On the Innervation of the Lungs of Cattle Embryo.

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Since in 1932 STÖHR and REISER achieved epoch-making results in their study on the histology of the vegetative nerve system, the histological study on the innervation of the lung has been promoted as the innervation of the other organs and many noteworthy works have been reported. Especially, the studies by SUNDER-PLASSMAXN (1933) and HAYASHI (1937), concerning human lungs and those by SAITO (1955) and NUMATA (1956) concerning animal lungs must be specially mentioned. MIZUKOSHI (1953) has studied the ontogenesis of the nerves in this part - a subject on which little mentionworthy results have been obtained owing to the imperfections in the nerve staining methods available in the past - and came by many highly commendable informations.

In succession of such brilliant works, the author has been of late given the opportunity of studying the innervation of the lung of cattle embryo at this laboratory. This study has been a very interesting one both from the comparative histological and the comparative ontogenetic points of view. The materials were obtained from cattle embryos of the 3rd and the 5th months. These were fixed for long time in 10% neutral formol, cut into 40μ frozen sections and stained with SETO’s silver impregnation in general use at this laboratory. The large series of the histological preparations thus obtained were minutely examined microscopically, and the findings detailed in the following have been obtained.

Individual Findings.

The lungs of the 3rd and the 5th month cattle embryos, as those in the embryos of man and other animals, are so much smaller than those in adults, that an overall survey of their histological picture is very easy in one section and thus are very convenient for the study of innervation. In these months of embryonic life, the nerve elements in the lungs of the cattle embryos are already in very perceptible development, and the nerve plexus already in almost perfected formation, as those in human embryo.

Now, before making reports on the innervation of the lungs of cattle embryos, I wish to touch on the common histological pictures of the lungs in the following, since it is indispensable to make clear the tissues of the

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In the lungs of the cattle embryo of the 3rd month, the bronchial tree in the course of embryonic formation is already very distinctly perceptible (Fig. 1), as is in human embryos of the same month. The large bronchial branches with cartilages around them (Fig. 2) go peripheralwards together with the a. pulmonaris giving out branches, and upon reaching the inside of the well-formed lobuli, are relieved of cartilages and pass over into the so-called bronchioli terminales. These bronchioli then pass further over into smaller ducts, the bronchioli respiratorii, and passing through the short alveolar ducts, end in round swollen blind sacs or the alveolar sacs. In this month, alveoli are yet formed neither in the alveolar ducts nor in the alveolar sacs (Figs. 1 and 3).

The air duct system in the lung lobuli is buried in a mesenchymal tissues, of which most of the mesenchyma, interestingly enough, is occupied by blood capillaries. The bronchial glands, even those in the large bronchial branches with cartilages, are not formed anywhere in this stage. What is especially noteworthy in the lungs of a cattle embryo is that the tunica muscularis around the propria of the duct system is better developed than in a 3rd month human embryo.
Fig. 2. Small bronchial branch of circa 1 mm diameter in a third month cattle embryo. e epithelium, m muscularis, c cartilage, a a. pulmonalis, l lobulus, n nerve bundle of the fundamental plexus. Details in the text.
Same staining. Photo ×24.

Fig. 3. Arborization of the bronchial ducts in a third month cattle embryo. l lobulus, r respiratory bronchiolus, d alveolar duct, s alveolar sac, i intralobular connective tissue filled with enlarged blood capillaries.
Same staining. Photo ×42.
The large bronchial branches found in a 3rd month cattle embryo are 3—4 mm in diameter and their mucous membrane has fairly tall longitudinal mucous folds on the surface. The epithelium is a 2—3 rowed cylindrical one, with the superficial ciliar formation already perceptible in most cases. The basal membrane formed close beneath the epithelium, however, is not yet distinctly observable. The propria is narrow but rich in connective tissue cells and contains blood capillaries here and there. The muscularis lining the outside of the propria is quite powerfully developed, and around it a submucosa containing small blood vessels and rich in connecting tissue cells is found. 1 or 2 rows of cartilages, large and small, are arranged outside this submucosa. This layer of cartilages is surrounded by an adventitia or fibre membrane of a comparatively loose connective tissue on all sides.

In the bronchial branches of the small diameter of 1 mm or so too, the fine structure is not essentially different from that of the larger branches detailed above, except that the dimensions are naturally smaller.

When we pass over into the smaller branches of about 0.5 mm diameter (Fig. 2), the number of the cartilages around them steeply falls off and come only sporadically forth, their individual size becoming also much tinier. The mucous folds also become much reduced, both in number and in height. The epithelium consists of 1—2 rows of cylindrical cells and the propria is also very weak in formation. The muscularis alone shows a considerable development. In the narrow branches of less than 0.5 mm in diameter (Fig. 1), cartilage pieces are to be found no more around them, while they run into the lobuli through the interlobular septa as the so-called bronchioli terminales and then branch into still finer branches or the bronchioli respiratorii. These bronchioli consist of a one-rowed cylindrical epithelium, a very thin propria and a one-rowed but rather densely arranged smooth muscle layer. The development of this muscularis here is much better than in a human embryo.

It is possible to distinguish between the alveolar ducts and the alveolar sacs here, but their walls are not yet provided with alveoli, the former being composed of a one-rowed cubic epithelium and the latter of an equally one-rowed cylindrical epithelium alone. Smooth muscle fibres are still observed around the alveolar ducts but not around the sacs.

In the lungs of a 5th month cattle embryo, the development is further advanced, the large bronchial branches attaining the diameter of about 6 mm, the cartilages having larger size, while the bronchial glands and their ducts, though indeed yet in a much undifferentiated state, are formed in the submucosa and the propria, and ciliar formation on the epithelial surface becomes quite marked. The formation of bronchial glands and ciliae becomes also perceptible in the small bronchial
The bronchioli terminales free of cartilages make further ramification upon entering the lobuli to form alveoli respiratorii, but the epithelium of these ducts, somewhat dissimilar to those in a 3rd month cattle embryo, consists of a one-rowed cubic epithelium, though no mentionable change is observed in the smooth muscle fibres surrounding them. The alveolar ducts are made of a one-rowed cubic epithelium and a small number of a smooth muscle fibres as in the earlier embryo, and no alveolar formation is observable in their wall either. The alveolar sacs have fairly grown in size from those in the 3rd month embryo and 2 or 3 alveoli are formed in their wall. The epithelium makes the change from a cylindrical to a cubic one.

As is well known, the nerves supplied to the lung comprise the sympathicus and the parasympathicus coming from the n. vagus, but some sensory fibres originating in the n. vagus are also included has been made quite clear by the studies of HAYASHI, MIZUKOSHI, SAITO and NUMATA. The above nerve elements form along the large bronchial branches the plexus bronchialis, and enter the lung through its hilus. Such plexus was found chiefly in mammalian lungs by GLASER, STÖHR and TAKINO, who divided it further into the peri- or extrachondral plexus and the subchondral plexus. HAYASHI observed there plexuses also in human adults and named the former the fundamental plexus and the latter the inner secondary plexus, and further added the outer secondary plexus discovered around the fundamental plexus and the subepithelial plexus formed in the propria.

In the lungs of my cattle embryos, the distribution of the intrapulmonary plexuses is in general agreement with the findings of the above researchers. So, plexus was found formed of thick nerve bundles in the adventitia of the large bronchial branches, but it is never complicated in formation and in some places, the nerve bundles are in very loose arrangement. The inner secondary plexus is formed by the nerve branches from the fundamental plexus in the submucosa around the muscularis. This plexus is sometimes a little complex in the parts free of surrounding cartilages, but subchondrally, the formation is extremely weak, no plexus formation being observed in many places. Accordingly, it is not apt to call this plexus the subchondral one. Thus, in agreement with HAYASHI, we wish to call it the secondary plexus. In the fundamental and the secondary plexuses, nerve cells are found in groups in cattle embryos as well as in those of man and other mammalia. The outer secondary plexus, as named by HAYASHI, was not found in the lungs of cattle embryos. The formation of the subepithelial plexus was also found very poor in this animal.
The above plexus formation becomes the poorer, as the bronchial branches run further peripheralwards, that is, as the branches diminish in size, and around the bronchioli, we find only extremely minute nerve fibres in sporadic existence. In the last place, we find fine nerve bundles running through the connective tissue of the visceral pleura.

The fine structure of the nerve cells found in the intrapulmonary plexus of adult man and adult mammals have been studied by HAYASHI, SAITO and NUMATA and very wide informations have been obtained on the subject. It has been made clear that these cells are of sympathetic nature and can be classified into DOGIEL’s type I and II, of which the latter accounts for the majority.

In his genetic study on the lung in human embryos, MIZUKOSHI has found that the nerve cells in the intrapulmonary plexus are as yet of very infantile type in 4th month embryo, but in 6th to 8th month embryos, abreast with the development of their short processes, they begin to show multipolarity as sympathetic cells. It is still impossible to distinguish DOGIEL’s I and II type cells among them.

In my cattle embryos, the nerve cells found in the ganglia formed in the intrapulmonary plexus count only 50–60 per section of even a large ganglion, most of the ganglia comprising only 20–30 cells. Consequently, the total number of such cells seems to be considerably smaller than in human embryos. It seems they are even less numerous than in dog (SAITO). Since, however, in bat (NUMATA), the large ganglia in the lung contain only 20–30 cells, the number of the cells is much larger in cattle.

These nerve cells are as yet very poorly developed in the lung of a 3rd month cattle embryo (Fig. 4). The round large cell nuclei are rather well formed, but the cell bodies around them are very low in development, in frequent cases their formation being most clearly perceptible. The nerve fibrils in the cell bodies are also in very poor development, as are also the accessory cell nuclei around the nerve cells, only a few of them being found even in the larger ganglia. These accessory cell nuclei are deemed to increase in number abreast with the differentiation of the nerve processes emerging from the nerve cells, as has been established by many works reported from this laboratory (MIKAMI, NUMATA, TAKAHASHI).

In a 5th month cattle embryo, as shown in Fig. 5, the development of nerve cells is somewhat more advanced. The cell bodies have become sufficiently distinct, reticular arrangement of fine nerve fibrils is already demonstrable in them and some nerve processes make appearance suggestive of multipolarity as sympathetic cells. The accessory cell nuclei are still only very limited in development. Upon comparing these findings
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Fig. 4. A non-capsulated ganglion filled with very young nerve cells found around a small bronchial branch in a third month cattle embryo. Details in the text. Same staining. ×400, reduced to 3/5.

Fig. 5 A capsulated ganglion found in the fundamental plexus in a large bronchial branch of a fifth month cattle embryo. Nerve cells barely show the multipolarity as sympathetic cells. Details in the text. Same staining. ×400.

with those in human embryos, we find that the development of sympathetic nerve cells is somewhat retarded in cattle embryos than in human embryos, for the development of the intrapulmonary nerve cells in a 5th month cattle embryo is poorer, not only than that of the same cells
in a 4th month human embryo (MIZUKOSHI) but also than that of the nerve cells in the submandibular ganglion of the latter (TAKAHASHI), in their multipolarity and other respects.

I need not emphasise that the termination of the vegetative nerve fibres in the lung of a cattle embryo is represented always in a vegetative terminal reticulum (STÖHR), as may be inferred from the results of numerous studies undertaken at this laboratory in the past. Accordingly, no such sharp or knob-like free endings of vegetative fibres allegedly found by LARSELL and DOW in the bronchial glands and muscles could ever be found in my specimens. That the formation of a terminal reticulum becomes already very clearly perceptible in cattle embryos by the 3rd month is well demonstrated by what we see in Figs. 6 and 7.

Such terminal reticula are formed powerfully in the walls of the blood vessels, especially, the arteries, as well as in the bronchial muscles (Fig. 6), and are found here and there also in the propria mucosae (Fig. 7). The terminal reticula in the muscularis usually run along and touching the muscle fibres but seemingly never into their cell bodies — a finding.

Fig. 6. Vegetative terminal reticulum formed in the muscularis of a large bronchial branch of a third month cattle embryo. e epithelium, p propria. Same staining. ×500, reduced to 2/3.
in good agreement with what has been reported from this laboratory on many past occasions. The terminal reticula formed beneath the epithelium often spread close up to but never into it.

The reports by LARSELL, LARSELL & DOW, and GLASER contain allusions to sensory terminations in the lung, but their so-called sensory terminations, as STÖHR and HAYASHI have pointed out already and as I take it, seem to be nothing but artefacts produced by faulty staining. More recently, SUNDER-PLASSMANN (1933) found sensory terminations type I concerned with blood pressure falling reflex in the muscularis of bronchial branches, while HAYASHI (1937) has described various sensory terminations in the lung of human adults and quite lately SAITO (1955) and NUMATA (1956) those found in the lungs of dog and bat respectively. The terminations reported by them are described as originating in thick myelinated fibres running through the intrapulmonary plexus, terminating in free endings and being very distinct from the very finely constructed vegetative terminal reticula. Thus, the penetration of the lung by sensory fibres and their terminal formation have been brought to light. MIZUKOSHI (1953) also carried out a developmental study of the sensory terminations of the lung of human embryos and succeeded in obtaining many interesting observations.

I have studied the development of sensory terminations in the lung of 3rd and 5th month cattle embryos, and in the following I will report on the findings in comparison with those on the lung of human embryos as reported by MIZUKOSHI.
In the lungs of my cattle embryos, as already pointed out in many embryological studies undertaken in the past at this laboratory, the sensory terminations were found to show yet much undifferentiated and very simple structure in the embryonal period, so that I could never find any such very complex branched terminations as described by LARSELL and DOW in my sections. In the earlier stage of the embryonic life at least, the sensory fibres have no myelin sheaths, as always provided for in human adults, covering them. Since, however, these sensory fibres consist in axis cylinders thicker than the thin vegetative fibres, sometimes by several times of the latter in size, the distinction between the two kinds of fibres is very easy. Besides, as the former end in free terminations while the latter form terminal reticula, it is not difficult either to know the one from the other at their terminal parts. In cattle embryos, the number of sensory fibres seems to be smaller than in human embryos. Most of these fibres run out of the secondary plexus through the muscularis into the propria, to form their terminations therein. It is not rare, however, that the terminations are formed within the muscularis or the epithelium.

As explained above, in the lung of a cattle as well as human embryo, the sensory terminations are developed only to such a simple structure that no such specific complex terminations as those concerned with blood pressure fall reflex were ever found in it. As MIZUKOSHI has opined, it is probable that such complex terminations are formed slowly after birth.

The number of the sensory fibres distributed in the lung of a cattle embryo seems to increase and decrease in proportion to the size of bronchial branches, that is, they are more numerous in the larger branches and gradually decrease as the size of the latter diminishes. The size of the branches, however, seems to be little related with the complexity of terminal formation of the sensory fibres. Thus, we find often very simple terminations in the large bronchial branches, while the small bronchial branches and the bronchioli are sometimes provided with rather complex branched terminations.

First, I will speak on the sensory terminations found in the large bronchial branches. The sensory fibres here emerge from the secondary plexus and forming fine bundles in admixture with vegetative fibres, run toward the mucous membrane. In some cases terminations are formed in the course in the muscularis, but in most cases the fibres penetrate into the propria before terminating. Not rarely, the fibres penetrate into the epithelium as intraepithelial fibres. Fig. 8 shows two branched terminations spreading out in the muscularis and the propria, and Fig. 9 a bifurcated termination ending in the propria and an intraepithelial fibre.
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Fig. 10 shows a somewhat more complex branched termination formed in the propria of a third month cattle embryo. m muscularis. Same staining. ×320.

Fig. 9. An unbranched intraepithelial sensory fibre and a bifurcated sensory termination formed in the propria of a large bronchial branch of a third month cattle embryo. m muscularis. Same staining. ×500, reduced to 2/3.

Fig. 8. Simple branched sensory terminations found in the mucous membrane of a large bronchial branch of a third month cattle embryo. m muscularis, p propria, fine fibres are vegetative fibres. Same staining.

Around the bronchial branches of about 1 mm diameter, I found sensory terminations of similar structure, though in somewhat smaller number. For example, an unbranched termination originating in a comparatively thin fibre ending sharply in the subepithelial propria in illustrated in Fig. 12. Simple branched terminations are also not rare here. In Fig. 13 is shown such a termination originating in a thick fibre formed in the muscularis. Thus, sensory terminations are often formed in the muscularis. The termination illustrated in Fig. 13, however, is of a
very specific construction, a type very rarely found in the lung of a cattle embryo. In this termination, the terminal fibres are rather thick and show frequent change in size, and one of them has a large ampullar fibrillar swelling in its course, it ends, however, in a sharp point as do the other two terminal fibres. Such specifically formed terminations, it may be, postembryonally differentiate into sensory terminations concerned with blood pressure fall reflex.

In the lung of a cattle embryo, sensory terminations are found also frequently in the vicinity of the

Fig. 10. 2 simple branched sensory terminations formed in the propria of a large bronchial branch of a third month cattle embryo. m muscularis, t terminal reticulum. Same staining. ×500, reduced to 2/3.

Fig. 11. An unbranched thick sensory intraepithelial fibre ending in a sharp point found in a large bronchial branch of a third month cattle embryo. Fine fibres are vegetative fibres. Same staining. ×500, reduced to 4/5.
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terminal and the respiratory bronchioli. Most of these consist of simplest unbranched fibres ending close beneath the epithelium in sharp points as shown in Figs. 14 and 15, but sometimes as intraepithelial fibres penetrating more or less into the epithelium. Besides, simple branched terminations are not rare too. For example, as illustrated in Fig. 16, sensory fibre, upon coming into the vicinity of a respiratory bronchiolus, would run into the muscularis to branch out into terminal fibres which end usually sharply in the muscularis or just beneath the epithelium. Sensory fibres also sometimes reach the vicinity of the

Fig. 12. An unbranched thin sensory termination ending sharply in the propria of a small bronchial branch of a third month cattle embryo. Fine fibres are vegetative fibres. Same staining. ×400, reduced to 4/5.

Fig. 13. A simple branched sensory termination of a specific type found in the muscularis of a small bronchial branch of a third month cattle embryo. e epithelium, c cartilage. Details in the text. Same staining. ×500, reduced to 4/5.
Fig. 14. Two unbranched terminations formed around a respiratory bronchiolus (r) and an alveolar sac (s) of a third month cattle embryo. Same staining. $\times500$, reduced to $4/5$.

Fig. 15. An unbranched sensory termination ending sharply beneath the epithelium of a respiratory bronchiolus of a third month cattle embryo. Same staining. $\times500$, reduced to $3/4$. 
alveolar ducts or the alveolar sacs. We see a terminal fibre reaching an alveolar duct in Fig. 16 and another an alveolar sac in Fig. 14, both ending in sharp points.

Fig. 16. A branched sensory termination found around a respiratory bronchiolus of a third month cattle embryo. Terminal fibres show conspicuous change in size and winding courses, one of them reaching the alveolar duct (d). Same staining. $\times 500$, reduced to $3/5$.

Fig. 17. Sensory fibres and unbranched sensory terminations found in the visceral pleura of a third month cattle embryo. Details in the text. Same staining. $\times 500$, reduced to $3/5$. 
Recently, NUMATA has succeeded in blamelessly proving the existence of sensory terminations in the visceral pleura of the lung of bat, mostly of unbranched type. Now, I have been able to observe sensory fibres running into the connective tissue of the pleura visceralis of cattle embryo and to obtain full information on their terminal formation as well. Sensory fibres were found usually singly, but also often enough in plural number (Fig. 17), invading the pleura, wherein they run more or less lengthy courses and without branching out end sharply in most but bluntly in fewer cases. Sometimes, however, the terminations are of simple branched type, as exemplified in Fig. 18, in which a single-stranded sensory fibre parts into 2 branches upon approaching the pleura, thus forming a bifurcated termination. One of the terminal fibres here run up to the superficial layer of the pleura before ending in a sharp point.

Since sensory terminations, of very simple structure, may be, are thus found even in the visceral pleura of animal lungs, it should not be difficult to infer that sensory fibres would be found similarly terminating in the pleura of the human lung.

In human adults, according to SETO, the distribution of the so-called sensory aortic nerve concerned with the blood pressure lowering reflex is limited to the lower part of the aortic arch and partly to the atria cordis, but in a human embryo, the area of distribution is much larger, and the terminal formation of the fibres is also different from that in adults, namely, the fibres run into the media and even as far as into...
the intima of the large arteries to end in specific branched terminations (YABUKI). MIZUKOSHI could further add to YABUKI's findings concerning these fibres in human embryos. He could find a small number of the same sensory terminations in the media of the pulmonary artery running intrapulmonarily.

Thus I was led to expect a similar finding in the intrapulmonary blood vessels in my cattle embryos in my silvered preparations. As expected, I succeeded in demonstrating the existence of specific branched terminations of sensory fibres coming through the externa and ending in the media of the comparatively large a. pulmonalis running intrapulmonarily, much in the same manner as in MIZUKOSHI’s human embryos. Such terminations, as shown in Fig. 19, consist of terminal fibres rich in specific changes in size, running circularly along the muscle fibres and ending in sharp or blunt points. Thus, the result of my study has proved that terminations of sensory fibres concerned with the blood pressure lowering reflex are found, albeit in a very small number, in the a. pulmonalis of oxen in the embryonic period.

**Summary.**

In cattle embryos, the bronchial tree of the bronchial duct system is very distinctly in formation already in the 3rd month, the large cartilaged bronchial branches branching out into the terminal and the respiratory bronchioli without cartilages through manifold ramification, and the latter turning into the short alveolar ducts and then into spherically inflated alveolar sacs in the lobuli. This duct system in the lobuli is embedded in a mesenchyma full of broad blood capillaries.

The bronchial branches are provided with well-developed longitudinal
mucoes folds, a 2—3 rowed ciliated epithelium and a narrow propria, but the bronchial glands are not yet formed in the submucosa around the well-developed muscularis. The cartilages around them are 1—2 rowed and the adventitia is composed of a loose connective tissue. The terminal and the respiratory bronchioli consist of a one-rowed cylindrical epithelium and a densely arranged one-rowed smooth muscle layer and have only a very meagre propria. The alveolar ducts are narrow tubes consisting of a one-rowed cubic epithelium and a minor number of muscle fibres, and the alveolar sacs of a one-rowed cylindrical epithelium and no muscle fibres.

The duct system in a 5th month cattle embryo is larger than in a 3rd month one in the size of the ducts, with the various tissues forming them better-developed and with the bronchial glands and their ducts formed to a small extent. The epithelium of the bronchioli is now of a one-rowed cubic type, and though alveoli are not yet formed in the alveolar ducts, a few of them are found in the alveolar sacs and the epithelium comes to be composed of cubic cells.

In the lung of cattle embryos too, fundamental plexus and secondary plexus are formed in the adventitia and the submucosa of the bronchial branches, respectively. The former consist of loosely arranged thick nerve bundles, but the latter are only poorly developed beneath the cartilages. Nerve cell groups are found in many places in these plexuses. HAYASHI's so-called outer secondary plexus was nearly absent and the development of the subepithelial plexus was very poor in my specimens. The development of these plexuses becomes the poorer as the bronchial branches become the thinner, being finally reduced to sporadic thin nerve fibres around the bronchioli.

In the lung of a cattle embryo, even a major ganglion contains only 50—60 nerve cells in one section, most of the ganglia consisting of 20—30 cells. Thus, the number of the ganglion cells is lower than in man or dog, but far larger than in a bat lung. The development of these nerve cells is considerably behind that in human embryos, the formation of the nerve processes being almost indefinable and the number of the accessory cell nuclei around them being as yet very small. In a 5th month embryo, the development has barely advanced to the stage where the multipolarity of the sympathetic cells becomes dimly perceptible. The vegetative fibres always end in terminal reticula (STÖHR) is the lung of a cattle embryo too.

Thick sensory fibres have been found existing also in the bronchial plexus of cattle embryos. The number is perhaps smaller in cattle than in human embryos and they become poorer in distribution as the bronchial branches lose distally in size. Their terminations are as extremely simple
in construction as in human embryos.

In the large bronchial branches, the sensory fibres run into the mucous membrane in company with vegetative fibres to form their terminations in the propria, but sometimes they end in the muscularis before reaching the propria or not rarely fibres are found to penetrate into the epithelium. These terminations are of unbranched and simple branched types, and their terminal fibres sometimes show perceptible change in size and specific winding courses, but usually they are of uniform size throughout, run comparatively straight courses and taper off into sharp points. The intraepithelial fibres are mostly of unbranched type.

In the small bronchial branches we see terminations similar to the preceding in formation, but in number they are not nearly so large here. Besides, not rarely I found some branched terminations with terminal fibres showing very frequent change in size in their courses and perhaps as I take it, destined to develop into sensory terminations concerned with blood pressure lowering reflex in postnatal life.

Around the terminal and the respiratory bronchioli too, sensory terminations were found to exist. Most of them are of unbranched fibres and end subepithelially or sometimes intraepithelially. Simple branched terminations are not rare either. Their terminal fibres often reach close up to the alveolar ducts and saes.

As was the case in bat lung (NUMATA), sensory fibres are found running into the visceral pleura of cattle embryos also. In most cases they end unbranched and sharply, but simple branched terminations are also often formed. Their terminal fibres run up even to the superficial layer of the pleura.

Quite as in a human embryo, in my sections of cattle embryos I have found specific branched terminations with terminal branches showing frank change in size in the media of the a. pulmonalis running in the lung. These belong to the terminations of the aortic nerves concerned with the blood pressure lowering reflex and their presence within the lung shows that such nerve elements are distributed in a much larger area in the embryonic period than in the adult.
劣勢、5ケ月胎児でも交感神経細胞としての多極性が従かに証明されるに過ぎない。植物神経の終末は終経で表われる。

気管支神経叢内にも多い知覚神経が証明され、共量は人胎児に於けるよりも少し、共分布は気管支枝が細くなるに従って劣勢を示す。終末形成は人胎児の場合と同様極めて単純である。

大きな気管支枝では知覚神経の多くは固有膜内、然し殿々神経内にも又上皮内にも共終末を形成する。之等終末は非分岐性及び単純性分岐性終末から成り、終末線維は概ね尖銳状を終る。小さな気管支枝でも前者に於けると同様知覚終末が見られるが、共量は少し、又稀ならず血圧下降反射に関する知覚終末の幼弱型と思われる終末も発見された。

細気管支に於いては上皮内に非分岐性時には単純性分岐性知覚終末が証明される。共終末枝は殿々肺胞管及び肺胞囊の周りにまで延びている。

内臓胸膜内にも細胞の場合（沼田）と同様に尖銳状に終る非分岐性知覚終末の形成を見る。又稀ならず単純性分岐性終末も認められる。人胎児に於けると同様肺動脈の中膜内に特有な単純性分岐終末の形成を見、之は血圧下降反射に関する知覚性大動脈神経の終末に属し、胎生時に於ける神経の分布範囲の広汎である事を示すものである。

References.