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Microscopic Anatomy and Nerve Supply of the Rectum, the Anus and the Hairy Skin surrounding them in Mole.

土龍の直腸、肛門及び周囲の有毛性外皮の顕微鏡解剖と神経分布とに就て.

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Many works have been reported from this laboratory on the nerve supply, especially, the sensory nerve supply, of the lower parts of the alimentary tract, i. e., the rectum and the anus, of man and some animals from the standpoint of comparative anatomy. The present author also was given the opportunity of studying the nerve supply of the rectum and the anus of Japanese mole, a mammal of the rather lowly order of Insectivora. The fine structure of the rectum and the anus, especially, that of the latter part, has been found to show interesting differences by different species of mammals studied hitherto at this laboratory, involving considerable inequality in the nerve supply, especially, sensory nerve supply by species.

The materials fixed for a long time in 10% neutral formol solution were cut into 40μ frozen serial cross-sections and stained by SETO's silver impregnation method. Upon thorough examination of the large series of the very beautifully stained preparations, the results reported hereunder were obtained, in comparative study with the findings observed in man and some other mammals at this laboratory.

I. Individual Findings.

a) *Microscopical Anatomy.*

In mole, the part of the rectum just dorsal to the pars muscularis urethrae (HOSOKAWA) or the part of the urethra corresponding to the pars prostatica and the pars diaphragmatica urethrae in man constitutes the upper part of the ampulla recti where the rectum is inflated as if forming an ampulla. The mucous membrane of this part consists of very short intestinal crypts lined by goblet cells and very ill-developed laminae propria and muscularis mucosae. The submucosa of loose connective tissue is also thin and contains small blood vessels. The tunica muscularis is also very ill-developed but the lamination into the inner layer of circular fibres and the outer layer of longitudinal fibres is fully observable. Outside the muscularis there is an adventitia of loose connective tissue wherein run rather large blood vessels. The dorsal wall of this ampulla recti is closely connected with the sacral bone through a loose connective tissue. This part of the rectum of mole thus is composed of a very thin wall of the large intestine.

In the more caudal pars of the rectum at the level of the basis of the glans penis, the rectal lumen is considerably narrowed down and the intestinal crypts become more or less taller, as shown in Fig. 1. The laminae propria and muscularis

Fig. 1. A cross section of the ampulla recti of a mole at the level of the basis of the glans penis covered by the common epithelium (*e*) to the glans penis and the inner plate of the praeputium. *c* intestinal crypt, *m* tunica muscularis, *s* m. shincter ani ext. of striated nature, *p* periproctal glands, *g* specific large gland layer, *u* urethral lumen. Details in the text. SETO's impregnation. Photo $\times 24$.

Fig. 2. Higher magnification of the specific gland layer covered by striated muscle fibres (*m*) in Fig. 1. *g*. *s* sebaceous glands, *p* glands of periproctal gland nature. Details in the text. Same staining. $\downarrow$ Photo $\times 60$.

mucosae become slightly better developed and the latter is divisible into the inner circular and the outer longitudinal layers in many places. The submucosa becomes thicker and the tunica muscularis is also better grown, particularly so in the dorsal side, where the inner circular layer forms a feeble *m. sphincter ani internus*. It is of interest that in the adventitia of this part of mole periproctal glands lined by a one-rowed cylindrical epithelium already make appearance. Their ducts do not open out into the intestinal crypts but run distalwards to open out in the stratified flat epithelium of the anal mucosa.

Outside the adventitia is a layer of striated muscle fibres circularly covering it. This forms the *m. sphincter ani externus* which is better developed more distalwards. Interestingly enough, a gland layer covered by a striated muscle tissue is found between the basis of the glans penis on the ventral side and the ampulla recti of this part in mole (Fig. 1). This zone is semilunar in form in cross-section and contains two kinds of glands, one of which are located centrally and have the structure similar to that of the periproctal glands and the other are the sebaceous glands found on both sides of the former. Fig. 2 shows a part of Fig. 1 under higher magnification. The ducts of these glands are very powerfully formed and running distalwards open out in the haired skin in the distalmost part of the anus.

Fig. 3. A cross section through the distal end of the rectum of a mole at the level where the glans penis ends. *f* mucous fold, *a* anal epithelium, *m* tunica muscularis, *p* periproctal glands in the adventitia, *s* *m. sphincter ani ext.*, *l* preputial lumen. Details in the text. Same staining. Photo $\times 24$.

Near the distal end of the rectum, longitudinal mucous folds are markedly in formation in the mucous membrane (Fig. 3) and the rectal lumen becomes further constricted and the anal canal finally takes its place (Fig. 4). This part is on the level where the glans penis ends together with the praeputium on the ventral side. The intestinal crypts still show good development in the rectal end part, and no notable change comes forth in the laminae propria and muscularis mucosae, but the submucosa becomes well developed, particularly so in the mucous folds, and comes to contain lymphocytic gatherings and solitary lymph follicles here and there. The tunica muscularis is also well developed and the *m. sphincter ani int.* is very powerfully formed especially in the dorsal side. Formation of the periproctal glands in the adventitia becomes fuller and the *m. sphincter ani ext.* is also in good development.

Once out of the rectum in the anus, the general histology shows abrupt change.

Fig. 4. A cross section through the proximalmost part of the anal canal of a mole. *r* rectal mucous membrane, *f* anal mucous fold lined by the stratified flat epithelium, *i* *m. sphincter ani int.*, *e* *m. sphincter ani ext.*, *p* periproctal glands in the adventitia, *s* haired skin covering the outside of the anal canal. Details in the text. Same staining. Photo $\times 24$.

What we notice first are the well-developed mucous folds, as shown in Fig. 4, and the thick non-cornified stratified epithelium that covers both the columnae and the sinus of the zona columnaris ani as in the zona intermedia.

The lamina muscularis mucosae goes out here without even leaving a rudiment as found in the same part of man and some other mammals. Accordingly, the lamina propria mucosae is directly lined by the submucosa. This subepithelial layer is made of fibrous connective tissue very rich in lymphocytes and sends out well-developed papillae into the epithelium.

The *m. sphincter ani int.* consisting of smooth muscle fibres enters a short way into the distalmost part of the anus but fades out completely before long, so that the submucosa is in direct contact with the adventitia of a loose connective tissue rich in proctal glands. On the other hand, the *m. sphincter ani ext.* of striated nature on the outside of this adventitia retains its good development far into the

Fig. 5. A cross section through the boundary between the zona columnaris (*c*) provided with the mucous folds and the smooth surfaced zona intermedia (*i*) of the anal canal of a mole. *p* periproctal glands, *m* *m. sphincter ani ext.*, *s* outer haired skin. Same staining. Photo $\times 24$.

distalmost part of the anal canal.

The anal canal is a considerably long canal extending distalwards and covered externally by a haired skin. The inside mucous membrane becomes free of folds in the distal one-third of the canal, where the epithelium also thins down. This part corresponds to the *pars intermedia* in man etc. (Figs. 5 and 6).

Fig. 6. A cross section through the *zona intermedia* and devoid of mucous folds of a mole. *p* periproctal glands, *m* m. sphincter ani ext., *s* outer haired skin. Same staining.

Photo $\times 24$.

In the distalmost part of the anal canal, the epithelium turns into an epidermis of thin stratified layer of flat cells which cornify at the surface. The corium of loose connective tissue beneath it contains a small number of hair follicles with sebaceous glands and in nature similar to that of the haired skin covering the anus externally. The m. sphincter ani externus comes between these two skinny parts. The hair follicles in the haired skin around the anal canal gradually increase in number as the rectum is approached and it is of interest that smooth muscle fibres run circularly within it, as in the skin of the outer genitals. Besides, the papillae growing out of the stratum papillare into the epidermis are also very well developed.

b) *Nerve supply.*

Since the tunica muscularis as well as the submucosa are only very ill developed in the upper part of the ampulla recti, the number of the nerve fibres running into these layers is very meagre, and the AUERBACH's plexus formed between the inner and the outer muscle layers as well as the MEISSNER's plexus found in the submucosa are very poorly developed, while the ganglion cells contained in these plexus are exceedingly rare. But as we go more distalwards along the ampulla, the muscularis as well as the submucosa slowly gains in development, so that the above laminae and nerve elements become slowly better and better developed to the maximum in the distalmost part of the rectum. In particular, the m. sphincter ani internus comes to be very powerfully developed in the dorsal side and very well-developed AUERBACH's plexus is formed between this muscle layer and the outer longitudinal muscle layer (Fig. 7). The plexus contains large ganglia formed of numerous nerve cells.

Fig. 7. Well-developed AUERBACH's plexus containing some large ganglia in the distal-most part of the rectum of a mole. *n* small nerve bundle accompanied by a small ganglion in the adventitia, *c* intestinal crypts, *s* submucosa, *i* and *o* inner m. sphincter ani int. and outer layers of tunica muscularis. Same staining, Photo $\times 100$.

Nerve bundles accompanying small ganglia are found running between this muscularis and the m. sphincter ani externus of striated nature, too. The MEISSNER's plexus found in the submucosa, however, is comparatively ill developed and the ganglion cells in it are very few in number.

The ganglion cells in the AUERBACH's plexus can be hardly distinguished into the DOGIEL's Type I and II cells, though some of them show clear enough multipolarity. Seemingly apolar cells with no definable nerve process are not rare either.

The nerve fibres coming into the rectal wall of such a formation contain besides unmyelinated fine vegetative fibres also a considerable number of myelinated thick sensory fibres. Of course thick motor fibres are distributed in the m. sphincter ani

exteruns. These have comparatively simple motor end-plates as their terminations.

The characteristic feature of an AUERBACH's plexus is its constitution by fine incoming vegetative fibres and ganglion cells belonging to the sympathetic, but here, some thick sensory fibres are found also running into the plexus in this part. These sensory fibres come into no fibrous connection with the ganglion cells but pass through the plexus and thence through the inner circular muscle layer or m. sphincter ani int. into the submucosa or further into the propria. Such running courses of these fibres are clear enough in Fig. 7 of low magnification but even better delineated in Fig. 8 of higher magnification.

Fig. 8. Higher magnification of Fig. 7 A. Thick sensory fibres passing through the large ganglion in the AUERBACH's plexus are very clarified. Photo $\times 400$.

Sensory fibres are found in the upper part of the ampulla recti too, but only very sparsely, but in the distalmost part of it, the number of such fibres grows extremely large, as shown in Figs. 7 and 8. Some of these sensory fibres, as shown in Figs. 9 and 10, end in the submucosa or beneath some crypts beyond the muscularis mucosae, but most of them run right through the muscularis mucosae into the connective tissue between the intestinal crypts and end near the surface of such crypts. The terminations are usually of the unbranched and the simple branched types, formed by myelinated stem fibres which, after losing their myelin sheaths, run more or less winding courses while showing frequent change in size, and end sharply without branching or after branching out into 2 or 3 branch fibres.

In Fig. 11 is shown an unbranched sensory termination found between two crypts in the distal part of the rectum. A simple 3-branched termination found between 2 crypts on the boundary between the rectum and the anus is shown in Fig. 12; 2 of the terminal fibres end in the side wall of so many crypts and the other just beneath the stratified flat epithelium of the anus, all in sharp points, and none

Fig. 9. An unbranched sensory termination (*t*) ending sharply in the submucosa (*s*) of the distal part of the rectum of a mole. *M* MEISSNER's plexus, *A* AUEBACH's plexus, fine fibres are vegetative fibres and thick fibres are sensory fibres, *c* intestinal crypts, *m* lamina muscularis mucosae. Same staining. $\times 280$.

Fig. 10. An unbranched sensory termination ending sharply in the basis of the propria mucosae (*p*) of the distal part of the rectum of a mole. *c* intestinal crypt, *s* submucosa, *m* ill-developed muscularis mucosae. Details in the text. Same staining. Photo $\times 400$.

Fig. 11. An unbranched sensory termination ending sharply in the proprial connective tissue between the intestinal crypts (*c*). Details in the text. Same staining. $\times 400$.

Fig. 12. A simple branched sensory termination formed in the propria mucosae of the boundary between the rectum and the anus of a mole. *c* intestinal crypt, *a* anal epithelium, *m* lamina muscularis of the rectal mucous membrane. Details in the text. Same staining. $\times 400$.

of them end intraepithelially.

Besides such sensory terminations, unencapsulated simple glomerular terminations may be found in the submucosa, though only on rather rare occasions. E. g., as illustrated in Fig. 13, the stem fibre, after losing its myelin sheath, repeats des-

Fig. 13. A noncapsulated simple glomerular termination formed in the submucosa (s) of the distalmost part of the rectum of a mole. *c* intestinal crypt, *m* lamina muscularis mucosae. Details in the text. Same staining. $\times 400$.

cribing loops 3 or 4 times to form a glomerule without branching out once. The fibre shows some change in size during its terminal course.

The anal canal extends rather long and has longitudinal folds in its proximal two-thirds, where the lumen is also rather narrow. Both the columnae and the sinus of the zona columnaris forming these folds are covered under a non-cornified stratified flat epithelium and the papillae growing out of the propria into it are also considerably well developed. Lymphocytic gatherings are frequent here, too.

Into this zona columnaris are found running a far larger number of sensory fibres than into the distalmost part of the rectum above. These fibres are sometimes of medium size but often of very large size and usually end in branched terminations, very frequently of rather complex type. The terminal fibres often spread over a considerable area, show frequent and notable change in size in their wavy or looped courses and end mostly in sharp points.

In Fig. 14 is shown a complex branched sensory termination formed of many terminal fibres found spreading over from the somewhat lymphocytose submucosa into the propria beneath a sinus in the uppermost part of the zona columnaris. The same is shown under higher magnification in Fig. 15, which shows very vividly

Fig. 14. A complex branched sensory termination composed of many terminal fibres spreading over from the submucosa into the propria mucosae (*p*) beneath a sinus in the uppermost part of the zona columnaris ani of a mole. *e* epithelium. Details in the text. Same staining. Photo $\times 400$.

Fig. 15. Higher magnification of Fig. 14. A Branch fibres rich in change in size and running specific winding courses are very vividly illustrated. Photo $\times 800$.

how all the terminal fibres very often change their size in their more or less markedly looped courses.

In Fig. 16 is illustrated a branched termination of rather complex form found

Fig. 16. A rather complex branched sensory termination found beneath the anal epithelium on the boundary between the anus and the rectum of a mole. Many branch fibres originated in a thick myelinated stem fibre (s) running in the submucosa show conspicuous change in size during their winding courses before ending sharply. Details in the text. Same staining. $\times 280$.

on the boundary between the anus and the rectum. Here, a thick myelinated stem fibre, upon losing its myelin sheath in the deepest layer of the submucosa, bifurcates into 2 branch fibres which run rather long mutually parallel courses within the deeper part of the submucosa, then turn upwards through the surface layer of the submucosa into the propria; here the branch fibres branch out again into many terminal fibres which run wavy or looped courses while showing very perceptible change in size and spread over a rather wide area before ending sharply. Some of these terminal fibres end beneath the stratified flat epithelium of the anus and some others end in the lower part of the intestinal crypts of the rectum.

In the zona columnaris, branched sensory terminations are found in a rather large number in the upper as well as the middle and the distal parts. As illustrated in Fig. 17, a considerably complex branched termination was found in the distal part of the zone. Here, the stem fibre already bare of its myelin sheath comes into the propria and then branches out into a number of terminal fibres frequently showing change in size which run courses similar to those shown in Fig. 16 above and end in sharp points.

As stated above, the propria of the zona columnaris of mole was found to contain a rather large number of branched terminations spread over a considerable area, but never could I find an intraepithelial sensory fibre in the anal mucous membrane of this part or an intraepithelial or periductal sensory termination in the ducts of

Fig. 17. A rather complex branched sensory termination found in the distal part of the zona columnaris ani of a mole. Details in the text. Same staining. $\times 400$.

the periproctal glands, as found in man and some higher mammals. These negative findings are of interest in showing the low development of nerve supply in this lowly mammals.

The distal one-third of the anal canal is devoid of the longitudinal folds and the lumen is nearly circular in cross-section. This part thus corresponds the zona intermedia ani of man and some other mammals. The epithelium here is somewhat thinner than that in the zona columnaris and the papillae growing out of the propria into it are worse developed while the subepithelial connective tissue is looser in arrangement. But this connective tissue is still rather rich in sensory fibres. Most of the terminations are of branched type similar to those in the preceding zone but somewhat simpler in formation. No intraepithelial fibres as found in this part in man and some other animals could be found in the epithelium of this part of mole. Neither could I find any genital nerve bodies or other corpuseular terminations in my specimen.

This part corresponding the pars intermedia extends far to the distalmost part of the anal canal and thence passes over into the zona cutanea ani which in turn makes transition into the outer haired skin around the m. sphincter ani ext. at the margin of the anal canal. I have outlined the fine structure of these parts already in a foregoing paragraph. The sensory innervation of these skinny parts is considerably different from that in common haired skin, perhaps on account of the similarity of the skin in these parts to the skin of the outer genitals and in particular the rather powerful papillary formation from the stratum papillare of the corium into the epidermis. Here too, I found branched terminations and corpuseular terminations especially, end bulbs formed by sensory fibres of more than medium size in

the stratum papillare, as was the case with the skin of the scrotum and praeputium of man. Besides, plexus-like terminations of sensory hair nerve fibres were notable in the hair-follicle necks.

The abovedescribed subepidermal sensory terminations are more frequent and more complex in formation in the skin over the lower part of the rectum than in the skin over the anal canal. First, I will illustrate the branched terminations with a few examples. In Fig. 18 is shown a branched termination found in the skin

Fig. 18. A branched sensory termination originating in a thick myelinated fibre (s) formed beneath the epidermis (e) of the haired skin covering the distal part of the rectum of a mole. *f* hair follicle, *h* hairs, *m* a few smooth muscle fibres. Details in the text. Same staining. $\times 400$.

covering the lower part of the rectum. The thick myelinated stem fibre runs sub-epidermally into a papilla, then loses its myelin sheath and branches out into several branches. These terminal fibres run winding courses while showing strong change in size and end in sharp points. They never enter the epidermis.

Fig. 19 shows a complex branched termination formed by a thick myelinated sensory fibre just beneath the epidermis of the skin covering the lower part of the rectum. The photo showing only one plane of the specimen, the complicated courses of the numerous terminal fibres are not sufficiently distinct as might be desired. These fibres were found to form frequent loops in their courses while showing conspicuous change in size and were arranged glomerularly in general appearance, so that the possibility of its being an uncapsulated glomerular termination seems not excluded.

The corpuscular termination found in these parts of skin usually belong to the type of rather large-sized end bulbs. These bulbs are mostly found just beneath the epidermis, but it is not rare at all to find some in the deep part of the corium. They are oval in outline and the inner bulb encased in a connective tissue capsule contains

Fig. 19. A complex branched sensory termination showing somewhat a glomerular arrangement of their terminal fibres found subepidermally in the haired skin covering the lower part of the rectum of a mole. Details in the text. Same staining. Photo $\times 800$.

sometimes many and sometimes few cell nuclei. The single thick sensory fibre running into it sometimes ends without branching (unbranched fibre type) or after

Fig. 20. An ovoid end-bulb (*e*) found in a rather deep part of the corium of the haired skin covering the boundary between the rectum and the anal canal of a mole. A thick sensory fibre entering into the end-bulb bifurcates into 2 thick branch fibres showing some change in size before ending more or less sharply. *f* cross section of a hair follicle, *g* sebaceous gland. Details in the text. Same staining. Photo $\times 800$.

branching out into some terminal fibres which show frequent change in size (branched fibre type), in most cases in blunt points, but less frequently in neurofibrillar expansions or sharp points. Not rarely, 2 or 3 end bulbs are found formed on a single stem fibre.

In Fig. 20 is shown an ovoid end bulb found in a rather deep part of the corium of the skin covering the boundary between the rectum and the anal canal. A thick sensory fibre running into the inner bulb poor in cell nuclei in the connective tissue capsule bifurcates there into 2 branch fibres which show some change in size while proceeding near to the distal pole and end more or less sharply.

In the next figure (Fig. 21), we see 2 end bulbs (a and b) formed on a single

Fig. 21. 2 end-bulbs (*a* and *b*) originating in the same stem fibre formed close to the epidermis (*e*) of the haired skin covering the anal canal near its outer orifice of a mole.

Details in the text. Same staining. $\times 600$.

thick myelinated fibre close to the epidermis of the haired skin covering the anal canal near its outer orifice. In *a*, 2 branch fibres run into the inner bulb containing many cell nuclei, then form 3 terminal fibres showing change in size which run looped courses and end in neurofibrillar expansions, while in *b*, the branch fibre, upon running into the end bulb with many cell nuclei, sends out 2 thick terminal fibres which both describe a small loop before ending bluntly.

According to HOSOKAWA, no genital nerve bodies or end bulbs could be found

in the glans penis of mole, but in the inner plate of its praeputium penis, very simply formed end bulbs could be discovered not rarely in the distal part. In my specimens of the haired skin covering the anal canal and the lower part of the rectum, however, rather large and somewhat complexly formed end bulbs and stout complex branched terminations were found in considerable abundance. Thus, it is probable that the haired skin covering the anal canal and the rectum is much more sensorily sensitive than the outer genitals in mole — a finding of high interest from the view-point of comparative neurology.

II. Summary.

The ampulla recti of mole in its proximal part being lined by a very thin wall, the nerve fibres running into it are very limited in number and both the AUERBACH's and the MEISSNER's plexus are very poorly developed, the ganglion cells in them being exceedingly scarce. In the more distal part of the ampulla, however, the muscularis as well as the submucosa become better developed and these formations attain the maximal development in the distalmost part of it. Therefore, in the last part the AUERBACH's plexus is powerfully formed and contains large ganglia, and smaller ganglia are otherwise found in the adventitia covered by the m. sphincter ani ext. of striated nature, The MEISSNER's plexus, however, remains rather ill developed here too.

The nerve fibres coming into the lower part of the rectum contain a considerable number of thick myelinated sensory fibres besides numerous fine vegetative fibres. The sensory fibres run through the plexus without coming into contact with the sympathetic ganglion cells and form their terminations in the submucosa or further up in the propria. The larger part of the terminations are of unbranched and simple branched type formed in the propria and most frequently in the connective tissue between the intestinal crypts. The terminal fibres are usually medium-sized and often show change in size in their gently winding courses. Besides, some unencapsulated simple glomerular terminations can be found on rare occasions.

The anal canal of mole extends very long. The proximal two-thirds of it constitutes the zona columnaris ani having longitudinal mucous folds, with both the columnae and the sinus covered under a noncornified stratified flat epithelium and well-developed papillae formed into it out of the propria. Far more numerous sensory fibres come into this zona columnaris than into the lower part of the rectum. Their terminations are of branched type. The terminal fibres show conspicuous change in size during their wavy or looped courses and usually end sharply over a wide terminal area. In this part, however, such intraepithelial fibres and sensory terminations in and near the periproctal glands as found abundantly in this part of man and some other mammals could never be found.

The distal one-third of the anal canal is the zona intermedia devoid of the longitudinal folds. The epithelium is here somewhat thinner than in the zone columnaris above and the papillae are worse developed. The mucous membrane here, however, contains a number of incoming sensory fibres forming branched terminations, which are, however, somewhat simpler in formation than those in the preced-

ing zone. None of the terminal fibres form intraepithelial fibres here either.

The distalmost part of the anal canal forms the *zona cutanea ani* containing a few hair follicles and is followed by a patch of haired skin covering the anal canal and the lower part of the rectum. This skinny part contains a huge number of sensory fibres, perhaps accountable by the presence of circularly running smooth muscle fibres in the corium and the good development of the papillae from the stratum papillare into the epidermis, giving the skin of this part a close resemblance to that of the outer genitals. The fibres usually terminate in branched terminations and end bulbs formed by very thick sensory fibres. Of course the hair follicle necks are found to contain well-formed sensory terminations as usual.

The branched terminations in this part are found mostly beneath the epidermis. The branch fibres are large- or small-sized and show conspicuous change in size during their winding courses common to such fibres before ending in sharp points. Sometimes very many terminal fibres partake in forming rather complex branched terminations. On rarer occasions, the terminal fibres are found arranged in glomeruli. The end bulbs are rather large ovoid bodies containing a single thick sensory fibre in the inner bulb encased in a connective tissue capsule and holding more or less numerous cell nuclei, the fibre ending without branching or branching out into 2 or 3 branches near the distal pole of the inner bulb in blunt points or neurofibrillar expansions or more rarely in sharp points. Not rarely 2 or 3 end bulbs are found formed on one stem fibre.

No such complex branched terminations or large-sized end bulbs as described above have ever been found in the outer genitals of mole (HOSOKAWA). Thus, it is highly probable that the anal and the rectal skin has a far higher sensory sensitivity than the outer genitals in mole — certainly an interesting finding never hitherto observed in any animal.

内 容 自 抄

土龍の直腸膨大部の近位部は極めて菲薄、従って之に対する神経線維も甚だ僅少、又 Auerbach 及び Meissner 神経叢も発達極めて劣勢、神経細胞は稀に見られるに過ぎない。然し膨大部の遠位部では筋膜も粘膜下膜も発達良好となり、そして最末端部では以上の組織像は最高頂の発達を示す。特に内肛門括約筋は甚だ強力、従って Auerbach 神経叢も強力で、中に大型の神経節も含まれる。又横紋筋性の外肛門括約筋で包まれる外膜内にも小型神経節の形成を見る。然し Meissner 神経叢は発達劣勢である。直腸下部に対する外来神経線維は多くの植物線維の外に、可成り多数の知覚線維を含む。後者は交感性神経細胞と何等関係せず、神経叢内を通り貫いて専ら固有模様に腸隠窩間に来て非分岐性及び単純性分岐性終末に移行して終る。又稀ではあるが非被膜性糸球状終末に終るものもある。幹線維は一般に中等大線維で表わされ、終末枝は屢々著明な太さの変化を示す。

土龍の肛門管は甚だ長く延びていて、その近位 $\frac{2}{3}$ は従走性粘膜ヒダを有し、肛門柱帯に属する。その柱も洞も非角化性重層扁平上皮で包まれ、之に対し固有膜

からの乳頭形成も著明。この柱帯には直腸下部に於けるよりも遙かに多くの知覚線維の進入を見、その終末は分岐性終末で表わされ、終末枝は著明な太さの変化を示し広範に拡散する。尚お人及び他動物に富豊に見られる上皮内線維がこの動物では何処にも見られない事は興味深い。

肛門管の遠位³は縦ヒダの消失する肛門中間帯を示す。上皮は柱帯に於けるより背が低く、乳頭形成もより弱い。然しこの粘膜にも可なり多くの知覚線維の進入を見、その終末は分岐性終末で表わされる。但しその構成は柱帯に於けるよりはより単純、又終末枝はここでも上皮内に入らない。

肛門管の最遠位部は僅かの毛嚢所有の肛門外皮帯を示し、之は肛門管を包囲する有毛性外皮に移行する。この外皮は直腸周囲にも及び、中に極めて多くの知覚線維の分布を見る。それは真皮の中に平滑筋線維を含み、表皮に対する乳頭形成も顕著で外陰部外皮の性状を具えることに基くものと思考される。その知覚終末は概ね甚だたい線維に由来する分岐性終末と終末棍とで表わされる。尚お毛嚢頸にも著明な知覚終末の見られる事は言うまでもない。

分岐性終末は多くは表皮下に見られ、その終末枝は太さの変化を示す太い或は細い線維から成り、一般に尖鋭状に終る。又屢々多数の終末枝で構成される複雑性分岐性終末も発見される。終末棍は可なり大型で卵円形を呈し、結合織被膜内の内棍内には太い線維の非分岐性及び単純性分岐性終末を見、その終末枝はその遠位極に鈍状に又は原線維性拡散を以て終る。その他2—3終末棍が同一幹線維に由来する事も稀でない。

この動物の肛門及び直腸下部の外皮はその外陰部(細川)に於けるよりも遙かに知覚線維とその終末とに恵まれている。即ち前者は後者に於けるよりもより重要な知覚作用の営まれる所であり、この点比較解剖学的に見て極めて意義深く思われる。

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