A COMPARATIVE STUDY OF THE GREY AND WHITE MATTER, OF THE MOTOR-CELL GROUPS, AND OF THE SPINAL ACCESSORY NERVE, IN THE SPINAL CORD OF THE PORPOISE (*PHOCŒNA COMMUNIS*).

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PART II.

(b) *The Thoracic Region.*—In the thoracic region the segments have a close generic resemblance to one another, and the differences between individual segments are only of a minor character.

The cord is nearly circular in outline, and the grey matter occupies a relatively small area. At the sixth dorsal segment the white matter forms nearly seven-eighths of the whole,[1] and the grey matter is everywhere separated from the surface by a wide area of white matter (Plate XXVII. fig. 2).

The anterior horns are rather quadrilateral and diverge from each other ventrally. The outer border of each is concave, and about its middle there is a large rounded projection very characteristic of this region—the intermedio-lateral tract. The posterior horns are short, triangular in shape, with a wide base and a pointed apex. On the antero-external aspect of each posterior horn, and parallel to it, there is a small pointed process of grey matter containing a number of nerve cells.

The grey commissure is rather wide above, but narrows towards the lower or hinder part.

In the lowest segment an increase in the size of the grey matter is apparent, but the shape is not altered.

[1] Stilling found that in man, between the second and eleventh dorsal nerves, the white matter formed five-sixths of the total area of the cord, and Tserni-schoff (His' *Archiv*, 1894), at the seventh dorsal segment of a child, about three-fourths.

(c) *The Lumbo-sacral Region.*—In examining the segments from the lumbo-sacral region and comparing the outline of the grey matter and groups of cells from their anterior horns with similar groups and outlines of cells from the human cord, it must be borne in mind that the absolute number of vertebræ and nerves in this region differs in man and the porpoise. In the latter mammal the lumbo-sacral vertebræ, which in the present specimen numbered nineteen, represent the five lumbar and five sacral and the coccygeal vertebræ of man. Since, however, in man the distribution of the associated nerves is known, it is possible to compare the segments *seriatim* with those of the porpoise, as several of its nerves possess a distribution similar to that of the same segments in man.

From the upper lumbar region nerves are distributed to the abdominal wall; lower down, branches from three or four nerves unite to form a trunk comparable to the internal pudic nerve of man as regards its distribution. The lowest or hindmost of the nerves of this region are distributed to the great muscles associated with the powerful tail. Morphologically these are placed in rear of the genital muscles and of the musculature of the hind limb, the latter not being represented in the porpoise, unless a comparatively small fasciculus of muscle which extends backwards from the hinder pointed end of the pelvic bone, upon which the crura of the penis and their erector muscles are supported, be accepted as homologous with the hamstring group.

In the lumbo-sacral region of the cord of the porpoise it is possible to arrange the segments in groups, and thus subdivide the cord into regions, in each of which the sections present certain definite and well-marked characters.

The first region is formed by the upper four segments (Plate XXVIII. fig. 3); the second region includes the sixth, seventh and eighth segments (Plates XXVIII. and XXIX.); and the third region includes all from the tenth segment onwards (figs. 4 and 5).

The fifth and the ninth (Plate XXX. fig. 6) segments show intermediate conditions, for each partakes of the characters of the two regions between which it lies. From the tenth segment onwards the grey matter gradually undergoes modification, but the same typical form runs through them all.

This subdivision harmonises to a great extent with the distribution of the nerves arising from these segments.

Speaking generally, the anterior lumbo-sacral nerves are distributed to the walls of the abdomen and to some special muscles; from certain of the intermediate nerves, twigs combine to form a large genital or internal pudic nerve; while the hindmost segments give off branches which form longitudinal trunks distributed to the muscles of the tail and to the skin.

The upper four lumbo-sacral segments are characterised by anterior horns somewhat quadrilateral in outline, with a rounded extremity, and the length nearly twice the width. The posterior horns are short and pointed. The commissure is of medium width.

In the intermediate region there is a marked elongation of the anterior horns, which become long and slender, apparently in connection with the appearance of a new group of central cells. The tips of the horns are still rounded. The posterior horns are short and pointed, and so widely divergent that their mesial borders are now placed almost horizontally across the cord. The commissure increases in width towards the hinder end of the series.

In the lowest group a distinct alteration takes place, both in the shape and in the proportions of the anterior horns. Their inner or mesial borders are straight and almost parallel to each other, but at the front end the outer border slopes away so as to give the entire horn a crescentic or D-shaped outline. Traced backwards, this D-shaped horn diminishes in antero-posterior length, but maintains its width and the symmetry of its outline until near the end of the series.

The posterior horns again increase in size, and gradually return to the oblique direction in association with the reduction in the proportions of the posterior columns of white matter. The commissure likewise undergoes some diminution in width.

Before analysing these groups, it is necessary to note a curious appearance seen in some sections, especially about the third, fourth, fifth and sixth segments (Plates XXVIII. and XXIX.). In these, a short triangular mesial process of grey matter containing nerve cells appears. It passes dorsalwards from the middle

of the posterior border of the grey commissure, and when traced backwards through successive sections it is found to divide into two lateral halves, which ultimately become detached from the rest of the grey matter, so that two isolated masses of grey matter are seen lying on opposite sides of the mesial plane in the substance of the posterior columns. Gradually becoming smaller, they disappear at the sixth segment. The cells contained in the interior of this peculiar mass number from six to eight, and in shape they resemble the cells of the group or column of Clarke. It is not possible to trace fibres into connection with this grey mass, but the observation appears to be entirely new so far as the porpoise is concerned. What appears to have been a very closely allied condition is referred to by Waldeyer[1] in his exhaustive monograph, "Das Gorilla-Ruckenmark," where, on p. 107, he says:—

"Interessant ist ein hier wohl zu erwähnender Fall von Pick (*Arch. f. Psychiatrie und Nervenkrankh. herausg. v. Westphal.*, Bd. vii. s. 287). Er fand bei einem menschlichen Ruckenmarke die beiden Clarke'schen Saulen dicht zusammengelagert unmittelbar hinter der grauen Commissur nahe der Medianebene; es handelte sich hier also um eine Ahnlichkeit mit dem Verhalten bei den Affen."[2]

The intermediate group of segments includes the anatomical origin of the nerves which are distinguished by contributing branches to form the internal pudic nerve. In the dissection of our specimen this nerve was found to arise from the seventh, eighth and ninth segments, receiving a twig from the sixth segment. It may be added that the observation as to the origin of this nerve was made prior to and in ignorance of the fact that the lumbo-sacral segments could fall into the groups that we have described. The chief feature of the anterior horns in the group of segments under consideration is their forward prolongation.

Comparative.

In comparing the shape of the grey matter of the cord of the porpoise with that of the human subject the special

[1] Waldeyer, "Das Gorilla-Ruckenmark," *Abhandlungen der Kon. Akademie des Wiss. zu Berlin*, 1888.

[2] Rawitz in his paper (*loc. cit.*) describes similar appearances as being present in the specimen examined by him.

characters of the cetacean cord must be borne in mind, and allowance be made for the effect which peculiarities in the size of the different columns of white matter must produce in the position of the grey matter, surrounded as it is on all sides by white matter.

The special character in which the cetacean cord differs from that of other mammals is that the posterior columns of white matter are relatively small, and therefore the posterior roots are nearer to one another, especially at their bases. This feature is especially well-marked in the lower cervical region, where, as a consequence, it would appear that the shape of the grey matter taken as a whole had undergone most modification. The relatively large size of the anterior and lateral columns in association with the small size of the posterior columns forms a very noteworthy feature. The nature of the alteration in the grey matter appears to be that the enlargements of the anterior horn which occur in the cervical swelling of the cord are situated more on the lateral than on the anterior aspect of the cord, and extend more in the dorso-ventral direction than transversely. If, for example, we contrast the fifth cervical segments of the two types, we find that in man a large area of grey matter has been superadded on the antero-external border of the anterior horn, while in the porpoise the addition is situated on the postero-external border of the anterior horn. However, when this fact is taken into consideration, the general similarity in outline of the anterior horns in the two cords leads us to conclude that they are really constructed upon a common plan, and that the modifications in the shape of the anterior horn are due to variations in the size and relative proportions of the white columns.

(a) *Cervical Segments.*—If we compare the cervical segments of the cord of the porpoise with those of the human cord as figured by Kaiser (8) or Bruce (7) we find that the second and third segments are constructed on the same plan in the two specimens, *i.e.* the general form of the anterior horn is quadrilateral and elongated, but in man the posterior horn is long and slender. Again, in man the third segment differs from the second in having a wider anterior horn, and thus resembles the cetacean. The fourth segment in the two is very different, as in man there is not the striking change which occurs in the

cetacean cord at this level. In man the change does not take place until the fifth segment is reached, but at this level the character of the alteration is similar, *i.e.* there is the addition of a large triangular area of grey matter on the lateral aspect of the cord, but in man it occupies a more anterior position, so that the transverse diameter is increased at the tip of the anterior horn and not at its postero-lateral angle, as is the case in Cetacea, and this difference is probably due to the higher origin of the nerves for the upper limb in the cetacean. In the fourth segment in man, Bruce figures a large group of cells lying in the antero-lateral area of the anterior horn, which he identifies as the phrenic nucleus. This seems to be the same as the distinct group peculiar to this segment in the porpoise, but which, in it, is situated more posteriorly, and seems to have the same relative position throughout the cord in this animal to groups of cells other than those belonging to the anterior group, that is, they are placed rather posterior to the anterior horn than on its lateral aspect. In the porpoise the anterior groups of cells are larger than the corresponding groups in man; and as this condition is present in the fifth and sixth segments, the same difference in outline is present in these segments, the cetacean enlargement being situated at the postero-lateral angle of the anterior horn, whereas in man the new area is placed on the outer border of the antero-external angle of this horn. It seems probable that alterations in the size of the posterior columns may not only account for the amount of divergence between the posterior cornua, but may also affect the position of cell-groups situated upon the lateral aspect of the grey mass, by causing them to assume a position nearer to or farther from the ventral aspect, in accordance with the amount of divergence of the posterior horn.

The Grouping of the Motor Nerve Cells.

In attempting to compare the arrangement of the motor cells in the anterior horn of the cord of the porpoise with that found in man, one is met by the initial difficulty of a want of agreement in the terms to be employed, and even in the cell groups to be recognised. The description of the anterior horn of the human spinal cord has varied from time to time in the hands of different observers.

The earliest writers distinguished two groups of motor cells, viz., an inner and an outer (Kölliker). Numerous subdivisions of these groups have since been attempted, but among recent descriptions Obersteiner (10) and Waldeyer (5) recognise—(1) a mesial group of cells occupying the entire mesial border of the anterior horn, and for the most part not distinctly demarcated; (2) a ventro-lateral group; (3) a dorso-lateral group; (4) a central group. Kaiser (8) subdivides the groups of cells in a similar way, but he terms the ventro-lateral group sometimes anterior group (vordere) and sometimes accessorius group, while he applies the term 'lateral' to the dorso-lateral group of this description.

The majority of writers, in describing the arrangement of the motor nerve cells in the anterior cornu of the spinal cord in man, recognise two main columns, a mesial column (Sano (6), Waldeyer (5) and Kaiser (8), etc.), and an intermedio-lateral (Sano); the latter representing the 'Seitenhorn zellen' of Waldeyer, and, with Waldeyer's 'Mittelzellen,' being equivalent to the intermedio-lateral tract of Lockhart Clarke (*Phil. Trans.*, 1859), each of which may be subdivided in places into two, three or four secondary columns.

The mesial-cell column may be separated into an anterior and a posterior set.

Von Lenhossek (13) believes that the most mesial and ventral cells give rise to axones which pass through the ventral commissure to the other side of the cord, and the appearances seen in our sections are in harmony with this observation.

The other cells send their processes into the anterior nerve roots, and this group has been declared to contain the cells from which the muscles of the trunk are innervated.

The intermedio-lateral column is most distinct in the dorsal region.

In the regions from which the nerves for limbs arise there are intercalated between these two nuclei numerous groups of cells, known as the nuclei of the upper and lower limb.

These nuclei have been isolated and the nuclei for individual muscles determined by Van Gehuchten (11), Bruce (3) Sano (*loc cit.*), chiefly by means of experiment or from examination of pathological material.

Further subdivisions and additional groups have been described, such as the 'post-postero-lateral' of Bruce and Van Gehuchten.

Dorso-mesial cells were found along the inner margin of the anterior cornu, but never in large numbers or in a distinct group.

For the present, therefore, we have left them out of consideration, and would rather describe the nuclei found in the anterior and antero-external parts of the cord.

In our comparison of the groups of cells found in the anterior horn of the cord of the porpoise with the corresponding groups in the human cord, it will be found convenient to follow as far as possible the classification and subdivision of the groups adopted by Bruce.

(a) *Cervical Region.*—In Phocœna the first segment shows a large group of cells which occupies the front and inner parts of the anterior horn. This group is clearly marked off from a second large group which lies on the outer border of the horn. Still farther back on this outer border a few large cells form a third group. The two latter groups are probably the nuclei for the spinal accessory nerve, since fibres from that nerve can be traced into them.

In the second and third segments the front of the anterior horn is in each case occupied by a number of cells of medium size, but there is no clear subdivision into antero-internal and antero-external groups; and while there are cells situated on the inner border of the horn, we cannot differentiate an antero-mesial group from the other cells. The outer border, however, shows a lateral group of cells, and some fibres of the spinal accessory nerve appear to rise from the most posterior of these. In the third segment there are distinctly two groups of cells in relation to the outer border of the horn, and the groups found in this segment of the human cord, and named antero-mesial, accessorius and intermedio-lateral, harmonise with the three groups in the cord under consideration, viz., anterior, lateral, and a third group, probably also for accessorius—intermedio-lateral.

In the fourth segment of the human cord five cell groups have been isolated. These are arranged in the following order along the border of the grey matter, commencing at the antero-internal angle, viz., antero-mesial, phrenic, antero-lateral, acces-

sorius, postero-lateral. In the same segment of Phoccena the cells are of large size and several groups are clearly demarcated. In its anterior part there is a large group of cells, distinctly defined from a group situated about the middle of the outer border. In its turn, this latter group is marked off from a third group occupying the projecting postero-lateral angle of the horn.

If one accepts the first group as corresponding to the combined antero-mesial and phrenic groups of man—and so far as position is concerned they are similar—then the other two groups represent the antero-lateral and postero-lateral, and again these present a marked resemblance to the arrangement in the human cord, although in the porpoise the groups are larger than in man.

The fifth segment closely resembles the fourth, both as regards the outline of its grey matter and in the arrangement of the cells. In the anterior part the cells are not so numerous as in the fourth, probably because the nucleus of the phrenic nerve is no longer so large, but the other groups were visible. Comparing the groups with those present in the same segment of the human cord, one cannot but be impressed with the alteration in outline seen in both specimens coincident with the origin of the nerves for the supply of the fore or upper limb. In Phoccena from the fourth segment to the sixth a large group of cells occupying the postero-lateral angle has been added to the grey matter of the anterior horn. As in man, the fifth and sixth segments probably supply chiefly the muscles of the shoulder-girdle which are present in Phoccena, and thus these two segments closely resemble each other in man and Phoccena, and they present the same cell groups, viz., antero-mesial, antero-lateral and post-lateral.

The change in the outline of the anterior horn as we pass to the seventh segment is due to an absence of one of the groups of cells, probably the antero-lateral. There are now two distinct groups, an anterior and a lateral; the great enlargement of the latter is a most striking feature, for it now consists of a large number of cells occupying the triangular projection on the lateral border.

In this segment in man two very similar groups are found, bearing much the same relative proportion to each other.

The eighth segment shows the same groups even more distinctly, viz., an anterior and a lateral. There is no evidence of a post-postero-lateral group such as is found in the human cord at this level, and its absence is strongly confirmatory of the relation between that group and the small muscles of the hand, since, of course, these are not represented in Phocœna.

(b) *Thoracic Segments.*—What may be called the typical thoracic segments, those from the middle of the series, show a general structure very similar to segments from the same region of the human cord.

The anterior part of the ventral horn is occupied by a varying number of motor cells, distributed throughout the anterior horn, and not separable into subgroups.

On the lateral aspect of the horn there occurs the lateral projection known as the lateral cornu, or intermedio-lateral tract, containing another group of motor cells. Another group throughout nearly the whole region occupied a pointed process, situated more dorsally, in the outer border of the grey matter, near the root of the posterior horn. It contained about six cells, which were smaller than the anterior motor cells, and rather more fusiform. There was no distinct group of cells to form a Clarke's column, but there were cells of the character of those of Clarke's column lying in the posterior part of the commissure, and frequently aggregated together near the mesial plane. The appearance in the lumbar region, noticed elsewhere, is to be compared with this.

These cells were to be seen from the fourth thoracic segment downwards as far as the sixth lumbar segment.

(c) *Lumbo-sacral Segments.*—According to Bruce, the motor nuclei for the muscles of the lower limb of man extend from the second lumbar segment, but chiefly from the third lumbar segment to the third sacral segment inclusive. The same observer places motor nuclei for the muscles of the bladder and urethra, and for the levator ani and sphincter ani muscles in the third and fourth sacral segments. The nuclei for the limb muscles lie in the antero-lateral, postero-lateral and post-postero-lateral groups of cells in these segments, while the cell centres for the trunk muscles occupy the antero-mesial group.

The lumbo-sacral segments of the cord of Phocœna are every-

where distinguished by an absence of the great lateral projection seen in the human cord at the corresponding levels.

For reasons already stated, we cannot carry out the comparison of the lumbo-sacral nerves of the porpoise segment by segment with those of the lumbar and sacral nerves of man, as was done in the cervical region, for it is only possible to divide the segments into series, each of which gives origin to nerves whose distribution is known.

At the hinder or lower end of the lumbo-sacral region of the porpoise—from LS 10 onwards—the motor nerves are distributed solely to caudal muscles divisible into a ventral and a dorsal set. Taking LS 14 as a typical segment, it is found that the large motor cells are grouped in the anterior part of the anterior horn as an anterior mesial group and a lateral group. These are the two principal groups, but behind and between them there is an indication of a central group of cells, three in number. Possibly these groups may represent more than single units, because a certain amount of subdivision was frequent, but it was not advisable to carry the subdivision further. These appear to be the groups of cells associated with the supply of the musculature of the tail, and the same groups can be recognised to the end of the series.

The grey matter on the dorsal part of the anterior horn and in the region of the grey commissure contains a large number of small nerve cells whose function is quite unknown. From their structure they are probably not motor in function. A similar arrangement obtained in LS 13, 12 and 11, but doubtfully in LS 10.

The next series, LS 6 to LS 9 inclusive, has no homologue in man, since in man the motor nerve is distributed to a limb, but in Phocœna only to genital, the great caudal, and other somatic muscles.

In the ninth segment there is a large anterior group of cells, and behind it a mesial or central group, apparently distinct from the former. On the outer border of the horn there is a large lateral group, while on a level with the anterior border of the commissure, but further back, and just in front of the base of the posterior roots, there is a distinct group of cells of large size and motor structure, and distinct from the collection of small cells which occupied the commissure.

In the eighth segment the grey matter is further elongated antero-posteriorly, but apparently unequally on the two sides. This may have been due to a slight obliquity of the section on one side. The groups of cells resemble those in the ninth segment, but the proportions of their size are different. The anterior group is distinct, and the mesial or central group is considerably larger. The lateral group has diminished, and the posterior group is only represented by one or two scattered cells.

The seventh segment practically repeats the eighth as to the position and relative size of the cell groups.

The sixth segment presents the anterior and the mesial groups, while the lateral groups have almost disappeared.

The outstanding feature of the series just passed in review is the presence of the large and distinct mesial group of cells, a group which is absent both at a higher and a lower level, but which characterised the series of segments from LS 6 to 9 inclusive. The fact that the nucleus for a nerve distributed to the perineal muscles of man has been associated with a mesial group of cells occurring in man in the third and fourth sacral segments, renders it highly probable that this distinct and large group of cells is the origin of the motor fibres which pass from segments LS 6, 7, 8 and 9 through the genital nerve to the powerful musculature of the genital organs of the porpoise. We do not overlook the fact that, according to Bruce, the central group of cells in man supplies the hamstring muscles, but as the porpoise is entirely devoid of even a rudimentry hind limb, and only a slender band of muscle attached to the pelvic bone could by any possibility be regarded as representing the hamstring group, it seems highly improbable that a large group of cells would persist for the innervation of a small bundle of muscle.

The upper lumbo-sacral segments present a great similarity in appearance, some of them being conspicuous by the tail of grey matter containing large nerve cells and situated behind the grey commissure, as has already been described.

From the last thoracic segment onwards the anterior cornu gradually increases in size, especially in a dorso-ventral direction, and the anterior group of cells lies at a greater distance from the lateral group and from the anterior border of the commissure.

In the first lumbar segment there is a large anterior group and a distinct lateral group, both of them containing more cells than an average dorsal segment. There were also more cells of the 'commissural group' along the mesial border of the anterior horn and in the grey commissure, and the pointed process at the root of the posterior horn also remains.

The same groups were present in LS II, LS III and LS IV, but the anterior group increased in size, more cells appearing at the dorso-internal part of the anterior group, and the lateral process was more rounded in outline.

The commissural cells were greater in number, and the width of the commissure was increased.

The arrangement in LS V showed an intermediate form: some of the groups of cells noted in the next group of segments began here to be distinct.

Summary of the Cell Groups.

We can clearly follow the arrangement pointed out in the human cord by Sano, who distinguishes throughout the spinal cord two longitudinal columns of motor cells, viz., the columna medialis and the columna intermedio-lateralis, between which there are intercalated additional nuclei, which are related to the muscles of the extremities.

The antero-mesial group of cells persists throughout the cervical region, probably for the supply of the muscles of the trunk. Behind it, in the upper segment, there are two nuclei, both of which are probably for the spinal accessory nerve, the more posterior representing the intermedio-lateral column.

In the second and third segments the arrangement is similar, but the anterior nucleus for the spinal accessory nerve has disappeared, while the posterior remains.

From the fourth segment downwards new nuclei appear; those which we distinguish are not the nuclei for individual muscles, which cannot be isolated in normal specimens, but for groups of muscles.

In the fourth segment the anterior group is enlarged by the addition of large cells corresponding in position to the nucleus for the phrenic nerve in man, and probably with the same function, while two distinct lateral groups appear as in man, viz., an antero-lateral and a postero-lateral—(Sano's 6 and 7

and 5 and 7)—for the muscles of the shoulder and biceps, and lower down, for the triceps and anconeus, and for the extensors of the fingers.

In the seventh and eighth segments the limb nuclei become reduced to a lateral group—(the post-postero-lateral group being absent)—for the supply of the muscles of the arm and forearm.

In the dorsal region the cell groups are found in the same situations as in man, and they have the same kind of structures to supply.

Anterior and intermedio-lateral groups are present from D 3 onwards.

There are scattered cells in the body of the anterior horn, but they do not form a distinct group.

In this region there is a projection on the outer side of the base of the posterior horn, and we are unable to bring the cells which it contains into homology with any recognised group of cells.

In the lumbar region it is impossible to carry out a comparison with the cord of any described mammal in regard to the limb nuclei, but there is clear evidence that the arrangement in the region where the extensor and flexor muscles of the trunk are supplied consists of an antero-mesial and a postero-external set of cells occupying the body of the anterior horn.

The antero-mesial set remains throughout the entire cord, but it is augmented by deeper-placed groups of cells in the region from which the perineal muscles are supplied, but there is an absence of the lateral or limb projection so evident in the cervical region whence the nerves for the fore or upper limb arise.

The cells on the mesial border of the anterior horn were arranged irregularly, but appeared to send their axones to the opposite side of the cord, and they were more distant, as well as the cells in the substance of the commissure, where the commissure was increased, *e.g.* in the lumbo-sacral lower region.

The arrangement of the cell groups in the upper cervical segments of the cord is complicated by the presence of a nucleus for the spinal accessory nerve, situated among the motor cells of the anterior cornu.

The exact position of this part of the nucleus of that nerve—the spinal portion—is described differently by various observers.

The fibres of the nerve emerge from the lateral columns of the cord in front of the posterior nerve roots, and can be seen passing outwards from the lateral cornu of grey matter. Within the grey matter it is recognised that many fibres of origin of the nerve do not pass out from the segment in which they take origin, but first of all pass towards the central region, forming an isolated and distinct group of fibres in the formatio reticularis at the outer aspect of the anterior cornu, a group known as the respiratory bundle of Krause—(Dees, *W. Allg. Zeitschrift f. Psych.*, 43 Bd.).

This bundle was distinctly seen in the second and third segments of the cord of Phocœna, and we therefore consider that the nucleus for the spinal accessory nerve in this animal extends to the fourth cervical segment, although no fibres emerge from the lateral aspect of the cord below the lowest root of the first cervical nerve.

Within the grey matter in Phocœna we observed that in the first cervical segment the spinal accessory fibres passed in part into the lateral cornu, and in part appeared to be continued ventrally to a large and distinct group of cells occupying the lateral aspect of the anterior cornu. This latter group corresponds in position to the group identified as the spinal accessory nucleus by Bruce and others in the first cervical segment.

Below the first cervical segment this nucleus was absent, and the fibres of the 'respiratory bundle' appeared to arise from cells occupying the lateral cornu.

We are therefore inclined to believe that in the upper cervical segment the nucleus for the spinal accessory nerve is double.

Professor Cunningham (*Text-Book of Anatomy*, 1902, p. 447) figures the upper segment of the cord of an orang, in which the spinal accessory nerve is seen entering the grey matter and dividing into two bundles, which have a termination apparently similar to that observed by us in Phocœna; and he has kindly sent us a section similar to the one figured, in which very much the same appearance is seen.

Ziehen's observations agree with those of Clarke, Roller and Kölliker (Bardeleben, *Handbuch der Anat. des Mensch.*, Bd. 4,

test. i. p. 125) in placing the nucleus of the spinal accessory in a group of cells lying in the 'postero-lateral process' of the anterior horn; and this observation is in harmony with ours as to the position of the nucleus in the lower cervical segments (2, 3 and 4).

Dees (*loc. cit.*) states that the nucleus of the spinal accessory lies, in sections from the first cervical segment, in the middle of the anterior horn, and then passes to the lateral aspect of the anterior horn, and lies as far down as to the sixth segment, at the base of the lateral cornu.

Our observation therefore harmonises closely with those of Dees, and also with those of the other writers quoted, the presence of a double nucleus in the upper cervical region bringing into harmony the conflicting statements as to the position of the nucleus.

Van Gehuchten (*Anat. du Système nerveux de l'homme*, 3rd edition, vol. ii. p. 55) states that the spinal part of the spinal accessory arises from the cells of the lateral cornu of the cervical cord, from the third or fourth cervical nerve to a little below the first cervical nerve.

On dividing the nerve of Willis within the spinal canal in the rabbit, and studying the cells which showed chromatolysis, he found these cells situated in "the lateral part of the anterior horn, from the fourth cervical nerve to a little below the first," and states that these cells therefore represent the nucleus of origin of the fibres of the spinal part of the nerve.

The spinal accessory nerve has a distribution to two sets of structures, viz., to the muscles of the pharynx and larynx, and also to the sterno-mastoid and trapezius muscles. Bruce associates the lower more posterior nucleus with fibres which go to the latter muscles, and the upper anterior nucleus with fibres which are distributed to the former muscles, but it is a new observation to find both nuclei present in the same section.

The division of this nucleus into two separate portions is probably to be associated with the comparatively minor part played by the laryngeal structures of the cetacean as compared with their importance in man. The modifications of the cetacean larynx rendered necessary in connection with respiration have probably unfitted it for purposes of vocalisation, and produced a corresponding reduction in the size of the nucleus

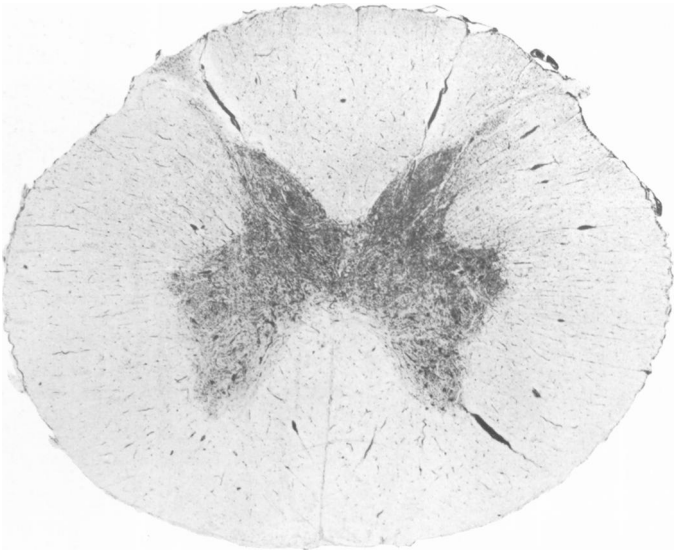

FIG. 1.

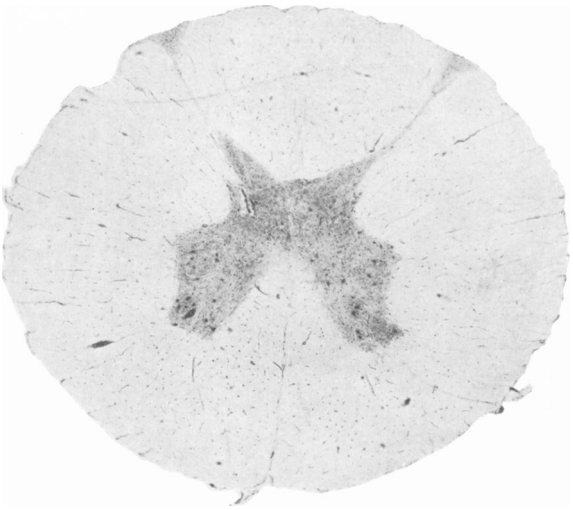

FIG. 2.

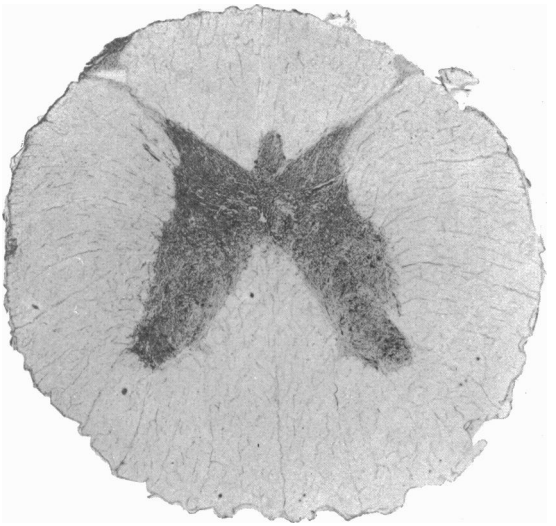

FIG. 3.

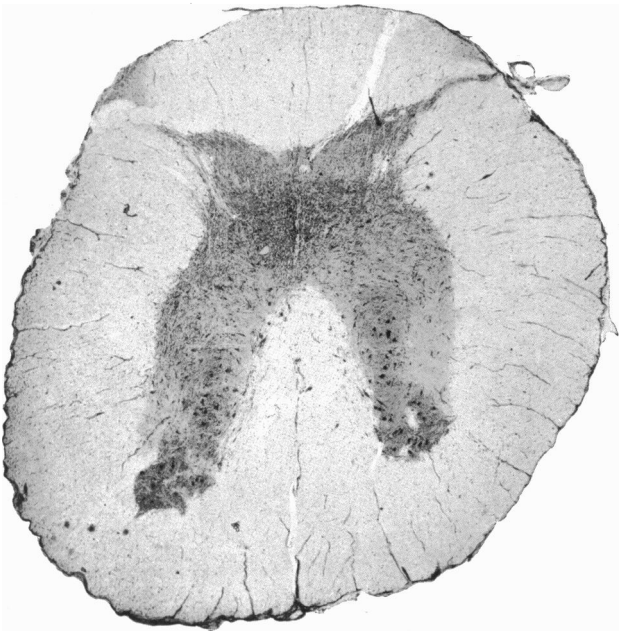

FIG. 5.

PROF. HEPBURN and DR WATERSTON.

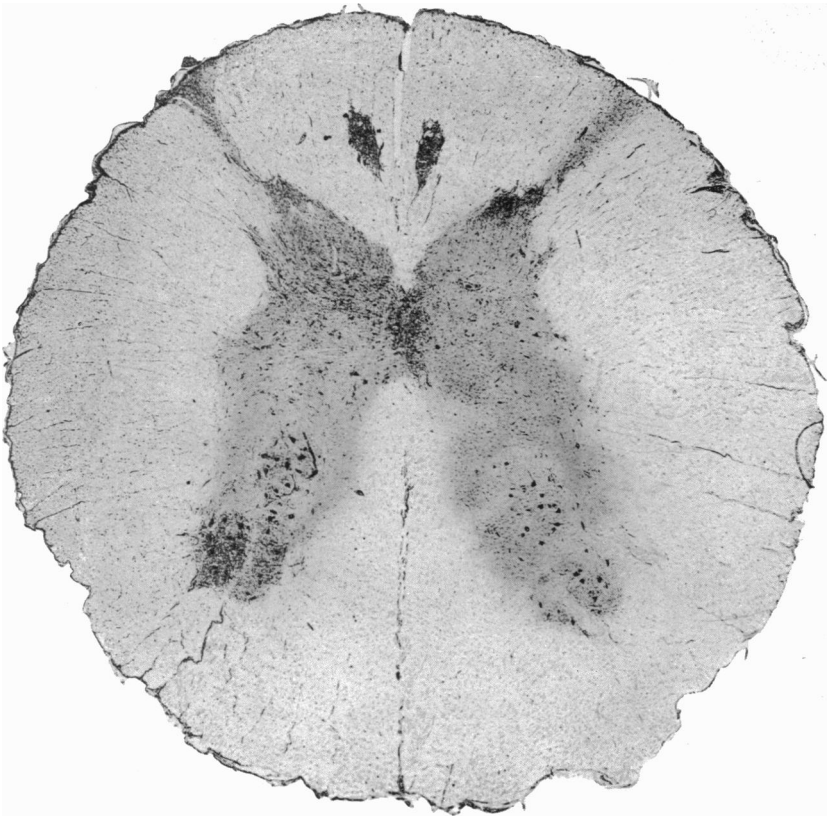

FIG. 4.

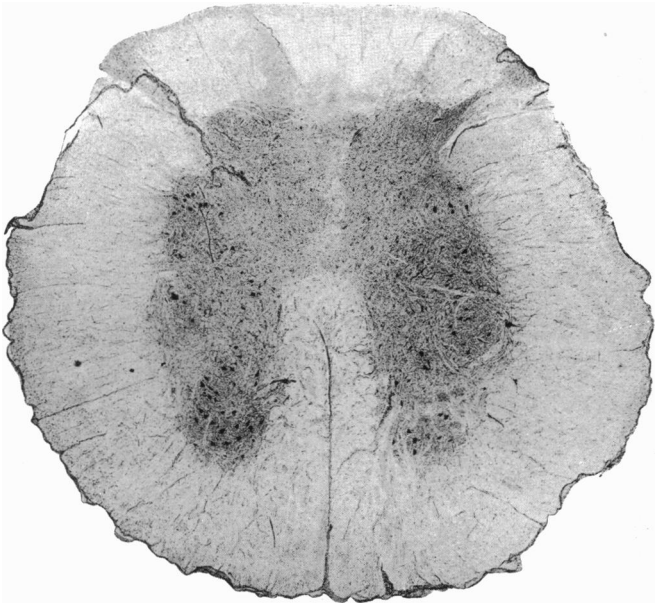

FIG. 6.

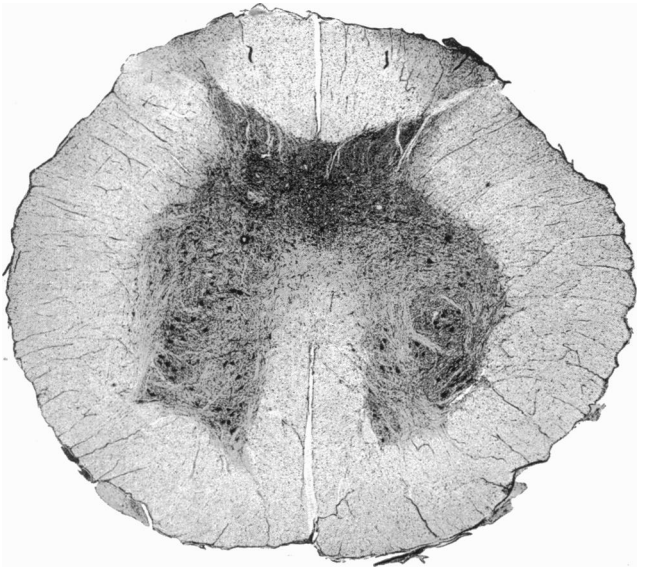

FIG. 7.

PROF. HEPBURN and DR WATERSTON.

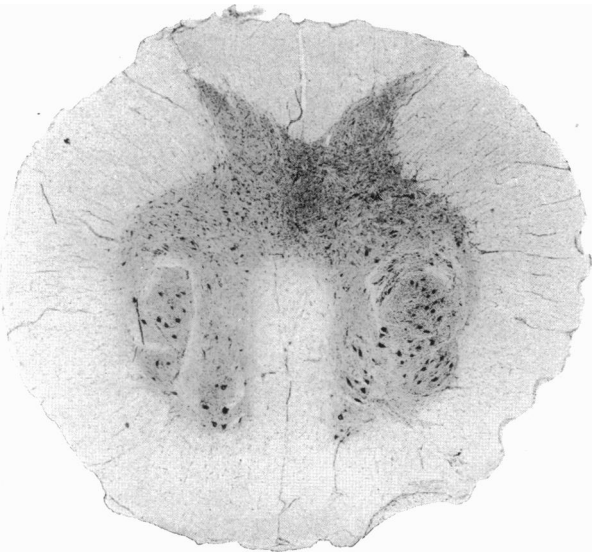

FIG. 8.

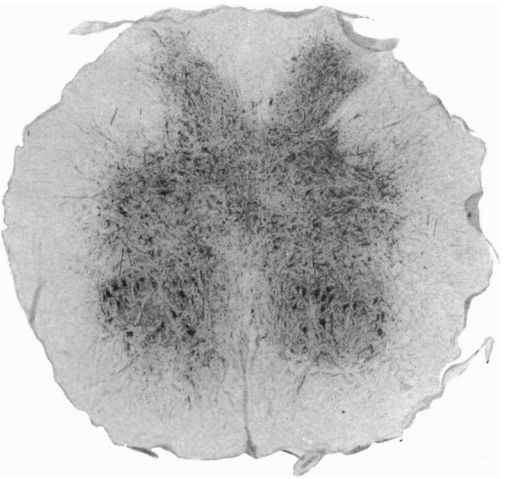

FIG. 9.

connected with laryngeal muscles. Being thus reduced, it has become more clearly demarcated from that more posterior portion of the nucleus whose distribution is associated with such powerful muscles as the sterno-mastoid and trapezius.

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Area of Columns, cf.—

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ILLUSTRATIONS.

Plate	XXVII.	fig. 1.	Photograph of T.S.,	1st	dorsal	segment.		
,,	,,	,, 2.	,,	,,	6th	,,	,,	
,,	XXVIII.	,, 3.	,,	,,	4th	lumbo-sacral	segment.	
,,	XXIX.	,, 4.	,,	,,	6th	,,	,,	
,,	XXVIII.	,, 5.	,,	,,	8th	,,	,,	
,,	XXX.	,, 6.	,,	,,	9th	,,	,,	
,,	,,	,, 7.	,,	,,	10th	,,	,,	
,,	XXXI.	,, 8.	,,	,,	11th	,,	,,	
,,	,,	,, 9.	,,	,,	17th	,,	,,	

Plate XXIX., fig. 4, represents a magnification of 19 diameters. The other figures are reduced by a third from this magnification.