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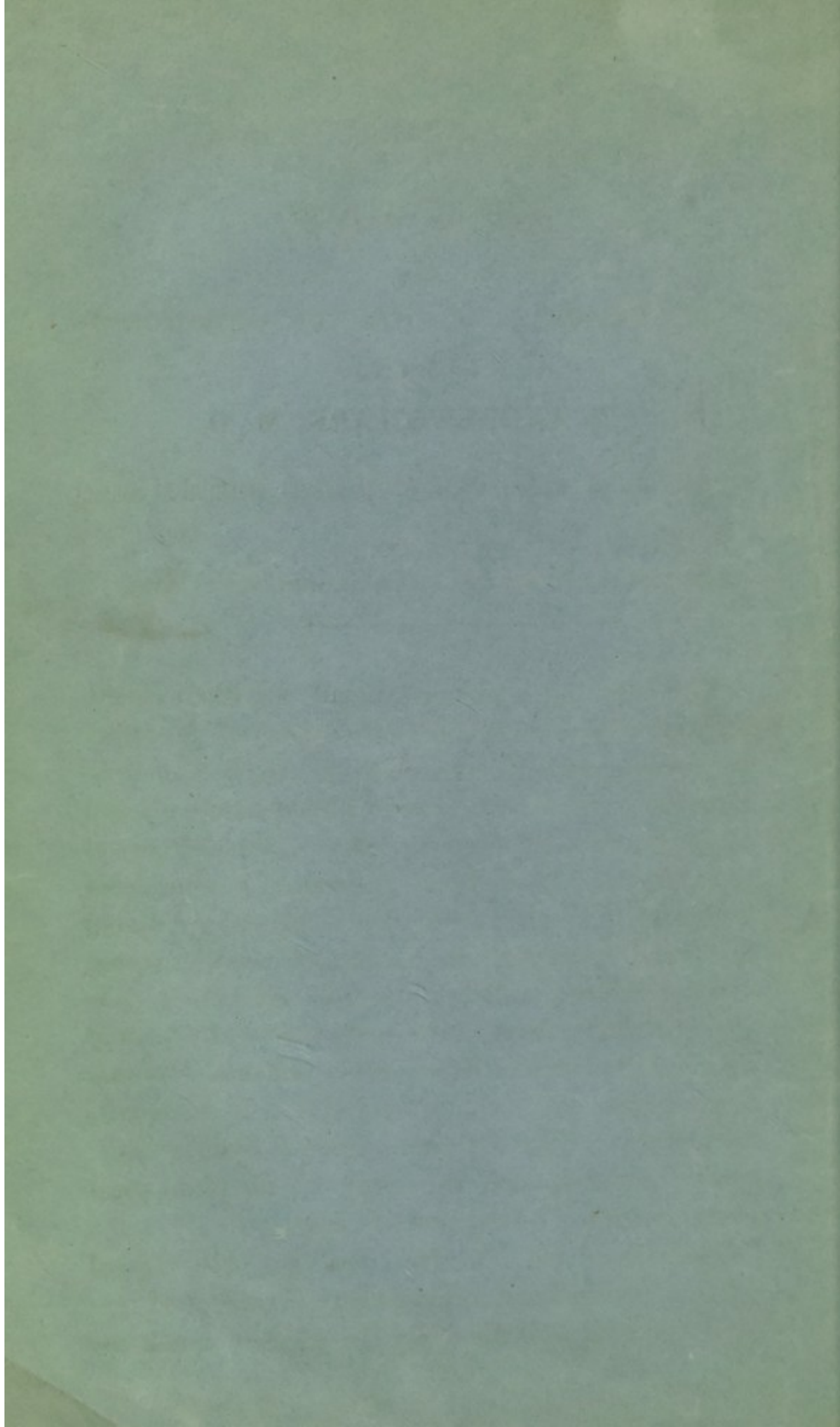
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*To Edwin Rizzall Esq
With Mr. Thomas's kind regards*

OBSERVATIONS
ON
THE ANATOMY OF THE SKIN OF A SPECIES OF
MURÆNA.

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THE following anatomical details are based chiefly on examinations of the skin of a species of *Muræna*; but as the skins of several allied species were likewise examined, and as the points of difference were few and of degree only, the present account of the anatomy of the skin may, in as far as it extends, be considered typical of such members of the eel tribe as are devoid of dermal appendages in the form of bones or scales.

The thickness of the skin in these animals, its density, and the presence of much oily matter, render any minute examination of it extremely difficult. By macerating the skin, however, sometimes in ammonia, sometimes in ether or potass, these difficulties were greatly lessened, and the study of its histological elements rendered comparatively easy.

The skin of the *Muræna* may, in a philosophical sense, be considered a mediate phase of compound textural development, connecting the mucous membrane

on the one hand with the less highly organized tegumentary membrane on the other, and affording an illustration of one of the many gradations of form by which these structures merge into each other.

The only essential elements in the composition of the mucous tissue in its most comprehensive signification are the primary, germinal, or basement membrane, and the layer or layers of epithelial cells on its free surface, the conjoint inflexions of which constitute the follicles or glands.

These elements undergo various modifications, and receive also certain appendages, according to the position in which the tissue is found and the particular end which it is destined to fulfil in the economy.

To the primary membrane and its epithelium are added on its deep surface various forms of areolar tissue and capillaries; and, with the modifications of the former the modifications of the latter sometimes correspond, but not always, and never necessarily. The areolar or filamentous tissue is subservient simply to the mechanical support of adjacent textures and to the preservation of form; or it is present as a means of facilitating motion. The capillaries represent merely so many instruments for the conveyance of nutrient materials to the textures, which themselves select, assimilate, and absorb.

Modified in one way these elements are presented to us in the form of mucous membrane: modified in another way, with additions subservient to protection, motion, &c., they occur as integument or skin.

It is of the essential elements of the mucous tissue, and of certain appendages to these as they occur in the

skin of the *Muraena*, that we are at present to speak. The appendages alluded to are certain layers of fibrous tissue, which from their form and arrangement seem to be in some way subservient to motion.

Instead of considering the germinal membrane as a whole, it will render our remarks more intelligible to treat separately of its inflections in the form of glands; of its epithelium and its modifications; and lastly, of the layers of fibrous tissue on which the basement membrane is placed.

If the surface of a vertical section of the skin be examined with the naked eye, it will appear divisible into two pretty equal parts; — an outer one, dark, dense, firm and semitransparent, and an inner one, yellowish, loose, oily and opaque. The former part consists of the epithelium, the germinal membrane, the pigment, the glands, and the fibrous tissue, which collectively constitute the skin proper; the latter of a very loose filamentous tissue, the interstices of which are filled with fat-globules. The loose tissue just mentioned forms the medium of connexion between the skin proper and the dense white fascia covering the muscles.

Epithelium.

The free surface of the skin is covered by several layers of epithelial cells. Although the form, and even the constitution of these cells varies according to their position on the skin, there are certain fixed characters common to the whole, — characters of which the different forms are simply modifications.

With the exception of vibratile cilia, with which a few of the cells are furnished, the following is the general constitution of these bodies: — 1st, a transparent homogeneous cell-wall lined on its internal surface by a layer of elementary molecules and granules: 2nd, an eccentric nucleus: and 3rd, more or less solid or fluid cell-contents.

In the majority of instances there is an additional layer of granular matter on the exterior or free surface of the cell-wall. These granules are rendered paler, but are not dissolved by acetic acid;* and their quantity appears to be increased on the addition of strong ammonia. The action of acetic acid upon these cells and their contents is much less strongly marked than is ordinarily the case in cells bearing the same structural relations. The cell-contents are either fluid or imperfectly solidified like gelatine: they are of an albuminous character, and have elementary granules imbedded in their interior. The nucleus is large, oval, slightly cupped, and marked by two dark circumferential rings. It is possessed of two coats, — an outer one, clear, structureless, and forming nearly two-thirds of the whole thickness of the nucleus, and an inner one investing an aggregation of dark, refractive, elementary granules. This body appeared to resist the action of ordinary re-agents: dilute sulphuric acid alone appeared to exert any effect upon it, and that, simply by rendering the central granules paler and less distinctly defined.

As illustrative of the principal modifications of these

*The cell-membrane strongly resisted the action of acetic acid: I could never dissolve it entirely by the use of this re-agent.

general characters in respect to both the constitution and form of the cells, I subjoin examinations of the mucus scraped from three different parts of the body,—*from the exterior of the mouth, from the middle of the back; and from around the anal orifice.*

In the matters scraped from the exterior of the mouth there were found, in addition to fluid mucus and elementary granules, three different forms of epithelial cells: these were the ciliated, the tessellated, and the caudate.

The ciliated epithelial cells were from three to five times the diameter of the human blood-disk, irregularly spherical, and analogous in constitution to the same bodies as observed in all the lower classes of the animal kingdom. Each cell was truncated, so as to form an abrupt extremity, which retained its form by means of a ring of elastic fibrous tissue to which the hollow pyramidal cilia were attached.

The tessellated epithelium occurred in the form of patches, the individual cells composing which were small — about $\frac{1}{1000}$ of an inch in diameter — thin, and derived evidently from the cutaneous follicles or glands.

The caudate-shaped epithelial cells were large, delicate, and nucleated. Their greatest breadth might be five, and their length eleven times the diameter of the human blood-disk. The one extremity was full, rounded, bulging, and contained the nucleus; — the other was narrow, and terminated in a filiform point.

The mucus taken from the middle part of the back exhibited the following cellular forms: 1st, the spherical: 2nd, the caudate: 3rd, the tessellated; to these

forms of epithelial cells were added also, a few oil-globules. 1st, the spherical forms of epithelial cells. These varied in size from three to nine times the diameter of the human blood-disk. The smallest cells were nucleated and pretty darkly granular; the larger were paler and more finely granular; whilst the circumferential ring appeared darker and more refractive. The largest cells, though they presented few — and these morphological — differences from the others in anatomical constitution, appeared to differ widely in chemical composition. They were pale, smooth, and delicate; the nucleus generally interior; and the granular constituents either entirely absent or imperceptibly fine. They resemble delicate vesicles filled with oil; and by the action of ether were rendered still paler and less distinct. The first merged into the form last described by a series of almost insensible gradations; and they evidently possessed a definite morphological relation to each other. Of that relation, however, I am not at present prepared to speak: I indicate merely my belief in its existence.

The caudate forms of cells here met with differed considerably from those observed in the neighbourhood of the mouth. They were not pointed at the one extremity; in the majority the cell-contents were of a gelatinous consistence; exosmosis could not be induced in them; and in not a few the nucleus had escaped, carrying with it a portion of the original cell-wall and leaving a distinct hollow in the substance of the parent cell.

The tessellated forms were analogous to those already mentioned as having been found in the neigh-

bourhood of the mouth, and will be described at large when speaking of the cutaneous glands.

Mucus scraped from around the anal orifice, exhibited cellular forms similar to those just described; but in addition to these, there were observed also certain combinations of epithelium which will be noticed under the head of glands. The integument about this part was soft and velvety; and conveyed to the touch an impression similar to, but somewhat rougher than that experienced on moving the fingers along the mucous lining of the ileum in man.

By microscopic examination, this was found to arise from the presence of numerous villous-looking bodies projecting from the free surface of the skin. These were about half the size, and somewhat of the shape, of the villi met with in the human intestine. They appeared as long saccular projections from the skin, filled with granular non-nucleated corpuscles. The outline of each was dark, sharp, and depended evidently on the presence of a distinct limitary membrane. I could detect no cellular forms on the outer or free surface of these bodies: they resembled in their general outline the villi of the choroid plexus, but there was no apparent cavity and no trace of vessels in their interior.

The limitary membrane of these bodies presented on its inner surface delicate hexagonal markings, analogous to those met with in the middle or basement membrane of the scales of the *Percidæ*: I was unable, however, to trace the structural relations of that membrane to the other tissues of the skin.

These bodies would seem to possess a definite, though

as yet unexpressed, relation to the various maturely developed dermal appendages.

Glands.

These are formed by inflections of the primary or germinal membrane and its epithelium; and are situated in the textures of the skin, on the free surface of which they terminate by open mouths. Some of these openings are visible to the naked eye: others require the aid of the microscope for detection: the former are confined to the lateral line; the latter are of two kinds, — the one studded over the whole surface of the skin, — the other found only around the anal orifice. These openings are the orifices of follicles or glands, — the first and last superficially, the second deeply seated in the structure of the skin.

The glands of the lateral line are continued onwards to the head, with the ossicles of which they communicate by branched and complicated diverticula. It is to these glands, as they are found along the lateral line of the body that I shall confine my present observations. These vary from four to nine lines in length, the chief portion of which lies in a direction nearly parallel to the surface of the skin. The orifice is about half the diameter of the body of the follicle, which immediately within the mouth is pretty equal in breadth throughout. They do not resemble in shape, therefore, nor as we shall afterwards see in structure, the flask-shaped glands of the skin of *Amphibia*.

The margins of the openings of these glands are thick, rounded, almost papilliform; and their cavities,

in the recent state, filled with small epithelial cells in various stages of development. When the latter are removed, the interior of the gland is seen to be lined by a layer of small, flattened, nucleated corpuscles, which, by pressure, may be forced out into the field and broken into irregular patches. These corpuscles are not completely flattened; are more or less regularly hexagonal, granular, and furnished with a nucleus which is imbedded in a number of elementary granules. It is seen also that these corpuscles rest on, and are attached to, a very delicate, almost homogeneous membrane, which on the addition of ammonia, becomes distinctly granular. Lining the cavity of the follicle this membrane may be traced towards the free surface of the skin, in which it becomes lost to view between the epithelial and pigmentary layers. This membrane is the analogue of the primary membrane of the mucous and serous tissues; it is the basement or germinal membrane of that modification of the former termed skin, and though it cannot be *distinctly* demonstrated in the interfollicular portions of the integument, no reasonable doubt can, in this case, be entertained of its continuity throughout. In the present case, the pigment of the skin appears to occupy a somewhat anomalous position. In the higher animals it is said to occur in the inferior or young layer of epithelium cells, and is situated externally, therefore, to the supposed seat of the germinal membrane. In the tribe of animals under consideration, it would seem to be the reverse; for although numerous pigmentary granules are found in the epithelial cells, by far the greatest part of the cutaneous pigment is placed *beneath* the

germinal membrane, is granular, occurs in rounded or stellar masses, and is not situated in the interior of cells, though it may possibly have had a cellular origin. The deep surface of this germinal membrane of the follicles is surrounded by a thick layer of inelastic fibrous tissue, which gives support to and determines the form of the gland. This layer is composed of distinct fibres, which appear as if regularly woven into each other, and which at the mouth of the gland are lost in the fibrous extension lying beneath the germinal membrane, and containing in its meshes the granular pigment of the skin.

Glands of the general surface.

In addition to the openings seen along the lateral line and visible to the naked eye, the general surface, as before stated, is studded with other openings of a similar character, but so much smaller as to become visible only to the assisted sight. The diameter of these openings is about $\frac{1}{300}$ of an inch, and nearly uniform throughout. They are rounded or oval; have their margins sharply defined, slightly elevated above the surface and surrounded by thickly set granules of pigment. In a vertical section of the skin, examined by transmitted light, membranous tubes are seen to proceed onwards from these openings to the subcutaneous filamentous tissue in which they terminate. The physical properties of this latter tissue offer a striking contrast to those of the skin proper. The latter is hard and dense, and thin sections may readily be made to transmit the light: the former is loose, soft,

oily, of a dead white colour when compressed, and under all circumstances transmits the light with difficulty. Demonstration of the mode of termination of these tubes, therefore, is attended with considerable difficulty; and even when effected is more the result of chance than of any peculiarities in the means employed. Under favourable circumstances, however, the termination of these tubes may be very distinctly made out. It will then be seen that they end in little saccular dilatations, more or less contracted at different points, as if the cavity were subdivided into compartments by imperfectly developed membranous septa. These tubes and their saccular terminations were generally filled with small oil-globules, which, by manipulation of the glasses, might be made to appear at the mouths of the follicles, on the free surface of the skin. It was almost impossible to determine the exact structure of the parietes of these follicles, on account of the great diffraction of light produced by the oily matter in their interior, from which they could not be freed. Two sorts of fibrous tissue appeared to enter into the composition of their walls,—the one external, loose, reticulated, and connected with the subcutaneous filamentous tissue, and the other an internal or fibrous coat proper, composed of distinct translucent fibres, marked by the presence of atrophied nuclei, and resisting the action of acetic acid. The inner surface of this latter tunic was very glistening, and appeared marked in various ways by horizontal and cross lines. These markings, though in some parts regular, I could not safely refer to a cellular origin. The saccular terminations of these follicles were each imbedded in a

quantity of loose filamentous tissue, containing numerous fat-globules in its meshes.

Glands around the anal orifice.

The openings of these glands were rather larger than those just described, and equal in width to any part of the cavity. The shape of each gland indeed might be likened to a semicircle, the flat surface of which would represent its mouth. The margins of these glands were slightly elevated above the surface, and surrounded each by a single layer of flattened epithelium. In structure, they resembled the glands of the lateral line; but the lining epithelial cells were larger and more delicate, and the surrounding fibrous tissue more scanty and fine.

Fibrous tissue of the Skin proper.

If a horizontal section of the skin be examined on its deep surface, by means of a simple lens, numerous bundles of fibrous tissue will be seen crossing each other at nearly right angles, so as to leave more or less regular quadrilateral interspaces. The one series of these fibres is circular, the other longitudinal, and both are placed somewhat obliquely, the latter more decidedly so than the former. These bundles occur in alternate layers that commence and end with the circular, which are somewhat larger and thicker than the longitudinal. Each layer is distinct, as are also the individual bundles composing it.

Prepared vertical sections of the skin, magnified

about two hundred times linear, are best adapted for developing the structure and relations of this tissue. Examined by transmitted light, a section of this kind exhibits from without inwards,—1st, the germinal membrane and its epithelium: 2nd a layer of reticulated fibrous tissue, containing the granular pigment in its meshes: 3rd, from fourteen to eighteen rolls or bundles of fibrous tissue running nearly parallel to the surface of the skin, traversed vertically — that is, from the outer to the inner surface of the skin — by the wavy tubes of the follicles formerly described, and by certain arctuous bands about to be noticed.

These rolls or bundles of fibrous tissue run in a direction nearly parallel to each other; their average diameter is about the $\frac{1}{500}$ th of an inch; in shape they are irregularly rounded, quadrilateral, or flattened; and the extreme sides of each are marked by two irregular dark refractive lines. Two or more of these layers occur in a section; and although the bundles composing each layer are placed on a level plane, and pursue a similar direction, they do not lie in immediate contact. Each roll, indeed, is separated from its fellow by a parallel depression equal in breadth to its own diameter, and about half as deep. The bottom of each interspace is filled up by one of the bundles composing the subjacent layer, and by the ends of the longitudinal fibres. Each of these cells or bundles of fibrous tissue is smooth on its exterior, of a yellowish colour, oily, and composed, apparently, of numerous molecular fibres, imbedded in a transparent structureless stroma or matrix. These molecular fibres appear to possess a longitudinal arrangement; but by

long maceration in water, or by the addition of weak ammonia, the separate bundles swell up, become pale and granular, and lose every appearance of being composed of longitudinal fibres. These changes are more rapidly and decidedly induced by the action of weak acetic acid. On the addition of this re-agent, the separate bundles almost instantly swell out to nearly double their original size, and become more regularly rounded, exceedingly pale and studded with granules. Simultaneously with the occurrence of these changes, a number of persistent nuclei make their appearance along the margins of each bundle. These are small, transparent, of a yellowish green colour, and oval or somewhat elongated in shape. In this condition, each bundle appears as a rounded, structureless mass studded with innumerable black points. These points or granules are arranged in a transverse direction, and it is in that direction too, that the bundles when in this state are generally cracked or fissured. When greatly diluted acid was employed, the appearance produced in the bundles was very peculiar. Each bundle seemed to be made up of a series of smaller bundles of molecular fibres, twisted in a spiral direction, and imbedded in, or connected to each other by a transparent, structureless matrix. This latter appearance was exceedingly common, and could be at any time induced by the careful reaction of acetic acid.

These bundles are retained in their position partly by a fine, filamentous tissue, which surrounds them in every direction, but principally by numerous arcuous bands which proceed onwards from the areolar

tissue beneath the germinal membrane, pass round the innermost fibrous bundle, and become firmly connected with the arcuous bands of other layers. These bands are composed of elastic, fibrous tissue, and in their progress inwards give off subsidiary bands, which pass between the individual bundles and become connected with other offsets from different parts.

In the foregoing observations, I have confined myself to the detail of mere facts, which on that account must appear more or less unconnected; and I have refrained, purposely, from considering the genesis, development, and morphological relations of the tissues therein described. When my observations have been extended, I shall take an early opportunity of promulgating my views of the physiological relations of these textures.

