Anatomy. — "*The vagus area in camelidae*". By Dr. H. A. VERMEULEN. (Communicated by Prof. L. BOLK).

(Communicated in the meeting of December 30, 1914).

In a previous paper [1]) I demonstrated the relation between the development of the dorsal motor vagus nucleus of some domestic animals with the size and structure of the stomach, as well as with the development of the stomach musculature. In that article I pointed out that the shape of its cell-column differs among our ruminating domestic animals; in the ox, for instance, it reaches its full size midway in its length, whereas in the goat not until past the frontal third part, which circumstance I connected with the fact that the omasus, a strongly developed and highly muscular division of the stomach in the ox, is very poorly developed in the goat. Later I examined the dorsal motor vagus-nucleus of the sheep, which animal has also a small omasus, and found similar proportions as in the goat as regards its form and size. In one respect only did the two cell-columns differ, viz. in the goat, $^1/_5$ of the nucleus lie spinally and $^2/_5$ of it frontally of the calamus; in the sheep the reverse is found; here, as in the horse and ox, $^2/_5$ of the nucleus lie in the closed, and $^3/_5$ of it in the open portion of the oblongata. (Series of 321 sections, of which 135 spinal and 186 frontal of the calamus, fig. 1).

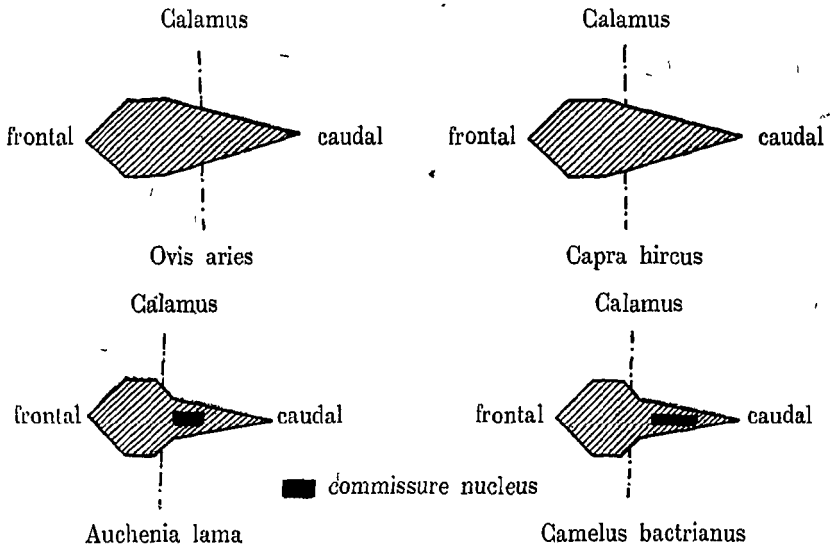


Fig. 1. Dorsal motor vagus nucleus.

[1]) The size of the dorsal motor vagus-nucleus and its relation to the development of the stomach. These Proceedings Vol. XVI p. 305.

I fortunately happened to get hold of the brain-stem of a camel. This ruminating animal is also in the possession of a huge stomach (245 liters capacity) which, however, differs from those of our ruminating domestic animals in many respects. It must be remarked here, however, that the largest of the proventriculi, the rumen, has at both poles a great many (about 50) distinctly separate bulges, each of which can be shut off from the rest of the rumen by a sfincter, and has a capacity of 200 to 300 c.c. These bulges were described by PLINIUS and by many after him as water-reservoirs. Even if this be so, which to an animal of the desert may be considered of great use, it cannot be the only function, for the mucous membrane in these peculiar stomach appendices is richly provided with glands (LESBRE), which points to a digestive function, and at the same time forms a great difference with the inner coating of the rumen in other ruminantia, which have all over a very horny cutaneous mucous membrane. Another remarkable point is that Cameliden have no omasus at all.

The Central Institute for Brain Research at Amsterdam, enabled me to further prosecute my researches. From the above-mentioned Institute I obtained the brainstem of another Camelide, a lama, for which I offer my thanks.

The research was not limited to the dorsal motor vagus-nucleus; other nuclei have also been examined, in particular the nucleus accessorii and the nucleus ambiguus. Special attention was paid to the two last nuclei, in the first place because, according to LESBRE's researches, the nervus accessorius spinalis does not occur in Camelidae, and in the second place because in these animals the nervus laryngeus inferior has no obvious recurrent course.

In his "Recherches anatomiques sur les Camélidés (Archives du Muséum d'Histoire naturelle de Lyon, Vol. VIII 1903) he says on p. 191: "Thespinal nerve (the accessory of Willis) is completely wanting; the sterno-mastoideus, mastoido-humeral, omo-trachelian and trapezius muscles receive their double innervation, sensory and motor, from the cervical pair. The absence of the spinal accessory nerve in Camelidae is an anatomical fact of great importance hithertho unknown." A number of root-fibres issuing behind the nervus vagus unite into a declining stem of 3 to 4 cm. in length. This little stem, running to the jugular ganglion, is considered by LESBRE as being the only part present of the nervus accessorius, the nervus accessorius vagi.

From his description of the innervation of the pharynx and the larynx it will be seen that in Camelidae the ramus pharyngeus vagi and the three laryngeal nerves, the nervus laryngeus externus for

pharynx musculature and the musculus cricothyroideus, the nervus laryngeus superior and the nervus laryngeus inferior (recurrens) rise from one stem, in such a way that this stem soon divides into two branches, one of which splits into the two first-named nerves, and a third descending branch, which gives off a ramus oesophagaeus, besides the nervus laryngeus inferior. This last describes a slight curve before reaching the larynx, is thus also recurrent, though not in the ordinary sense of the word.

This unusual course of the nervus recurrens is quite contrary to what has been hitherto assumed in favour of the phylogenetic and ontogenetic development of this portion of the periferal nervous system. In amphibians, which possess only one cervical vertebra, the heart is situated caudo-ventrally from the larynx. The nervi laryngei inferiores reach the larynx behind the large blood-vessels which come from the heart. With the development of the neck, the heart changes its place in a caudal direction and causes the above-mentioned nerves to descend with it and to reach their territory of innervation by a long recurrent course. Lesbre, who in his detailed treatise, gives a very clear illustration of the devious course of these nerves in Camelidae, is of opinion that the ordinary recurrent course of the nervi laryngei inferiores has been sacrificed to the unusual length of neck in these animals, and expresses the desirability of investigations as to whether similar differences are to be seen in the giraffe.

This fact, meanwhile, implies that the nervus laryngeus inferior in Camelidae has much less to do than in other animals which possess a genuine recurrens in which also more elements are joined.

Of both Camelidae the vagus area was cut serially into sections of 18 microns; that of the camel was coloured with cresyl-violet and that of the lama with toluidineblue.

Camelus bactrianus. The region of the *dorsal motor vagus nucleus* is cut into a series of 571 sections, of which 365 are spinal and 206 frontal from the calamus, so that, as in the goat about $^3/_5$ of the nucleus lie in the closed portion and $^2/_5$ in the open part of the oblongata (fig. 1). The nucleus begins caudally as a narrow horizontal row of cells, dorso-lateral from the canalis centr. in a region where the anterior horns of the cervical cord are still in full development. The nucleus increases slowly, and principally at its lateral side; 70 sections more frontally, before any distinct cells of nucleus XII are present, we see also the medial side becoming slightly thicker, and in the bridge which connects the nuclei right and left, dorsally from the central canal, a few cells occur, of the

same type as those of the vagus nuclei. More frontally the cells in the connecting bridge increase in number and soon both vagus nuclei form with the motor commissural nucleus, dorsally from the central canal, an elongated transverse nucleus column which thickens at both sides. In several sections this transverse cell-column is of uniform thickness, with the exception of the extremities, where the connection with the lateral nuclei occurs. (fig. 2). Ninety sections caudally from the calamus the connecting nucleus ceases, the lateral side of the dorsal motor vagus nucleus is then noticeably thicker and towards the calamus this side dips in a ventro-lateral direction (fig. 3). Here too, as in other animals, it may be noted that in the ventro-lateral portion of the nucleus, numerous cells occur of a larger type than in the rest of it.

Fig. 2.
X Dorsal motor vagus nuclei and commissural motor X nucleus in the camel; b = bloodvessels, c = canalis centralis.

Fig. 3. a = aberrant bundles, b = bloodvessels.

A *nucleus motorius commissuralis vagi* has never yet been met with in any other animal: as we shall presently see it also occurs in the lama. The connecting nucleus lies principally in the region of the commissura infima, the decussation of the tractus solitarii, the sensory glossopharyngeo-vagus tracts.

In the calamus the dorsal motor vagus nucleus has grown thicker; it then contains about 70 cells of the mixed type, the larger of which lie for the most part ventro-laterally. Frontally from the calamus the dorso-medial portion broadens out so that the nucleus becomes triangular in form with the base of the triangle turned towards the ependyma (fig. 4). In the frontal third part of the nucleus 170 cells can be counted in many of the sections, frequently we see the large-celled type in groups together in the ventro-lateral

(the figure is reversed; it represents the left side)
Fig. 4. a = aberrant bundles, b = bloodvessels.

Fig. 5. b = bloodvessels.

portion. As usually the nucleus decreases here first in its dorso-medial portion, a thin column, which creeps up the ependyma, is preserved longest and, as the ventral portion is well developed there, the nucleus in this region shows the form of a pyramid, with the apex pointing upwards (fig. 5).

The dorsal motor vagus nucleus of the camel does not reach to the level of the facialis nucleus, as is the case in several other mammals.

At the spinal extremity of the dorsal motor vagus nucleus in the camel, the *nucleus accessorius* is still clearly visible rather more ventral and decidedly lateral, in the substantia reticularis. It can even be seen on a level near the caudal extremity of the nucleus XII. (fig.6).

Here the accessorius nucleus is very unequally developed, frequently but few cells are found; but we may see a more or less round group of the familiar large cells, at the most 20—24, very

strongly developed. In several preparations intermediate cells are to be seen between the nucleus accessorius and the dorsal motor vagus

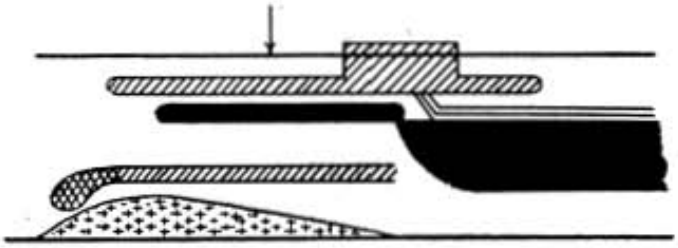
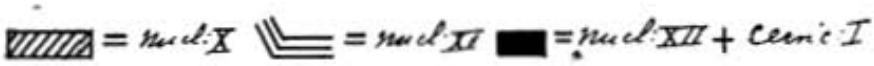


Fig. 6. Camelus bactrianus. [1])

EXPLANATION:



nucleus (fig. 7). Here, too, in several sections ventro-lateral outgrowths of the accessorius nucleus are present, which might give the impression

Fig. 7.

as if this nucleus in the camel continues directly into the nucleus ambiguus. This, however, can be proved not to be the case, since the ambiguus shows itself much more ventro-laterally. In a few sections both the accessorius nucleus and ambiguus are present [1]) (fig. 8) and their separate character is then easily seen. As the remainder of nucleus XI we frontally see a small cluster of cells medial from the ventral border of the radix descendens nervi V. The fact that the ambiguus in a more frontal plain is also found near this border, explains the old theory that the ambiguus is a continua-

[1]) In this diagram (Fig. 6) the caudal extremity of the nucl. ambiguus is a little shortened for clearness sake.

tion of the accessorius nucleus. The rad. descend. V is, however, more developed in the oblongata, and its ventral border comes to lie in a much lower region. Ambiguus and accessorius nucleus are both derivatives of the dorsal motory vagus nucleus. This has been proved phylogenetically and ontogenetically by KAPPERS, and is again confirmed in the camel by the intermediate cells between the dorsal motor X nucleus and the nucleus XI and the simultaneous but distinctly separate presence of the latter and the nucleus ambiguus on the same transverse level.

The *nucleus ambiguus* of the camel is, with the exception of its frontal pole, but slightly developed. In the closed part of the oblongata it shows no more than 10 to 12 cells in one section and very frequently none at all are to be found. This holds good also for the rest, with the exception, as said above, of the frontal pole. On a transverse level corresponding with the frontal end of nucleus XII, we still find clusters of 4—6 large ambiguus cells, while on the other hand, on the level corresponding with the frontal pole of the dorsal motor vagus nucleus, the nucleus ambiguus enlarges very rapidly to an immense complex of cells in which a maximum of 80—85 cells

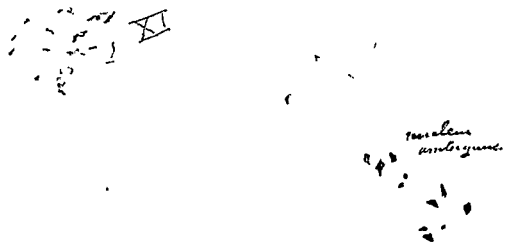


Fig. 8.
Showing the separate character of the nucleus accessorius and nucleus ambiguus.

Fig. 9.
Frontal enlargement of the nucleus ambiguus in the camel.

may be counted. Frontally the enlarged nucleus ambiguus can be divided into a medial portion with smaller and a lateral portion with larger cells. While the frontal enlargement of the ambiguus (where it occurs) is generally described as a mass of closely crowded cells of smaller type than the ordinary ambiguus cells, it is here remarkable that the cell group is not so crowded together and contains, especially in the lateral portion, typically large ambiguus cells (fig. 9).

Its frontal extremity has clearly shifted ventrally. It is 54 sections long and extends 30 sections frontally from the dorsal motor vagus nucleus (fig. 6). Twelve sections further the nucleus VII begins.

Concerning the *hypoglossus nucleus* it may be mentioned that its

caudal extremity is not easily determined; efferent hypoglossus roots can be observed very far caudad and it is frequently seen that, frontally from sections in which XII cells are present, ventral horn cells again appear; a sharp boundary between ventral horn and hypoglossus nucleus is not present (fig. 6). Also, it can be seen in several of the sections that cells have shifted from the vagus column ventrally to near the hypoglossus region (fig. 7), a position which strongly resembles that in birds. The first constant XII cells appear dorsally, close to the dorsal motor vagus nucleus, then the medial group of XII cells appears and finally its ventro-lateral group. Spinally from the calamus, the three groups of XII cells are not clearly defined and one or two groups of it are rather poorly developed. Frontally from the calamus the grouping is clearer and also central cells occur. The dorso-lateral group is most strongly represented and is the most constant, the other groups are in several sections less strongly developed. Frontally the dorso-lateral group disappears first, and the ventral remains longest.

The hypoglossus column extends 134 sections frontal from the calamus.

The *oliva inferior* of the camel is poorly developed. It appears with a ventral lamella, rather ventro-lateral, on the transverse level of the spinal pole of the nucleus XII. This ventral lamella spreads medially and then creeps up the raphe. The second lamella lying dorsally and representing the olivary nucleus sense strictiori does not appear before in the neighbourhood of the calamus. At the frontal pole of nucleus XII, it becomes thicker; it ends rather frontally from the ambiguus swelling (fig. 6). Its cell type is small, the cells being thinly sown in some places.

The exceedingly poor development of the *nucleus reticularis inferior* is striking. Very few cells occur in the raphe, most of them frontally in the ventral portion.

In the series of this camel, through the whole vagus region, at the left side, an *aberrating descending bundle* is seen. In the acoustic region we see cross-sections of a few small sharply outlined bundles, under the lateral ependyma, of the IV ventricle. At the right side we find at that place one little bundle. Caudally the bundles on the left side increase greatly in number and their diameter varies greatly. At the frontal pole of nucleus X dorsalis the bundles are crowded into a wedgeshape between the cells of this nucleus: fig. 4 (This figure is reversed, it represents the left side). An ascending bundle of fibres, beneath the ependyma runs in a dorsal direction along the top of the vagus nucleus; more caudally a ventral branch also appears, which runs medially from

the XII nucleus in the direction of the raphe. Near the calamus 40 bundles can be counted on the left side; at the right, where a few more are added, only 3 or 4 are to be found. The dorsal branch of the bundles has disappeared; caudally from the calamus the complex runs ventrally from the dorsal motor vagus nucleus and medially from the central canal (fig. 3). The complex gradually decreases, its outline finally fades away and 170 sections spinally from the calamus the last bundle disappears in the raphe. Regarding the exact connections of the latter I do not venture to make any statement.

Auchenia lama. Series of 365 sections; the calamus falls in section 219, so that here too, as in the goat and the camel, $^3/_5$ of the *dorsal motor vagus nucleus* lie in the closed part of the oblongata (fig. 1). The nucleus begins caudally as a small, round group of cells, dorso-lateral from the canalis centralis; it increases slowly in size chiefly at its lateral side, so that it becomes egg-shaped, not before the middle of the spinal portion does it become more oblong in shape and the first commissure cells appear, frequently lying more dorsally than in the camel, so that the whole cell-column, dorsally from the central canal takes a more or less curved course. (fig. 10).

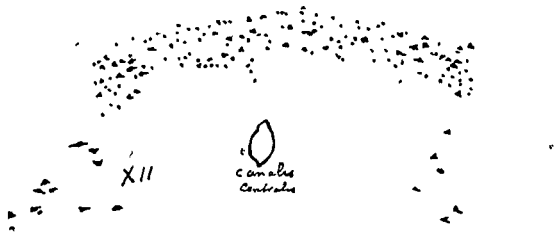


Fig. 10. Dorsal motor vagus nuclei and motor commissural X nucleus in the lama.

The *motor commissural vagus nucleus* of the lama (Fig. 10) is in general not so well developed as that of the camel. Although it stretches further frontally than in the camel (ending 20 sections spinally from the calamus) it is smaller in comparison (fig. 1). Its size is not constant, in some places it is more or less poorly developed.

In the lama too, the dorsal motor vagus nucleus lies obliquely near the calamus, and it has a much thicker ventro-lateral pole, containing many cells of the large type; in front of the calamus the dorsomedial part also bulges distinctly, and the nucleus thereby becomes triangular in shape, with the base directed towards the

bottom of the ventricle; more frontally it loses this form because the ventro-lateral pole also enlarges, after which the structure of the nucleus becomes looser and the number of cells grows less. Here too, the ventro-lateral portion remains longest, and the dorsal motor vagus nucleus does not reach into the region of the nucleus facialis.

The *nucleus accessorii* lies more medially into the lamat han in the camel, just on the border of the anterior and posterior horns. Near the spinal pole of the dorsal motor vagus nucleus it is well developed; in some sections ± 90 large XI cells, and medially from this, in the same level, 5—8 dorsal vagus cells can be counted (fig. 11). Very soon a tendency can be observed in the XI nucleus to extend medially; in one section it contains as many as 35 large cells and it is clearly prolonged in the direction of the dorsal motor vagus-nucleus;

Fig. 11. *A* posterior horn, *B* anterior horn.

Fig. 12. *A* posterior horn, *B* anterior horn, *C* canalis centralis.

immediately after the two nuclei join to one large group containing 55 cells, of which the most medial ones have kept the smaller type of the dorsal vagus cells, whereas the lateral cells exhibit the large accessorius-nucleus type (fig. 12 and 14). This constellation soon decreases in size and is only to be seen in 4 consecutive sections after which the vagus nucleus remains in its usual extent at that place; it contains then about 30 cells of mixed type; the large cell-type remains principally lateral. After this on more frontal levels with a very few exceptions nothing more of the nucleus accessorii is to be seen. Near the spinal extremity of nucleus XII, however, the process repeats itself to a slight extent, and we see a few XI cells rise and shift in a medial direction[1]). As far as the material at our disposal extended, i.e. 165 sections spinally from the beginning of the dorsal

[1]) Not indicated in the diagram of fig. 14.

motor vagus nucleus, the XI nucleus did seem to be constantly present and was very unequally developed. In the very first sections, however, it could be seen; on an average it contains here 8—20 cells.

Concerning the *nucleus ambiguus* it may be said that in general this is better developed in the lama than in the camel. It begins caudally from the place where the nucleus XII is clearly present and where the anterior horns of the cervical cord are still visible. More frontally it soon enlarges, but soon decreases again, and occurs but very slightly in the calamus region. In the open part of the oblongata its appearance is very different; as far as the frontal pole of nucleus XII its ventro-lateral part is generally the most strongly developed, occasionally the nucleus then contains 20—25 cells. As far as the frontal pole of the dorsal motor vagus nucleus, the development is again very poor, after which we see a round group of 8—10 cells arise that enlarges greatly on a level frontal from the dorsal vagus nucleus. Originally two cell groups can be distinguished in the frontal enlargement, but very soon these join to form one large complex, containing at the most 75 cells, mostly of the large type; the majority of the large cells are here also found in the lateral part (fig. 13). Also this enlargement of the nucleus ambiguus distinctly lies in a more ventral plane than the rest of the nucleus;

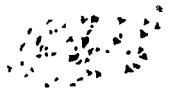


Fig. 13.
Frontal enlargement of the nucleus ambiguus in the lama.

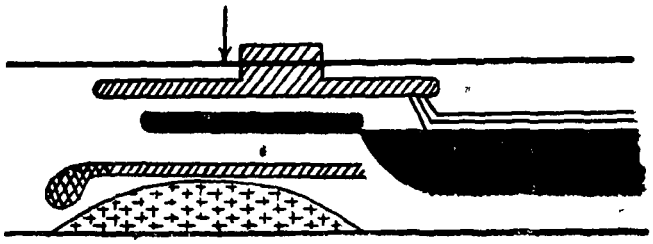


Fig. 14. Auchenia lama[1]).
(Explanation as in figure 6.)

as is usually the case in lower mammals. It projects 56 sections in front of the frontal extremity of the dorsal motor vagus nucleus (fig. 14) and it is in this region that the first cells of the nucleus facialis appear.

Also in the lama the connection of the *nucleus hypoglossi* with the anterior horn of the cervical cord be observed (fig. 14). Behind the calamus, the XII nucleus is poorly developed in this animal, and a division into groups can hardly be observed here. Frontally from the calamus the medial group appears, and soon after also the

[1]) In this diagram (Fig. 14) the caudal extremity of the nucl. ambiguus is a little shortened for clearness' sake.

ventro-lateral group. The nucleus is now well developed; the dorso-lateral part lies more ventrally than in the camel, so that we better speak of a dorsal group and a ventro-lateral group in this animal. More frontally the medial group becomes thicker and then contains cells of a larger type than those behind. The dorso-lateral group first disappears, and then the medial, so that the large cells of the ventro-lateral group remain longest visible.

The nucleus extends 116 sections in front of the calamus.

The *oliva inferior* is much better developed in the lama than in the camel. Also here it occurs latero-ventrally in the region of the spinal part of nucleus XII. It contains more cells than that of the camel, and the cell type in general is larger. On the level of the frontal pole of nucleus X dorsalis it is still clearly present; it decreases rapidly and ceases at the frontal extremity of the nucleus ambiguus (fig. 14).

The *nucleus reticularis inferior* is extremely well developed in the lama. It grows dorsally over the olive and spreads medially from the raphe into the substantia reticularis. A clearly defined cell group lies under the efferent vagus root. This disappears first, and the rest near the region of the nuc. facialis.

The dorsal motor vagus nucleus of Camelides lies, as in all other animals, in a region, that is rich in blood-vessels. All the illustrations of it, which occur in this article and which have been made after microphotographs, show cross-sections of large blood-vessels.

The form of the nucleus differs in Camelidae as well as in the sheep and goat, from that in the cow in so far as in the last-named animal it attains its greatest extent on the half of its extent, while in the first-named animals it does so not before the frontal third part. Since in the cow $^2/_5$ of the nucleus lies spinally from the calamus, the most developed part of the nucleus, which at this place is clearly less in size in other ruminantia, begins just frontally from the calamus *and we must therefore look for the centre of the innervation of the omasus in the most caudal portion of the fossa rhomboidea, at least in the ox and sheep. In the goat and in Camelidae, where a larger part of the nucleus stretches into the closed portion of the oblongata than in the first-named animals, that centrum may stretch, or at least partially, somewhat spinally from the calamus.*

Lesbre has shown that a *nervus accessorius spinalis*, such as we know in all other mammals hitherto examined, as a nerve which arises from a nucleus of its own in the cervical cord and runs

upwards united between the roots of cervical nerves, does not occur in Camelidae, and says of this that it is "un fait anatomique de haute importance". I have, however, proved that a spinal *nucleus* accessorius does really occur in these animals. It must a priori be considered as extremely doubtful that an anatomical centre which occurs so constantly in mammals should be absent in these animals. Undoubtedly it is highly remarkable *that the spinal accessorius fibres are not united in these animals to one stem* but *physiologically* this cannot be regarded as a fact of "haute importance", since also in these animals spinal accessorius fibres reach their destination, though more directly with cervical nerves, and not by a detour.

In all anatomical text-books the nervus accessorii Willisii will be found described as consisting of two parts, a *spinal* and a *bulbar part*, the latter (because it unites wholly or partly with the nervus vagus) being called also the *nervus accessorius vagi*. The distinction is based on the fact that in man the accessorius spinalis and accessorius vagi unite into one stem, viz. the *nervus accessorius communis*, after which the bulbar part separates again to join the vagus after this nerve has passed the jugular ganglion. RAMON Y CAJAL says meanwhile in his "Histologie du système nerveux de l'homme et des vertebrés" (Vol. I, p. 719) that he shares the opinion of KOSAKA that this division into an accessorius spinalis and bulbaris has no significance, since they are convinced that a bulbar accessorius does not exist, but that the latter originates in the dorsal motory vagus nucleus and thus contains ordinary vagus fibres.

I do not agree with CAJAL and KOSAKA, though their view seems to be proved by the fact that in domestic animals the two parts of the nervus accessorius do not unite into *one* stem, e.g. in the horse the front part of the pars bulbaris enters the ganglion jugulare, while only the hindmost part joins the accessorius spinalis; in ruminants and carnivora, on the other hand, the entire accessorius bulbaris enters the ganglion jugulare, while in the pig this part reaches the nervus vagus late viz. at the place where the ramus pharyngeus is given off. On account of my observations, however, in the camel and in the lama, I have come to the conclusion that accessorius cells really do occur in the oblongata. In these animals the accessorius nucleus is very distinct in the region of the dorsal motor vagus nucleus; in the lama it immediately joins the aforesaid vagus nucleus, in the camel there are only traces of such a connection. In any case, in both animals the accessorius nucleus extends into the oblongata. I am willing to assume that in the so called ramus internus n. accessorii, i.e. in such part of it as joins the nervus

vagus, genuine vagus fibres run, but there is no doubt whatever that a part of the nervus accessorius originates in the oblongata. Even the fact that fibres originate in the dorsal motor vagus nucl. does not in my opinion prove that they are necessarily vagus fibres. I consider it remarkable that in all the animals I have examined as yet the dorsal motor vagus nucleus shortly after its caudal appearance exhibits in the lateral part a type of cell which is larger than its original cell-type, a type which is maintained over a part of the nucleus, chiefly at its ventro-lateral and ventral sides.[1]) I venture to express the supposition that these large cells, although they pass over into the dorsal motor vagus nucleus, are accessorius elements. The accessorius nucleus, which has originated ontogenetically and phylogenetically from the caudal part of the dorsal motor X nucleus (KAPPERS[2]), thus exhibits this relationship in Camelus and Lama still in the full-grown animal.

The enlargement of the dorsal motor vagus nucleus in Camelide with the motor commissural nucleus may be explained by the striking differences which the oesophagus and stomach of these animals exhibit from other ruminants. Not only is the oesophagus in these animals remarkably long in proportion (in Camelus ± 2 meters!) but this organ is likewise in every respect particularly rich in glands (LESBRE), and, as has already been stated, the rumen contains many glands in some of its divisions. In this connection I may mention that, after I had shown the motor commissural vagus nucleus in Camelus and Lama, I car efully examined my series of the sheep and the the goat in respect to this, and only found in some sections indications of this connecting nucleus, a remarkable symptom, since in these animals glands are but rarely met with in the oesophagus and in a part of the omasus. The position of the nucleus motorius commissuralis vagi in the commissura inferior visceralis which contains descending sensory fibres of oesophagus and stomach must be ascribed to neuro-biotactic influences.

The short course of the nervus laryngeus inferior seems to be correlated with a smaller development of the caudal third part of the nucleus ambiguus. The pronounced development of the frontal enlargement of the nucleus ambiguus, the centre of the motor glossopharyngeus, may be explained by the exceptional

[1]) STUURMAN has also pointed out the occurrence of two celltypes in the dorsal motor vagus nucleus. F. J. STUURMAN, "Over den oorsprong van den nervus vagus bij het konijn." Acad. Proefschrift, Amsterdam. 1913

[2]) Weitere Mitteilungen über Neurobiotaxis, VII. Folia Neurobiologica. Bnd. VI. Sommerergänzungs Heft, p. 94.

length of the pharynx in Camelides (LESBRE). The unusual wealth of glands in the digestive tract of these animals is a result of their mode of living. Numerous plants on which they feed in a wild state are abundantly covered with large strong thorns, so that an extra development of glands in the mucous membranes is really not superfluous for them.

CONCLUSIONS.

The centre of the innervation of the omasus of the Ruminántia must be looked for in the most caudal part of the fossa rhomboidea or, for a part directly caudally from the Calamus.

In Camelidae an extension of the dorsal motor vagus nucleus occurs in the region of the sensory commissura infima visceralis, so that the motor dorsal X nuclei from the two sides are united (nucleus motorius commissuralis vagi). In the sheep and the goat only slight indications of this connecting nucleus are present.

The nervus recurrens is given of in Camelidae in conjunction with the ramus pharyngeus n. vagi and the nervus laryngeus superior (LESBRE); in accordance with this unusually short course the nucleus ambiguus, especially in the spinal third part, seems to be less developed than in other animals.

The frontal enlargement of the nucleus ambiguus in these animals is particularly strong, and possesses numerous cells of a larger type than are usually met with at that place.

A *nervus* accessorius spinalis is not present in Camelidae (LESBRE); since a *nucleus* accessorii is present in the cervical cord, however, the accessorius fibres must run with the cervical nerves.

An accessorius nucleus is also very clearly seen in the region of the dorsal motor vagus nucleus; since the region of this vagus nucleus is considered to belong to the bulbus, a really bulbar part of the nucleus accessorii has to be accepted, the presence of which has been denied by CAJAL and KOSAKA.

In those sections where in Lama and Camel the nucl. ambiguus and the nucleus accessorius are both present, they remain clearly separated. The nucleus accessorius is not continuous in these animals with the nucl. ambiguus.

In the lama a direct connection of the nucleus XI with the nucleus motorius dorsalis X, as has been observed embryologically (KAPPERS), can be distinctly demonstrated. The accessorius nucleus thus enlarges the vagus nucleus in question at its lateral side with cells of a larger type.

The nucleus XII in Camelidae exhibits very primitive features and has preserved its connection with grey matter of the anterior horn as in lower vertebrates.

In the camel the oliva inferior and the nucleus reticularis inferior are only slightly, in the lama on the contrary rather strongly, developed.

Utrecht, December 1914.

March 26, 1915.