

copies, have been used to swell this chorus of admiration.

He has another craze. He chooses to assert that there is a conspiracy among what he calls 'the Morgan men' to depreciate and crush him, and that these two articles are part of the plan. We suspect archeology is too engrossing a study for such trivial by-play; and we know, also, that the editors, whom he berates for lending themselves to such a plot, found students in the field too inclined to ignore his work, to bring themselves easily to the bestowal of any time upon criticising it. It is piteous to think how what might have been a useful labor is resulting in discredit and personal intrusiveness.

A STUDY OF THE HUMAN TEMPORAL BONE.—I.

It may be asked why the writer of the present article should publish a subject which has already been so thoroughly and repeatedly investigated, is so familiar, and is treated with the utmost detail in many manuals of anatomy. In his experience as a teacher of anatomy, he has, of necessity, been obliged to observe many important points over and over again; and, as one of the results, he has been led to see some of them differently from the views commonly entertained. As no other bone is so complex as the temporal, and none more important in its relations, it occurred to him that his view of it might prove of interest to students. No discoveries are claimed, and it is probable that what is here written may be found in previous anatomical literature. In some points the details are less complete than those given in the admirable, accurate, and exhaustive 'Handbuch der anatomie' of Professor Henle; but others are perhaps more definitely indicated. For brevity, some of the more obvious details, given in every manual, are excluded.

For convenience of study and reference, it is usual to consider the temporal bone as consisting of the squamous, mastoid, and petrous portions, though these do not accord with the natural divisions observed in its development. To avoid circumlocution, the terms 'squamosa,' 'mastoidea,' and 'petrosa,' are substituted for the ordinary phrases 'squamous portion,' etc.

The *squamosa* is the irregularly circular or oval plate, upright in position, at the fore-part of the bone. Its outer surface, nearly flat or

feebly convex, forms part of the temporal fossa. The inner surface is concave and pitted, as usual in the other bones of the cranium, and is marked by grooves for the great meningeal vessels. It is commonly defined by a fissure of variable extent, remaining as part of the petro-squamosal suture.

Projecting from the lower part of the squamosa, externally, is the *zygomatic process*, which articulates with the malar bone to form the zygoma. The base of the process is broad and strong, and has its upper surface slanting forward. The upper sharp border of the process is continuous backward with a curved line, the *temporal ridge*, which defines the squamosa from the mastoidea.

The squamosa underneath forms the articular surface for the mandible, consisting of the glenoid fossa with the articular eminence in front; both extending outwardly below the root of the zygomatic process. The *glenoid fossa* is a deep, transversely oval concavity, defined behind by the glenoid fissure. The *articular eminence* is a transverse ridge of variable thickness, convex fore and aft, and more or less concave to straight transversely. Variable prominences at the outer part of the articular surface are the *anterior* and *posterior glenoid processes*.

The *mastoidea* is the outer back part of the bone, externally defined from the squamosa by the temporal ridge. It is prolonged below into the conspicuous nipple-shaped eminence, the *mastoid process*. Internally, to the base of the process, is a large fore-and-aft groove, the *digastric fossa*; and internally to this again is a narrow groove for the occipital artery.

The broad archway between the mastoid and post-glenoid processes is formed by the *auditory plate*¹ (fig. 2, *d*), which extends inwardly as the roof of the external auditory meatus. It is partially defined from the temporal ridge by a variable, irregular crescentoid indentation.² The inner extremity defines the meatus from the tympanic cavity by an acute curved edge, from which a wide crescentoid plate, the *tympanic scute*,³ slants upward, and forms the outer boundary of the upper portion of the tympanic cavity. The *scute* (fig. 1, *b*; fig. 2, *c*) can best be seen by sawing the temporal bone fore and aft through the tympanic cavity, and viewing the outer division of the bone from within. The scute is separated externally from the rest of the auditory plate by spongy substance, but occasionally is continuous through thick, compact substance. Its anterior border joins the

¹ Lamina auditoria.

² Post-auditory fossa.

³ Scutum tympanicum.

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and its posterior surface is continuous with the fore-part, giving substance of the outer wall of the mastoid antrum.

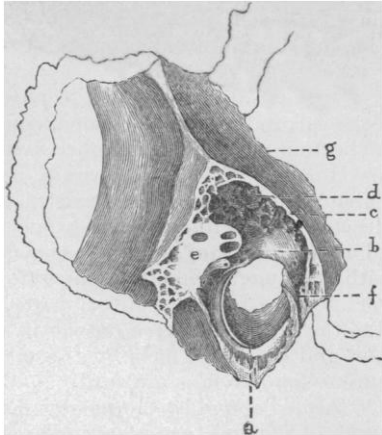


FIG. 1.—View from within of the outer portion of the left temporal bone, sawed through the tympanum, fore and aft, parallel with its inclination. *a*, tympanic margin of the external auditory meatus, formed below and at the sides by the grooved margin of the tympanic plate, and above by the margin of the auditory plate; *b*, scute, forming the outer boundary of the attic; *c*, tegmen; *d*, mastoid antrum; *e*, prominence of the inner posterior boundary of the attic; *f*, canal for the accommodation of the long process of the malleus; *g*, petro-squamosal fissure. Below *e* are seen the pyramid, and the aperture of the tympanic cord.

The inner surface of the mastoidea forms part of the posterior cranial fossa. Contiguous to the petrosa, it is impressed by the large curved channel for the lateral sinus. The upper border is defined from the squamosa by a notch, which receives the posterior inferior angle of the parietal bone. Usually a short canal¹ pierces the posterior border, from the outer surface to the groove for the lateral sinus, for the transmission of a vein.

The *petrosa* is a prostrate three-sided pyramid, with its base applied outwardly against the squamosa and mastoidea, and with its apex directed obliquely forward in the base of the cranium, between the occipital and sphenoid bones.

The posterior surface of the petrosa is the smallest, and forms an uneven slope at the fore-part of the posterior cranial fossa, defined outwardly by the groove for the lateral sinus. Internally, to its middle, is the *internal auditory meatus*, a short, wide canal for the passage of the auditory and facial nerves. Outward from the meatus is an oblique cleft of variable extent, sometimes large and conspicuous, and sometimes nearly obsolete. It communicates with a fine canal,² extending to the vestibule, for the passage of a vein.

¹ Mastoid foramen.

² Aqueduct of the vestibule.

er of the petrosa is an acute ridge, which continues outwardly to the upper border of the mastoidea, and gives attachment to the tentorium. It is usually marked along its course by a groove for the superior petrosal sinus, and its inner extremity is impressed by the trifacial nerve.

The posterior border of the petrosa is sharp and irregular, and joins the occipital bone. Its middle skirts the fore-part of the jugular foramen, and commonly exhibits two notches, separated by an angular process, which gives attachment to a partition of the dura dividing the foramen. At the apex it is usually marked by a groove for the inferior petrosal sinus.

The anterior border of the petrosa is the shortest; and it forms, with the squamosa, a notch, which receives the angular process of the sphenoid bone.

The anterior surface of the petrosa, broad and uneven, forms the posterior boundary of the middle cranial fossa. Above its centre, a conspicuous prominence, together with the contiguous depression internally, marks the position within of the labyrinth. Another depression in front of the apex accommodates the ganglion of the trifacial nerve, and the notch just below communicates with the carotid canal. The portion of surface below the position occupied by the labyrinth is formed by a wide, triangular plate, the *tegmen*,¹ which covers the tympanum, the mastoid antrum, and the eustachian tube. It is commonly more or less defined by a fissure, remaining as part of the petro-squamosal suture, which at birth extends from the notch at the bottom of the squamosa to that at its upper border. Frequently, also, a vascular groove, and several foramina for the transmission of vessels, mark the line of separation. The inner extremity of the tegmen is further somewhat defined from the rest of the petrosa by a groove directed outwardly, and ending in a small aperture, the *hiatus*² of the facial canal, for the entrance of the great superficial petrosal nerve. From the extremity of the tegmen, a narrow bar dips into the glenoid fissure, and separates the tympanic plate from the squamosa. The under part of the tegmen is commonly formed by a layer of spongy substance of variable thickness.

The inferior surface of the petrosa is very uneven. At its fore-part, outwardly, is situated the *tympanic plate*, originally a distinct bone from the rest of the petrosa. It presents a broad, concave surface, directed towards the glenoid fossa, and defined from this by the gle-

¹ T. tympani.

H. Fallopii.

noid fissure. It is produced below into a sharp, irregular crest, the *vaginal process*, variably extended into several uneven points.

The outer portion of the tympanic plate is produced into a cylindrical scroll, which forms the floor and sides of the external auditory meatus. The rough, crescentic border at the entrance of the latter is the *auditory process*, and gives attachment to the auricle. The scroll terminates at the inner extremity of the meatus with an abrupt *tympanic margin* (fig. 1, *a*), which is grooved along its course within for the insertion of the tympanic membrane.

The inner extremity of the tympanic plate closes the lower part of the eustachian tube.

Back of the vaginal process, and partially sheathed by a downward extension of the same, is the usually conspicuous *styloid process*. This is a narrow, tapering spine, of variable length, from half an inch to an inch or more, directed from the petrosa downward, forward, and inward. Before maturity it is commonly a distinct bone,¹ joined by cartilage to a short cylindrical base,² which occupies a pit or groove embraced by the vaginal process. Prior to puberty it is, for the most part, cartilaginous, and is usually lost in prepared specimens of the temporal bone.

Between the styloid and mastoid processes is the *stylo-mastoid foramen*, which is the exit of the facial canal. Behind it is a broad, mostly quadrate, articular facet, which joins the jugular process of the occipital bone. Adjacent, inwardly, is the *jugular fossa*, a concave recess of variable capacity, and commonly differing proportionately from that of the opposite bone of the same skull. It accommodates the commencement of the jugular vein, and forms the fore-part of the outer division of the jugular foramen. To its inner side is a pyramidal pit, which communicates at bottom with a fine canal,³ extending to the cochlea, for the passage of a vein. The mouth of the pit extends downward in a groove, which forms the fore-part of the inner division of the jugular foramen.

Inwardly from the lower extremity of the jugular fossa, and behind the inner extremity of the vaginal process, is the entrance of the *carotid canal*. This ascends vertically, and then curves abruptly inward, and proceeds to the apex of the petrosa. It is sometimes incomplete at its inner fore-part, when, in the recent state, it is closed by fibrous membrane. It gives passage to the internal carotid artery and sympathetic nerve.

The uneven surface beneath the apex of the petrosa, at the fore-part, gives origin to the elevator of the palate, and, just behind, gives attachment to the pharynx. Back of this, the irregularly grooved part joins the occipital bone, having the interval occupied by fibro-cartilage.

The *external auditory meatus*, or outer passage of the ear, in the prepared bone, communicates at bottom with the tympanic cavity. It is a curved canal, with the convexity upward, and is about two-thirds of an inch in length. It is directed from without inward, and a little forward and downward. Its cross-section is oval, with the longer diameter inclined forward. The roof, formed by the auditory plate, is extended to the greatest degree outwardly; while the floor and sides, formed by the tympanic plate, are extended most inwardly. The entrance is formed above by the narrowing of the broad arch of the auditory plate, and below by the auditory process curving up at the sides to the roof of the meatus. The *tympanic orifice*¹ (fig. 1, *a*), or communication with the tympanic cavity, is oval, or nearly circular, and very oblique, with its plane inclined outward and downward to an angle of about 50°. It is formed above by the sharp, curved tympanic margin of the auditory plate, and below by the horseshoe-like tympanic margin of the tympanic plate, grooved within for the insertion of the tympanic membrane.

The *glenoid fissure*² defines the tympanic plate from the fore-part of the squamosa, behind the glenoid fossa, and remains as a portion of the petro-squamosal suture. Its outer part is closed by ankylosis of the tympanic plate with the post-glenoid process. Its inner part receives a bar, dipping into it from the tegmen of the petrosa, and separating the tympanic plate from the squamosa. At its middle is a foramen, — the exit of a short, oblique canal³ from the tympanum, for the accommodation of the long process of the mallet and the tympanic cord.

The *eustachian tube* is a short, oblique canal, communicating outwardly with the tympanum, and opening inwardly in front of the apex of the petrosa, at the notch between this and the squamosa. It is formed in front and beneath by the inner extremity of the tympanic plate, above by the tegmen, and behind by the anterior wall of the carotid canal. Its inner extremity is roughened for the attachment of the cartilaginous portion of the tube.

¹ Stylo-hyal.

² Tympano-hyal.

³ Aqueduct of the cochlea.

¹ Apertura tympanica.

² Fissure of Glaser; Glaserian fissure.

³ Canal of Huguier.

At the upper part of the tube, extending into the tympanum, is the receptacle of the tympanic tensor muscle. This is formed by a thin, cylindrical scroll, commonly open along its fore-part, but closed in the recent condition by fibrous membrane. The upper extremity of the scroll tapers, curves outwardly, and projects as a short conical process¹ into the tympanum. Sometimes the receptacle forms a complete osseous tube, open only at the ends.

The *internal auditory meatus* is a cylindrical canal, about a third of an inch long, extending directly outward from near the middle of the posterior surface of the petrosa. The bottom of the meatus is directed forward and outward, and is applied to the base of the cochlea and to the vestibule. It is divided into two fossae by a transverse ridge, which expands, at the extremities, into the front and back walls of the meatus. In the upper fossa, internally, is the aperture of the *facial canal*,² by which the facial nerve leaves the meatus. The facial canal advances a short distance, and communicates, through the *hiatus*,³ with the anterior surface of the petrosa. Turning abruptly outward and backward in the upper part of the inner wall of the tympanum, it then curves downward in the posterior wall, and ends under the name of the stylo-mastoid foramen. It is sometimes open along its course at the upper part of the tympanum, but is then closed in the recent state by fibrous membrane. Outward from the entrance of the facial canal is a concave recess, with a circular or oval group of minute foramina, which communicate with the *superior cribriform macula* of the vestibule. On the outer extremity of the transverse ridge of the bottom of the meatus there is a variable number of little pits, or foramina, usually two or three, which likewise communicate with the macula just mentioned.

The lower fossa of the meatus is impressed with a band-like *spiral tract*,⁴ which is pierced along its course with numerous minute foramina. These sometimes exhibit a slight tendency to arrangement in little groups in longitudinal series; though I have never seen a specimen exhibiting even a well-marked approximation to the regularity represented in fig. 725 of Sappey's *Traité d'anatomie*, second edition. The foramina communicate with canals of the modiolus, and transmit the filaments of the cochlear nerve.

Centrally, at the termination of the spiral tract, there is usually a conspicuously larger

foramen, which gives passage to the central artery of the modiolus.

Above the commencement of the spiral tract, and just below the transverse ridge, is a recess, variably distinct, sometimes scarcely marked from the spiral tract, sometimes forming a conspicuous depression or pit, with a little circular group of minute foramina, which communicate with the *middle cribriform macula* of the vestibule.

In the outer wall of the meatus, near the recess just indicated, is the aperture of a narrow canal, which is directed outwardly, and terminates in a group of minute foramina, which communicate with the *inferior cribriform macula* of the ampulla of the posterior semicircular canal. The three groups of foramina, communicating with the cribriform maculae, transmit the filaments of the three divisions of the vestibular nerve.

The *tympanic cavity* occupies a position at the fore-part of the petrosa, beneath the tegmen, and closed in front by the tympanic plate. It communicates outward with the external auditory meatus, outward and backward with the mastoid antrum, and inward and forward with the eustachian tube. Closed externally by the tympanic membrane, it forms the *tympanum*, or ear-drum, — an air-chamber intermediate to the external auditory meatus and the labyrinth. Within it are contained the ear-ossicles.

The tympanic cavity is obliquely placed parallel with the long axis of the petrosa. It may be regarded as consisting of two portions, — the main chamber, which may be named the *atrium*, situated directly opposite the external auditory meatus; and a recess above this, which may be distinguished as the *attic* (fig. 1, b).

The *atrium*¹ is discoid in shape, and is defined outwardly by the prominent edge of the tympanic orifice of the external auditory meatus. Its usual dimensions are about half an inch obliquely, fore and aft, and in height, and about two and a half lines from within outward. The inner wall is next the labyrinth, and in great part is visible through the external auditory meatus. It exhibits a conspicuous smooth eminence, the *promontory*, caused by the projection of the cochlea. The back part of this arches over a deep recess, looking backward and outward, and having at its inner side an aperture, the *round window*,² which communicates with the cochlea, and, in the recent state, is closed by the cochleo-tympanic

¹ Processus cochleariformis. ² Aqueduct of Fallopius.

³ H. Fallopii.

⁴ Tractus spiralis foraminosus.

¹ Atrium tympanicum.

² Fenestra rotunda; f. cochleae.

membrane.¹ Above the promontory, and over the position of the round window, is a concave recess, at the bottom of which is the *oval window*.² This is half oval or slightly reniform, with its longer diameter nearly horizontal, and it is directed outwardly. It communicates with the vestibule, and, when complete, is closed by the insertion of the base of the stirrup.

In advance of the oval window is the projecting end of the scroll or tube, which serves as a receptacle for the tympanic tensor muscle.

Below the promontory, curving fore and aft around it, is a concave, rough, cellular recess, which extends outwardly, and is defined by the tympanic margin of the tympanic plate. The lower part of the recess is the floor of the tympanum, situated above the jugular fossa; its back part forms the lower portion of the posterior wall of the tympanum; and its fore part, the lower portion of the anterior wall, situated just external to the ascending portion of the carotid canal. Above the recess, in front and inwardly, is the orifice of the eustachian tube. In front of this is the short, narrow, oblique canal, which opens into the glenoid fissure, and receives the long process of the mallet, together with the tympanic cord.

Within the posterior wall of the tympanum is the descending portion of the facial canal; and in advance of this is the receptacle for the stapedius muscle. The receptacle is a cylindrical cavity, about a fourth of an inch long. Ascending in front of the facial canal, it then curves forward beneath this, and tapers to an aperture at the summit of a little conical process, the *pyramid*. It is separated from the facial canal by a thin partition; but this is not unfrequently more or less imperfect, and is then, in the recent state, closed by fibrous membrane. The receptacle also communicates with the facial canal by one or two small canals for the passage of the vessels and nerve of the stapedius. The pyramid projects forward into the tympanic atrium, behind the position of the oval window. It is commonly connected with the contiguous wall by several little radiating bars, one of which joins the promontory. Between the pyramid and the recesses of the round and oval windows there are two vacant recesses.

Close to the back margin of the tympanic orifice of the external auditory meatus, a little below the level of the pyramid, is the opening of a small canal from the facial canal, which admits the tympanic cord into the tympanum.

The *attic*¹ of the tympanum is a pyramidal recess over the atrium, and above the tympanic orifice of the external auditory meatus. Its upper anterior boundary is the tegmen, which separates it from the cranial cavity, and is mostly provided with a layer of spongy substance of variable thickness. Its inner boundary is a convex prominence (fig. 1, *e*; fig. 2, *b*) produced by the contiguous portions of the external semicircular and facial canals. Its outer boundary is the wide crescentic tympanic scute (fig. 1, *b*; fig. 2, *c*) of the auditory plate. It opens above the prominence of its inner boundary, outward and backward, by a large aperture² into the mastoid antrum. Beneath, it opens into the atrium by an elliptical aperture, formed internally by the ridge of the facial canal, and externally by the tympanic margin of the auditory plate. The attic is partially occupied by the mallet and anvil, which thence, by the handle of the former, and the long process of the latter, extend into the atrium.

The *mastoid antrum* (fig. 1, *d*; fig. 2, *f*) is a prolongation of the attic backward and

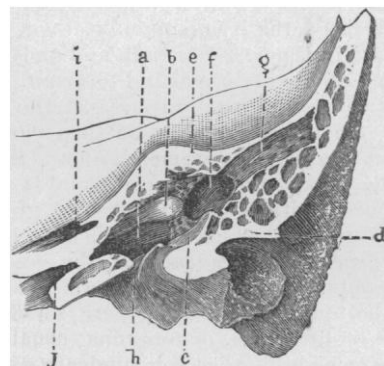


Fig. 2. — Section of the left temporal bone, through the squamosa, immediately in advance of the external auditory meatus. *a*, atrium of the tympanum; *b*, prominence on the inner back part of the attic; *c*, scute at the outer part of the attic; *d*, auditory plate; *e*, tegmen; *f*, mastoid antrum; *g*, anterior passage of the same; *h*, canal for the long process of the mallet; *i*, hiatus of the facial canal; *j*, eustachian tube.

outward in the spongy substance of the mastoid. It is of variable size, ordinarily ranging from that of the attic to double the dimensions of this. It sometimes ends in a blunt, flask-like recess, but is oftener more or less extended downward among the cellules of the mastoid process. Frequently it gives off a smaller fork or passage (fig. 2, *g*), which is directed outward and upward among the

¹ Secondary membrane of the tympanum.

² Fenestra ovalls; *f*. vestibuli.

¹ Atticus tympanicus, upper chamber of the tympanum of Huxley.

² Petro-mastoid canal of Sappey.

cellules above the external auditory meatus; and rarely a third branch is directed more anteriorly.

While the atrium of the tympanum varies but little in size, the attic and mastoid antrum vary greatly.

The *mastoid cellules*¹ consist of air-cavities of variable number, size, and extent, in the midst of the spongy substance of the mastoid. They are commonly more or less proportioned in number and size with age. With the advance of years, they increase in both respects from the conversion of the ordinary marrow-filled, spongy substance into vacant spaces. Later they increase in capacity by expansion and coalescence, and proportionately decrease in number; and often in old age some of them even exceed in size the antrum. The cellules communicate with one another, and, through the sides and extremity, with the mastoid antrum.

Some small but important foramina and canals of the temporal bone, besides those mentioned, are worthy of notice.

In the ridge separating the jugular fossa from the entrance of the carotid canal, there is a fine canal which ascends to the tympanum. It communicates with the atrium at the inner part of the floor, beneath the promontory, and is thence continuous with a groove ascending and dividing into several branches upon the latter. The canal gives passage to the tympanic nerve, which is distributed upon the promontory.

Among the nutritious foramina of the carotid canal, chiefly on its outer wall, there are several larger ones, which communicate with the tympanum, and transmit one or two minute arteries and connecting branches of the tympanic nerve with the sympathetic nerve.

Likewise, in the jugular fossa, there are several foramina communicating with the tympanum for the passage of minute veins. Another foramen in the fossa extends in a fine canal outwardly, and opens into the fissure between the mastoid and auditory processes. The canal transmits the auricular branch of the vagus nerve, and, in its course, communicates with the facial canal.

On the inner extremity of the tegmen, a cleft or groove ends in a fine canal, which proceeds outwardly to the inner side of the receptacle of the tympanic tensor, and communicates with the tympanum. The canal transmits the small superficial petrosal nerve. Another small groove on the tegmen, close to that for the large superficial petrosal nerve,

likewise ends in a fine canal, communicating with the facial canal, for the transmission of the least superficial petrosal nerve.

THE WEATHER IN MARCH, 1883.

The floods reported last month have nearly subsided, though their evil effects will continue to be felt for many months. The Mississippi remained above the danger-line at Cairo till the 12th; at Memphis, till the 15th. It was two feet above danger-line at Vicksburg, and ten inches below the same at New Orleans, on the 31st. The heaviest losses were on the west bank in Arkansas, and here they were more serious than in 1882. It is stated, that on the 11th, to the south of Helena for a distance of two hundred miles, nearly the entire country for about thirty miles from the river was flooded, and a great number of cattle were lost. On the St. Francis River there was more devastation than in 1882; in the vicinity of Oldtown, near Helena, the flood was the worst ever experienced. The situation is more favorable at Memphis than last year. There will be no interference in planting the crops between Cairo and Vicksburg. And while, in 1882, at least 20,000 destitute people were supported more than a month by the government, the losses this year are confined mostly to the drowning of stock. The heavy rains of the 20th and 21st caused damaging freshets in the maritime provinces of Canada.

The chart on p. 386 exhibits mean isobars, isotherms, and wind-directions, for this month. A comparison with the similar chart for February, published in SCIENCE, April 13, shows that the winter area of permanent high pressure, which in February was very extensive, and nearly divided in two by the Rocky Mountain range, had moved to the east of that range, and was central in northern Montana. This area, in connection with the prevailing north-west winds, accounts for the low temperatures of the east. These present a marked deficiency in all sections east of the 97th meridian, the mean being 3.2° below the normal. The lowest temperature reported was -34°, on Mount Washington, the 5th.

Eleven storms have been traced whose tracks lay either in the United States or a little to the north of the boundary. The following table exhibits the number and mean velocity of storms in each March since 1877, so far as they were sufficiently marked to enable a velocity to be determined.

¹ Mastoid sinuses.