporal bone. It prevents the hammer from being forced inward, and, being inserted above the axis of rotation of the hammer, it prevents the *manubrium*, which is below the axis of rotation, from moving too far outward toward the auditory canal.

The *ligamentum mallei posterius* is really the posterior edge of the ligament just described as the external ligament of the malleus. As the line followed by this bundle of fibres passes through the *spina tympanica major*, and since it represents very closely the axis of rotation of the hammer, Helmholtz has suggested that it should be considered a separate ligament, and he has given to it the name it bears. As this ligament and the *ligamentum anterius* are, in a mechanical sense, one ligament, although the hammer comes between them, the two sets of fibres have been named the axis ligament of the hammer (Helmholtz). The plane of the axis ligament is not quite horizontal, being a little higher in front than behind. In all its motions as a lever (pendulum-like) the malleus swings about this axis as the fixed point. All portions of the bonelet above its short process are above this axis ligament, and all below the short process are below this axis, or fulcrum-line. The *ligamentum mallei anterius* of Arnold was once described as a muscle, and called the *laxator tympani major* (Soemmering). It is, however, only a ligament which originates from the *spina angularis* of the sphenoid, passes through the petro-tympanic fissure (Glaserian fissure), and is inserted into the malleus. Under the name of *ligamentum mallei posterius seu manubrii*, the *ligamentum mallei externum* of Arnold, Lincke describes a ligament which passes from the upper edge of the end of the external auditory canal to the short process of the malleus, and occupies the position of a supposed muscle, once called the *M. laxator tympani minor*, or *M. mallei exterior seu Casserii*. It is now universally acknowledged that muscular fibres do not exist here (Henle).

The Incus or Anvil.—The middle one of the three auditory ossicles is the incus or anvil. The name is derived from the shape of its upper half. This small bone is divided into a body and two processes, viz., a long and a short one. The latter is also called the horizontal process. It is held to the posterior and to the upper walls of the tympanic cavity by ligaments. This is an important point in the mechanism of the ossicles. The longer process is also called the descending ramus of the *incus* (see Fig. 1686). It curves gradually outward and down-

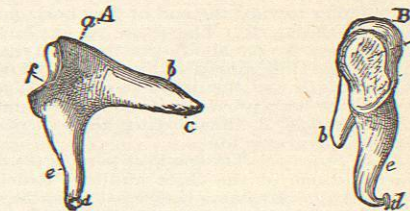


Fig. 1686.—Right Incus. (Magnified four diameters. Henle.) A, Inner surface; B, view in front; Aa, and B, body; b, short process; c, long process; d, processus lenticularis; f, articular surface for the head of the malleus; e, surface which lies in contact with wall of tympanic cavity.

ward, assuming a slight sigmoid shape; at its tip or lower end it curves rather sharply inward, to unite with the head of the *stapes* by means of the *processus lenticularis*. The narrowest part of the incus is at the middle of the body of the bone. Beneath this part it widens out again anteriorly into the important part which locks with the malleus in all its inward movements, and posteriorly into the descending ramus or long process. The articulation between the malleus and incus is a true joint, in which is found a *meniscus* (Rüdinger). If this articulation is viewed on its outer surface, i. e., on that side which

is toward the external auditory canal, it would seem that the *incus* quite overlaps or embraces the head of the hammer. When viewed, however, from the tympanic side, it appears that the largest share in the joint belongs to the *malleus*. This is due to the peculiar structure of this joint, first pointed out and explained by Helmholtz

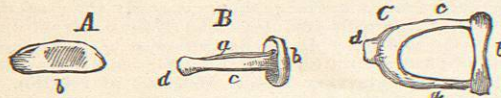


FIG. 1687.—Right Stapes. (Magnified four diameters. Henle.) A, From within; B, from in front; C, from beneath; D, foot plate or base; a, capitulum; c, anterior; a, posterior shaft or crus of stapes.

in 1869 ("Mechanik der Gehörknöchelchen," etc.). The greatest length of the *incus* is in a vertical line passing from the top of the body of the bone through the long process. It measures 7 mm. The horizontal upper edge of the body measures 5 mm. Its greatest thickness, 2-2.5 mm., is at its articulating surface for the *malleus*.

Malleo-Incudal Joint.—Helmholtz has graphically described this joint as follows: "It is, in fact, like the joint used in certain watch keys, in which the handle cannot be turned in one direction without carrying the steel shell with it, while in the opposite direction it meets with only slight resistance. As in the watch key, so here, this joint, between the hammer and anvil, admits of a slight rotation about an axis drawn transversely through the head of the hammer toward the end of the short process of the anvil; a pair of cogs oppose the rotation of the manubrium inward, but it can be driven outward without carrying the anvil with it." It is of that kind of joint known as ginglymus. The mechanism of this joint is best understood when it is known that the *malleus* is a lever, the fulcrum of which passes just below the short process. This, of course, leaves the head and neck—i.e., the articulating surfaces for the malleo-incudal joint, and all the free tympanic parts of the malleus—above the line of support of the lever, the handle or manubrium being below.

The latter is the long arm of the lever, and consequently all its movements are repeated in an opposite direction on the head of the malleus. Each inward movement of the handle, therefore, causes a slight outward motion of the head of the hammer, and a firm locking of the malleo-incudal joint, by which the *incus* is carried about an axis drawn transversely through the head of the hammer toward the end of the horizontal or short process of the anvil. The *incus*, or anvil, being also suspended as a lever, about the line just named, when all above that line moves outward, all below the line moves inward, i.e., as the upper part of the *incus* is moved outward the long process swings inward and carries the *stapes* ahead of it, thus forcing the foot plate of the latter into the oval window.

The Stapes, or Stirrup.—The smallest bone in the body, and the innermost one of the three auditory ossicles, is the *stapes*, or stirrup. Its name is derived from the striking resemblance it bears to a stirrup (Fig. 1687). It is divided into a head, a neck, two branches or legs (*crura*), and a foot plate or basis. The head, which is like a cup-shaped button, is placed at the junction of the two *crura*. It is designed for the reception of the lenticular process of the *incus*, with which it forms a ball-and-socket joint. There is a meniscus in this joint, according to Rüdinger. On the posterior surface of the head of the stapes the stapedius muscle is inserted. The two legs, or *crura*, are furrowed on their inner surface, which makes them stronger than if they were flat. The legs of the stapes arise from the base or foot plate, forming a graceful arch, and unite above in the head as stated above. The foot plate, or *basis* of the stapes, is nearly oval (slightly kidney-shaped), thicker at the periphery than in the centre, slightly convex toward the vestibule, and concave on its tympanic surface; it fits into

the oval window, where it is held by a fibrous packing. This permits a slight inward and outward motion on the part of the stapes. When this ossicle is in position, the long axis of its base is horizontal and coincides with that of the oval window. In this position the convex edge of the base looks upward, and its concave edge, which gives it to a slight degree the shape of a kidney, looks downward. The *ligamentum obturatorium stapedis* is a thin membrane stretching across the space between the base and the legs; it is attached to the crista of the former and the furrow on the inner edges of the latter. The *stapes* (stirrup) measures nearly 4 mm. from its head to the under surface of its base. The latter is 2.5 mm. long in its horizontal diameter, 1 mm. in its vertical diameter (the bone, of course, must be imagined in normal position), and about 1/2 mm. thick at its edges. It is slightly concave toward its centre.

The Joint between the Base of the Stirrup and the Oval Window.—According to Helmholtz ("Mechanik der Gehörknöchelchen") the base of the stapes is surrounded at its edge by a band of fibro-elastic cartilage 0.7 mm. thick. Over the inner surface of the base of the stapes, which is directed toward the cavity of the vestibule, in the plane of its outer wall, extends the periosteum of the wall of the vestibule, but the fibrous band on the edge of the foot plate, which fits into the oval window, is not attached to the latter, which leaves the stapes free to move slightly in and out of this fenestra. The mucous membrane of the tympanic cavity extends over the outer or tympanic surface of the base of the stapes. Regarding the fixation of the base of the stirrup in the oval window, the conclusions of A. H. Buck (1869) are as follows: 1. The base of the stapes is fastened to the edge of the oval window by means of a ligament of elastic fibres. 2. These fibres gradually converge toward the edge of the foot plate of the stapes. 3. The ligament arises from the periosteum in the neighborhood of the oval window and passes over to the base of the stirrup, when it again assumes the function of periosteum. 4. The breadth of the ligament is the same all around the periphery of the base of the stapes.

The Malleo-Incudal and Incudo-Tympanic Joints.—The malleo-incudal and incudo-stapedial joints may be regarded as a variety of synchondrosis or synchondrosis.¹⁰ These connections, furthermore, are not to be regarded as true or ordinary joints. They are all of peculiar structure, since between the cartilaginous surfaces of the bones there is a fibrous, or a fibro-cartilaginous, intermediate substance. Rüdinger reasserts the true joint-like structure of the articulations of the ossicula.¹¹ He also maintains that in both the malleo-incudal and incudo-stapedial joints there is a fibro-cartilaginous disc connected with the capsular ligament, but not with the hyaline covering of the articular surfaces of the bones.

If the *tegmen tympani* be removed, let us say, from the right tympanic cavity, the malleo-incudal joint and the incudo-tympanic joint will be exposed to view (see Fig. 1688), and just in front of the head of the *malleus*, but below it, will be seen the tendon of the *tensor tympani* muscle coming upward and inward from the left, to be inserted into the tubercle on the neck of the hammer. Above this tendon, winding from within outward, and to the right (in the figure) around the neck of the malleus, is seen the

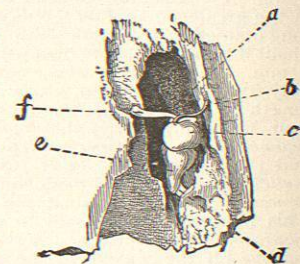


FIG. 1688.—Right Tympanic Cavity viewed from above: Malleo-incudal and incudo-tympanic joints. (Magnified two diameters. Henle.) c, Head of malleus; e, short process of incus; f, tendon of tensor tympani muscle; d, capsule of incudo-tympanic joint; a, ligamentum mallei anterius; b, chorda tympani nerve.

chorda tympani on its way to the Glaserian fissure. The suspensory ligament of the malleus is attached to the roof of the tympanic cavity, but is not shown in the figure, as it has been removed with the *tegmen*.

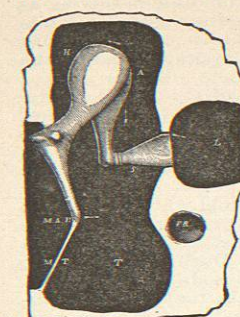


FIG. 1689.—Diagrammatic Representation of the Relation of the Ossicles to One Another, to the Membrana Tympani, and to the Internal Ear. (Buck.) T, Cavity of tympanum; L, labyrinth; M.A.E., meatus auditorius externus; H, hammer; A, anvil; S, stirrup; M.T., membrana tympani; F.R., fenestra rotunda.

incudo-stapedial joint. The *incus* is the most porous of the ossicles. The average length of the *stapes* is 3.7 mm.; its average breadth between the *crura*, 2.3 mm. Its head is either entirely straight (twenty-nine times) or inclined toward the anterior (eighteen times) or posterior limb (three times); in one case the head pointed upward, i.e., toward the upper edge of the foot plate of the *stapes*.¹²

The Weight of the Ossicula Auditiva.—The weight of the auditory ossicles varies greatly with the age of the individual. It is also a fact that the proportionate weight of the ossicula, one to another, is not constant. In the new-born child the proportionate weight of the *malleus* to the *incus* is generally as twenty to seventeen, and in a malleus weighing 20 mgm. the weight would be distributed as follows: The head of the *malleus*, including that portion of the neck just above the short process, 16 mgm.; the long process, including the short process, 4 mgm. In an *incus* weighing 17 mgm. the body of the *incus*, including the short process and the base of the *processus longus* as far downward as the lower lip of the inferior articulating surfaces, weighs 14 mgm.; and the long process with the *processus lenticularis* attached, 3 mgm., the corresponding *stapes* weighing very nearly 4 mgm. In the adult the weights of the *malleus* and the *incus* are, as a rule, more nearly equal; in some cases, however, the proportionate weight of the *malleus* to the *incus* is as seven to eight.¹³ According to the same observer, the distribution of the weight of the ossicula, above and below the axis line (see page 587), is as follows: In a *malleus* which weighed 21 mgm. and an *incus* 25 mgm., the combined weight of the portions of these two bones, above the axis line, was 30 mgm.; that below the line, 16 mgm., or in the proportion of fifteen to eight. This preponderance of weight in

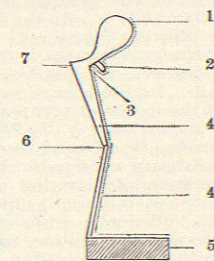


FIG. 1690.—Diagrammatic Representation of the Formation of the so-called Pouches of the Membrana Tympani. (C. H. Burnett.) 1, Mucous membrane of the inner surface of the membrana tympani, as shown by dotted line; 2, reflection of same over the chorda tympani; 3, pouch of the membrana tympani; 4, inner surface of the membrana tympani; 5, section through osseous floor of the tympanic cavity; 6, umbo of the membrana tympani; 7, short process of malleus.

the parts of the *malleus* and *incus* above the axis line tends to act as a mechanical counterbalance, and renders the two bones better able to swing upon the axis line. It also serves to increase the delicacy of a mechanism which responds to sound waves in excursions so infinitesimal that the highest powers of the microscope cannot detect them (Helmholtz).

The three ossicles which have been described, when joined together, form the so-called chain of auditory bonelets. They then act as sound conductors between the *membrana tympani*, in the external ear, and the vestibule, in the internal ear (see Fig. 1689). Every inward movement of the tympanic membrane is followed by a similar inward motion of the stapes, and the foot plate of the latter impresses the lymph in the labyrinth and, mediately, the terminal filaments of the auditory nerve in the cochlea and other parts of the internal ear. The compression of the lymph in the labyrinth finds a

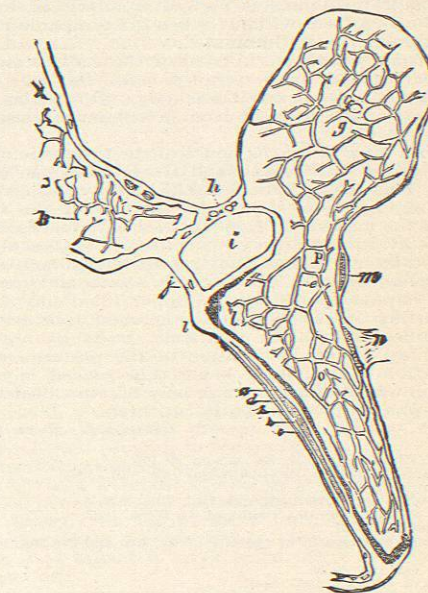


FIG. 1691.—Section through the Long Axis of the Malleus at Right Angles to the Membrana Tympani. From an adult. (Brunner.) Bony edge of the so-called scute or inner edge of upper wall of auditory canal, in the segment of Rivinus; g, head of the malleus; p, neck of the malleus; o, handle of the malleus; l, short process of same; j, membrana flaccida; h, ligamentum mallei externum; m, chorda tympani; n, tendon of tensor tympani; t, a cavity, according to Prussak and others; a, cartilage; b, b, fibres of the membrana tympani; c, dermoid layer of the membrana tympani; e, Haversian canals; f, medullary space.

compensatory yielding at the membrane of the round window. Were this not so, the nerve filaments would be in danger of too much compression with each sound wave which carries the chain of ossicles inward.

The *membrana tympani* forms most of the outer wall of the tympanic cavity. The limit of this outer wall is made by the *annulus tympanicus*. Upon the inner surface of this outer wall of the tympanic cavity lie the manubrium of the malleus, the *chorda tympani*, and the duplicature of mucous membrane about the latter, which forms also the so-called pockets of the tympanic membrane.

These pockets or pouches of the *membrana tympani* are the spaces lying between the upper edge of the *membrana tympani* and the aforesaid duplicature of mucous membrane around the *chorda tympani* nerve, in the so-called horizontal portion of its passage through the tympanic cavity. There are two, the anterior or smaller one

and the posterior or larger pocket, formed in the following manner (see Fig. 1690, 1, 2, and 3). After the mucous membrane of the tegmen tympani has been reflected over the chorda tympani, it ascends again to reach the upper edge of the drum membrane, in order to form the inner or mucous layer of the tympanic membrane; therefore the chorda tympani nerve is found at the free edge of a fold of mucous membrane which, with the membrana tympani, forms a groove opening downward (Fig. 1690, 3). Since the chorda tympani clings to the inner surface of the neck of the malleus, this groove or pocket is divided into two compartments, named as already mentioned. They were first described by von Troeltsch in 1856. He asserted that the posterior one contained in its structure traces of the fibrous layer of the tympanic membrane, but this is denied by Gruber and Bochdalek. The posterior pouch is about 3 mm. high and 4 mm. broad. This pouch is best seen when the tympanic membrane is viewed from within, but it can also be seen from without when the tympanic membrane is thin and well illuminated.

The anterior pouch lies in front of the malleus, and is much smaller than the posterior pouch. Its inner wall is composed of mucous membrane only. It contains "all the elements which proceed from or enter the Glaserian fissure."

There is a third or middle pouch of the tympanic membrane described by Prussak and Gustav Brunner (Fig. 1691, 4). This cavity is bounded behind by the neck of the hammer, below by the upper surface of the short process of the malleus, in front by the membrana flaccida, and above by a ligamentous band, the *ligamentum mallei externum*, which is inserted between the *margo tympanica* and the *spina mallei*. This cavity is separated from the anterior tympanic pouch by the upper blind end of the latter abutting on the neck of the hammer; posteriorly, it communicates with the tympanic cavity by a good-sized opening, above the position of the posterior tympanic pouch. This pouch, being thus placed in communication with the tympanum, may become filled with mucus or pus, and consequently ruptured.

Charles H. Burnett.

- ¹ Archiv f. Ohrenheilkunde, Bd. xl., pp. 99-113.
- ² Trautmann: Archiv f. Ohrenheilkunde, Bd. viii., 1873.
- ³ Trautmann: *Loc. cit.*, p. 28.
- ⁴ Kessel: Archiv f. Ohrenheilkunde, Bd. viii., 1874.
- ⁵ Gruber: Studien über das Trommelfell, Wien, 1867.
- ⁶ Gewebelehre, p. 707.
- ⁷ Helmholtz: Mechanism of Ossicles of the Ear and the Membrana Tympani.
- ⁸ Gruber: *Op. cit.*, p. 35.
- ⁹ Archives of Otolaryngology, 1885, p. 46.
- ¹⁰ Gustav Brunner: Monatschr. für Ohrenheilk., No. 1, 1872.
- ¹¹ Monatschrift f. Ohrenheilkunde, No. 3, 1872.
- ¹² Archiv für Ohrenheilkunde, Bd. xl., 1876.
- ¹³ Dr. C. J. Blake: Transactions American Otolaryngological Society, vol. 1, p. 543.

EAR DISEASES: ACUTE CATARRHAL OR NON-SUPPURATIVE INFLAMMATION OF THE MIDDLE EAR.—GENERAL CONSIDERATIONS.—In the beginning of an acute inflammation of the middle ear, and not infrequently for a considerable length of time after the apparent onset of the attack, it is impossible to determine whether the case should be classified as one of a suppurative or as one of a non-suppurative character. It is only after the acme of the disease has been reached, and after it has been ascertained what is the character of the inflammatory product that is poured out into the tympanic cavity, that we are warranted in classifying the particular case under observation as belonging to the one or the other category. If the inflammatory product is composed merely of serum, intermingled or not, as the case may be, with a few blood and lymphoid corpuscles, it is generally customary to speak of such an attack as an acute catarrhal or non-suppurative inflammation of the middle ear. But if the product under consideration quickly assumes a purulent character, and especially if the membrana tympani gives way and allows it to flow out into the external auditory canal for a period of one or more days, it is proper to designate such a case as one

of acute suppurative inflammation of the middle ear. It is difficult to resist the belief that in both of these types or varieties of middle-ear inflammation the underlying cause is an infection; some milder forms of bacteria serving as the exciting factors in the non-suppurative variety, while in the other variety the more virulent micro-organisms must be held responsible for the suppuration and for the actual destruction of tissue.

An acute catarrhal inflammation of the middle ear is a very common affection in the northern and middle zones. A large proportion of the cases designated by the laity as cases of "earache" will be found to belong in this category of acute catarrhal inflammations of the middle ear.

ETIOLOGY.—Undue exposure to cold while the body is in a heated condition, and especially to a draught of cold air, is by far the commonest cause of an acute catarrhal inflammation of the middle ear. Ducking and diving under water (especially salt water) is also occasionally a cause of such an attack, although in the majority of instances the result is a suppurative rather than a non-suppurative form of inflammation. Water may also enter the tympanum in the treatment of the nasal cavities by means of the nasal douche or the posterior nares syringe, or even when water is drawn into the nostrils by the patient himself. Finally, the disease may develop as a consequence or accompaniment of certain infectious diseases such as scarlet fever, measles, smallpox, whooping-cough, and cerebro-spinal meningitis.

SYMPTOMS.—*Pain.*—Adults suddenly find themselves seized with an agonizing pain in one, rarely in both, ears. If they are of an observing turn of mind, they will recall the fact, when they are thus seized with pain, that the throat felt sore and thickened for a few hours before the attack began. This, however, is not always the case. The pain is usually sudden in origin and goes on increasing in intensity until the rupture of a distended veinlet in the vicinity of Shrapnell's membrane, or of an epidermal sac containing blood-stained serum, or perhaps even of the membrana tympani itself, puts an end to the tension of the sensitive parts.

A Sense of Fullness in the Ear.—A marked sense of fullness or of stuffiness in the ear is another very annoying subjective symptom of this disease. It is likely to last as long as there is any appreciable swelling of the walls of the Eustachian tube.

Tinnitus Aurium.—This symptom, common to affections of the tympanum, is often a violent one in acute inflammation. In the first stages it is usually of a puffing or blowing character.

Resonance of One's Own Voice.—This symptom, sometimes termed *autophony*, is to many patients very annoying. It disappears with the subsidence of the swelling of the inflamed tympanic mucous membrane.

Impairment of the Hearing.—The extent to which the hearing is affected varies greatly in the different cases, and bears no fixed relationship to the degree of hyperemia and infiltration manifested by the visible portions of the membrana tympani. In most cases the hearing is not sufficiently impaired—even when both ears are involved—to exclude the patient from the pleasures of ordinary conversation. Now and then, however, the degree of impairment is very marked, and in these particular cases it is difficult to resist the belief that the labyrinthine cavities and structures are more or less involved in the inflammation.

Constitutional Disturbance.—In adults there is usually no rise in the body temperature and very little if any acceleration of the pulse rate; but in young children there may be well-marked feverishness, with a temperature reaching as high as 103° or even 104° F. In some cases the child may manifest an unnatural drowsiness, but in others the opposite mental state—that of excitableness and fretfulness—will be observed.

APPEARANCES PRESENTED BY THE MEMBRANA TYMPANI.—The picture presented by the drum membrane varies according to the stage which the disease has reached at the time when the examination is made. If the mem-

brane is seen at an early period of the attack, before pain has become the prominent symptom, the peripheral portions, especially the upper, and the region of the manubrium mallei will show evidences of congestion and beginning infiltration (Fig. 24, Plate xxv.). Farther along in the attack it may be found that the epidermis, in the vicinity of Shrapnell's membrane, has been pushed outward in the form of a bleb by exuded serum or even by pure blood that has escaped from a ruptured blood-vessel. In other cases the exudation remains confined chiefly to the tympanic cavity; in which event bulging of the drum membrane—more noticeably of its posterior half—will be the most conspicuous alteration. Finally, if the examination is made at a time when a watery, perhaps blood-stained, fluid is escaping from the orifice of the external auditory canal, it will be seen that all the usual landmarks have disappeared and that at the farther (inner) end of the canal nothing but a soaked epidermal surface, of very irregular form, can be distinguished.

DIFFERENTIAL DIAGNOSIS.—There are only two other pathological processes which might perhaps be mistaken for the disease which is now under consideration. These are an acute eczematous inflammation of the inner half of the external auditory canal, involving the dermoid aspect of the membrana tympani, and an acute suppurative inflammation of the middle ear. So far as the eczema is concerned, the previous history of the case, the absence or the insignificance of the pain, the small degree of the impairment of the hearing, the probable absence of tinnitus, and the marked hyperemia and infiltration of the skin covering the inner half of the external auditory canal,—all these facts will warrant us in assuming that we are dealing with this malady and not with an acute inflammation of middle-ear origin. On the other hand, no degree of familiarity with the pathological pictures presented by the membrana tympani and no degree of care in studying the other data furnished by the case in hand will enable the expert otologist to predict, with any degree of certainty, whether the disease will eventually prove to belong to the non-suppurative variety or whether it will assume the more serious characteristics of an acute suppurative inflammation. Fortunately, it is not a matter of any great practical importance that he should be able, at this comparatively early stage of the inflammation, to differentiate between the two. In either event he would employ the same plan of treatment; a change being called for only when it becomes clear that he is dealing with a disease the essential nature of which is an invasion of infective micro-organisms.

PROGNOSIS.—The prognosis in this disease is almost unqualifiedly favorable. The middle ear, after the subsidence of the acute attack, returns slowly to a condition of health, and it is only in a few exceptional cases that some slight permanent impairment of the hearing remains after the attack has entirely subsided.

TREATMENT.—An acute inflammation of the tympanum usually requires active treatment, especially in adults. The practitioner should at once combat the striking symptom, that is, the pain. The first means to be tried is the hot douche. Water of the temperature of from 100° to 105° F. should be allowed to run into the ear, from a fountain syringe or the like. The stream of water should be continuous; hence, the piston syringe is of no use under these conditions. This instrument is only valuable as a means of cleaning the ear, or of removing a foreign body. In case the warm douche fails to give relief in a few minutes, and if the patient is not an infant or a very young child, from one to four or even six leeches should be applied upon the tragus, according to the severity of the symptoms and the age of the patient. In addition to this the patient should usually be confined to his room, and be in bed, while the general indications of the disease, the condition of the bowels, the skin and the pharynx, are met by appropriate treatment. Usually the leeches will soon subdue the pain, and appropriate hygiene, without drugs, will allow the case to go on to recovery. It will sometimes be necessary to repeat the leeching and to continue the

use of the douche for some days; opium may also be required, but opium without local blood-letting will be of little or no service. Some authorities speak well of the instillation of a solution of sulphate of atropine, gr. ij. ad ℥ i., and of hydrochlorate of cocaine in a four-per-cent. solution, instead of the warm douche, but these remedies will not avail, except in mild cases. Hot vapors are sometimes of service. An old remedy is a poultice applied in the canal. The "heart" of a hot onion is especially used. Such a poultice will quiet the pain in many cases, but since it favors suppuration, and may lead to suppuration of the drumhead, its use is not generally proper.

Inasmuch as the question of paracentesis of the membrana tympani will be discussed by the writer of the article on the suppurative form of acute inflammation of the middle ear, it will not be necessary for me to say anything on this subject.

As soon as the acute symptoms have subsided it will be found advantageous to practise Politzer's method of inflation daily, and to wash the pharynx freely with a saturated aqueous solution of warm chlorate of potassium, Vichy, or the like. This treatment should be persisted in until the hearing power becomes normal, as tested by the watch, tuning-fork, and the human voice.

D. B. St. John Roosa.

EAR DISEASES: ACUTE SUPPURATIVE INFLAMMATION OF THE MIDDLE EAR.—Among the numerous diseases to which humanity is liable there is probably no single one which is capable of causing so much suffering for a short time, or is more dangerous to life, than an acute suppurative inflammation of the middle ear; to say nothing of the liability of the disease to cause the impairment if not the destruction of the function of one of the most important organs of special sense, on which are largely dependent the giving of knowledge to the individual, his social position in life, and his general well-being. Yet until within a very few years this disease has been treated as though it were a necessity in every household, a condition through which every child should pass; and even at the present time this way of looking at the disease prevails to some extent.

The distinction between an acute catarrhal inflammation of the middle ear and an acute suppurative inflammation is not always well marked in the early stages of the disease; the suppurative form being doubtless in many instances the outcome of the catarrhal, in consequence of infection or of some other unfavorable circumstance.

Acute suppurative otitis media constitutes from five to ten per cent. of all ear diseases, according to the character of the climate in which the patient resides; being more prevalent in one which is characterized by frequent, rapid, and extreme changes in temperature, and by the prevalence, to a greater or less degree, of dampness. Then, again, the disease is of more frequent occurrence among the poor, among whom the hygienic conditions are especially unfavorable.

The onset of the disease is usually sudden and is attended by violent febrile symptoms lasting for from a few hours to several days; the remission of the most severe symptoms generally occurs soon after the rupture of the drumhead, an occurrence which liberates the pent-up purulent exudate. The discovery of this discharge in the auditory canal is often the first indication of ear disease and even the first circumstance which leads the physician to think of the existence of any trouble in that organ.

The anatomy of the upper portion of the tympanic cavity, known as the epitympanic recess, is especially favorable for the development of suppurative inflammation. Enclosed within this little dome are the bodies of the two larger ossicles, the malleus and incus, and the ligamentous bands which hold these in position—redundations of mucous membrane and connective tissue. Frequently this network of tissue is so developed as to divide the tympanum into two distinct parts. Opening