THE ANTERIOR LIMIT OF THE CERVICO-THORACIC VISCERAL EFFERENT NERVES IN MAN.

By N. BISHOP HARMAN, B.A., M.B. (Cantab.), F.R.C.S. (Eng.), St John's College; *Demonstrator of Anatomy, Cambridge University.* (PLATES XLIV.–XLIX.)

CONTENTS.

I.—THE CERVICO-THORACIC RAMI COMMUNICANTES.

THIS research is a continuation of the examination of the limits of outflow of visceral efferent nerves, of which two sections have been published in this Journal, on the Lumbar Rami (12), on the Pelvic Splanchnics (13).[1]

1. *The Rami in Lower Animals.*

The results of the many investigations made upon these nerves by experimental and fine anatomical methods are dealt

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with exhaustively by Langley (16), in the report of his examination of this region in the cat, dog, and rabbit. It is therefore unnecessary for me to enter here into the literature of the subject in detail. As a means of comparison between the results obtained for man in the present research and those obtained for other animals, the results of the more important observations are classified:—

TABLE I.

Observer.	Date.	Animal.	Methods.	Anterior limit of reaction.	Highest level at which white bundles were found.
Budge (3)	1852	Rabbit	Stimulation of spinal roots	Thoracic I.	...
do. (4)	1853	do.	Excision of segment of spinal cord	Cervical VIII.	...
do. (5)	1855	do.	Stimulation of spinal roots	do. VI.	...
Bernard (2)	1862	Dog	do.	Thoracic I.	...
Salkowski (20)	1867	Rabbit	Cutting spinal roots	Cervical VII.	...
Ferrier (9)	1883	Ape	Stimulation of spinal roots	Thoracic II.	...
François-Franck (10)	1878	Cat	Stimulation of rami com.	Cervical V.	...
Navrocki and Przbylski (17)	1891	do.	do.	do. VIII.	...
Dastre and Morat (7)	1883	Dog	Stimulation of rami com. or spinal roots	do. VIII.	...
Gaskel (11)	1886	Dog	Dissection and serial sections	...	Thoracic II.
Sherrington (16, p. 89)	1892	Ape	Stimulation of spinal roots	Thoracic I.	...
Langley (16)	1892	Rabbit, Cat, Dog	Stimulation of spinal roots and fine dissections	do. I. do. I. do. I.	Thoracic I. do. I. do. I.

TABLE II.—*Analysis of Observations.*

Limit of Outflow.	No. of Sets of Observations.
Cervical V.	One
Do. VI.	One
Do. VII.	One
Do. VIII.	Three
Thoracic I.	Nine
Do. II.	Two

The summary of results obtained from the examination of these four animals, cat, dog, rabbit, and ape, marks out the Ist thoracic as the common upper limit of the visceral outflow. Of the other observations tending to show the existence of such fibres at higher levels, the latest experimental worker has thrown doubt upon their trustworthiness, on the grounds of insufficient certainty in the enumeration of the nerves, or in the control of the experiments (16, p. 88).

In those cases in which actual dissection has been performed the variations are less wide. Gaskell found the limit in the dog to be the IInd thoracic, and Langley in cat, rabbit, and dog, at the Ist thoracic root. The latter made a rough count of the fibres medullated in the rami of the Ist thoracic nerve root of the dog, and found about five hundred present (16, p. 116).

2. *The Rami in Man.*

The data at present recorded is very meagre. Suggestions are made in Quain (18) on the analogy of the conditions in the lower animals, that the anterior limit of the white rami is most probably the Ist thoracic nerve.

Two observations bearing somewhat upon the subject are to be found in the remarks on the origin of the great splanchnic nerve. Snow Beck (1, p. 215) notes the origin of tubular fibres for this nerve from all the superior intercostal nerves, and Rüdinger (19) traces the origin of white fibres from the IInd thoracic root to the same trunk nerve. There appear to be no observations bearing upon the origin of splanchnic fibres for the upper regions.

3. *Present Examination—Methods and Scope.*

In this examination into these nerves in the human subject, I have endeavoured to obtain results similar to those obtained in my earlier examinations of the lumbar rami and the pelvic splanchnics, and to those obtained by Langley for the cat, dog, and rabbit.

Fœtuses ranging from the eight months (48 cm.) to full time (55 cm.) were used. The subjects were dissected immediately on receipt, in the fresh state; the whole of the cervical and upper thoracic nerves and the sympathetic cord, with the connecting rami, were removed *en masse* to osmic acid (1 per cent. solution) for twenty-four hours, thence into weak alcohol for twelve hours. The nerves and cord were then fixed for the purpose of making a minute dissection of the rami. A part of each ramus was cleaned, its constituent fibres teased out in rows, and the character and number of the white fibres therein ascertained by examination with the microscope. When the number of white fibres was small, as nearly an individual count as possible was made, whilst in rami containing large numbers of the smaller fibres, the number was estimated by the aid of a micro-millimetre eye-piece.

These methods of investigation were employed in six cases, which, from the use of both sides, give twelve plexuses.

Appended are the drawings of the various dissections. To each of these there corresponds an analytical table, giving the results of the examination of each ramus, and from these analyses a general table (III.) has been prepared, which states the form of plexus examined, the number of white fibres found connected with each spinal nerve, and the averages for each spinal nerve from nerve V to XII inclusive.

4. *Results.*

From an examination of the analyses of the several dissections, and of the summary of the results given in the general table, it will be seen that medullated fibres were found throughout the range of rami examined, but that the character and number of these fibres is strikingly different when the upper

TABLE III.

MEDULLATED FIBRES IN RAMI.

MARK OF SUBJECT.	SEX.	LENGTH OR AGE.	SIDE OF BODY.	FORM OF PLEXUS.	Nerve 5, = Cervical V.			Nerve 6, = Cervical VI.			Nerve 7, = Cervical VII.			Nerve 8, = Cervical VIII.			Nerve 9, = Thoracic I.			Nerve 10, = Thoracic II.			Nerve 11, = Thoracic III.			Nerve 12, = Thoracic IV.		
					No. of Rami.	No. of White Fibres.		No. of Rami.	No. of White Fibres.		No. of Rami.	No. of White Fibres.		No. of Rami.	No. of White Fibres.		No. of Rami.	No. of White Fibres.		No. of Rami.	No. of White Fibres.		No. of Rami.	No. of White Fibres.		No. of Rami.	No. of White Fibres.	
						Under 4 μ.	4 μ and over.		Under 4 μ.	4 μ and over.		Under 4 μ.	4 μ and over.		Under 4 μ.	4 μ and over.		Under 4 μ.	4 μ and over.		Under 4 μ.	4 μ and over.		Under 4 μ.	4 μ and over.		Under 4 μ.	4 μ and over.
L	♂	55 cm.	R.	High. Large com. from IV Cerv. to V. Intc.-humeral = < $\frac{1}{3}$ II Dorsal.	1	0	1	1	0	6	1	0	10	2	45	3	2	160	35	2	45	5	3	230	45	3	400	59
			L.	Do.	1	...	...	1	...	...	1	0	6	2	70	10	1	85	3	3	375	85	2	80	50	2	200	55
M	♀	54 cm.	R.	Medium. Com. of $\frac{1}{4}$th IV Cerv. to V. Intc.-humeral = $\frac{1}{4}$ II Dorsal.	1	0	5	1	5	20	2	14	14	2	9	1	3	118	3	2	310	39	3	145	17	3	570	23
			L.	Do.	1	0	6	1	0	0	2	0	0	1	0	5	2	50	25	2	245	55	3	345	53	3	175	10
N	♂	53 cm.	R.	Medium. Com. of $\frac{1}{4}$th IV Cerv. to V. Intc.-humeral = $\frac{1}{4}$ II Dorsal.	1	0	0	2	0	5	3	0	32	3	20	11	2	270	7	2	210	17	3	340	19	3	110	16
			L.	Do.	2	0	25	1	0	0	1	0	6	2	20	16	3	145	45	3	185	23	3	205	16	2	170	15
O	♂	48 cm.	R.	Medium-Low. Small Com. from IV Cerv. to V. Intc.-humeral = $\frac{3}{5}$ II Dorsal.	1	0	7	1	0	0	2	15	2	2	10	3	5	155	10	3	135	14	3	290	26	3	205	12
			L.	Do.	1	0	2	1	...	...	2	0	14	3	19	10	3	200	32	3	340	31	3	160	10	3	300	10
P	♂	52·5 cm.	R.	Low. Com. of $\frac{1}{10}$ from IV Cerv. to V. Intc.-humeral of II Dorsal small. Intc.-humeral of III Dorsal = $\frac{2}{3}$rds.	...	V. and VI.	together.	1	5	30	2	2	3	3	5	1	3	90	27	3	310	32	3	130	9	3	220	13
			L.	Low. No com. from IV Cerv. to V. Intc.-humeral of II Dorsal = $\frac{2}{3}$rds. Intc.-humeral of III Dorsal = $\frac{1}{4}$ths.	1	0	0	1	0	0	1	20	8	2	30	20	2	140	10	2	240	13	2	140	8	3	230	40
Q	♂	54 cm. 14 days. extra-uterine.	L.	Very-Low. See Table VI.	1	20	10	1	5	10	1	8	2	2	43	7	3	150	6	3	320	24	3	370	43	2	320	2
			R.	Do.	1	0	0	1	8	2	2	10	0	1	20	10	1	90	5	4	425	20	3	310	15	2	125	0
Averages, ...					1	2	5	1	2	7	2	6	8	2	24	8	2·5	138	17	3	260	29	3	230	25	3	252	21
Averages for all White Fibres, ...					1	7		1	9		2	15		2	32		2·5	155		3	289		3	255		3	273	

and lower regions—Vth to VIIIth cervical and Ist to IVth thoracic—are compared.

The white fibres have been separated into two categories, a class for those under 4μ in diameter, and another for those of a diameter of 4μ and exceeding it. The significance to be attached to the varying sizes of medullated fibres has been pointed out repeatedly. The matter was briefly summarised in my earliest paper. Observers are in agreement that the small white fibres of a diameter, from 1·8 to 3·6 μ, having a characteristic bundle formation, are to be regarded as forming the efferent fibres of the sympathetic system, whilst those of the larger size have been shown by Edgeworth to be afferent in function.

The analyses show that the coarse fibres are scattered throughout the region examined in the same manner as was found in the lumbar region, and the irregular character of the distribution is such that no general plan of their passage through the rami can be formulated.

The distribution of the fibres of the smaller size is, however, one which may be regarded as sharply defined. The analyses show that their numbers were great in the lower rami, and that there was a sudden and marked drop in their numbers, amounting in some cases to a complete cessation, after passing the level of the rami of Ist thoracic nerve. Beyond this level the small white fibres in the rami were in most cases few in number, and scattered throughout the non-medullated fibres—(Table III.).

The exceptions to this manner of distribution are few. In subject 'L,' a case in which the plexuses for both the fore and hind limbs were of the high form, typical bundles of small white fibres were found in the rami connected with the VIIIth cervical nerve, and there could be no doubt that in this case the limit of outflow was extended upwards to include this spinal nerve. Bundles of small fibres were found in the rami of the VIIIth cervical nerve in other cases, and in one case, 'M' right, in the VIIth cervical rami, but in these cases the number of fibres within the bundles and within the rami as a whole, was too small to warrant an upward extension of the limit of efferent outflow so as to include these, when their small numbers were compared with the numbers contained in

the rami of succeeding nerves. The case of 'Q' left is somewhat doubtful, for in each of the two large grey rami connected with the VIIIth cervical nerve there was a bundle of about twenty fibres; in the right side of the same subject there were no such bundles within the rami of the VIIIth cervical nerve; and there was a fall below the general average in the number of fibres within the rami connected with the Ist thoracic nerve, a diminution which may perhaps be considered as consequent on the low form of the limb plexus.

The conclusion which may be drawn from this examination is that the usual superior limit of the cervico-thoracic visceral efferent nerves in man is at the level of the IXth spinal or Ist thoracic nerve, and that in some few cases the limit may be extended to the VIIIth spinal or VIIIth cervical nerve, and that this variation appears to be connected with the variation in the form of plexus for the fore limb.

II.—The Condition of the Sympathetic Cord.

1. *The Ganglia*—(Table IV.).

The 'typical' plan in which there should be three rami-bearing ganglia in the cervical region, and a ganglion for each nerve in the thoracic region, would appear to be a rare condition, for in these twelve dissections it was only met with once, 'M' left, while even in this case ganglion cells were found to extend along the cord linking the middle and inferior cervical ganglia, showing that the separation of the ganglia was more apparent than real. That linking of ganglia was frequent, can be seen from an examination of Table V., in which an asterisk indicates a continuity of ganglion cells along the cord. In the other cases the ganglia were completely fused to form a lesser number, whilst but rarely the doubling of a ganglion was found.

The only manner in which the superior cervical ganglion was found to vary was in its length. In subject 'L' it was on both sides unusually long, reaching to the level of the transverse process of the Vth cervical vertebra.

A middle ganglion was present nine times; of these it was in one case, 'N' left, double, and in another, 'O' left, the ganglion was constricted to form three parts. In only three of

TABLE IV.—*The Condition of the Sympathetic Cord.*

Subject.	Side.	Superior Cerv. Gg.	Middle Cerv. Gg.	Inferior Cerv. Gg.	1st Thor. Gg.	2nd Thor. Gg.	3rd Thor. Gg.	4th Thor. Gg.	Annulus.	Source of Origin of Rami.		
										V. Cerv. M.	VI. Cerv.	VII. Cerv.
L	R	Very long, reaches level of Tr. Pcs. of V. Cerv.	—	United		+	+	+	Very long. Extends from Sup. to Inf. Cerv. Gang.	Superior gang.	Superior gang.	Inferior gang.
	L	do.	—	do.		+	+	+	do.	do.	do.	do.
M	R	+	+ No rami	+	+	+	+	+	–	do.	Inferior	do.
	L	+	+	+	+	+	+	+	–	Middle	do.	do.
N	R	+	+ No rami	+	+	+	+	+	+	Superior	Superior and Inferior	do.
	L	+	+ With an extra lower ganglion without rami	United to form ganglion		Stellate	+	+	+	Middle	Inferior	do.
O	R	+	+ No rami	United to form Stellate ganglion		+	+	+	+	Superior	Superior and Inferior	do.
	L	+	+ Triple	do.		+	+	+	+	Middle	Middle	do.
P	R	+	+ No rami	United to form ganglion		Stellate	Doubled	+	+	Superior	Superior	do.
	L	+	—	do.			United		–	do.	Inferior	do.
Q	R	+	+ No rami	United to form Stellate ganglion		+	+	+	+	do.	do.	do.
	L	+	+ No rami	do.		+	+	+	+	Interior	do.	do.

+ indicates present, — absent.

these nine cases, however, did the ganglia give origin to rami communicantes; in the remaining cases it was small, and the reduced ganglion tended to be displaced in a downward direction. The position of the rami for the Vth and VIth cervical nerves in those cases in which no connections with a middle ganglion existed, would appear to show that the ganglion is only partially absorbed into the inferior ganglion, but that some of its ganglion cells are incorporated with the superior ganglion. In the three cases in which a middle ramus-bearing ganglion existed, the ramus of the Vth cervical nerve always sprang from it; in all other cases, excepting one, the ramus sprang from the superior ganglion, or the cords below it, and passed out in a downward direction, whilst the ramus for the VIth cervical nerve arose thrice from the superior ganglion directly or indirectly, twice from superior and inferior, and six times from the inferior ganglion alone.

The tendency towards fusion of the ganglia at the root of the neck is marked. In seven cases a good example of a 'ganglion stellatum' was found, and in three of these the fusion embraced the inferior cervical, first and second thoracic ganglia. Besides these seven cases, in two other, fusion of the inferior cervical and first thoracic ganglia was partial. In a single case the third and fourth thoracic ganglia were fused, and once a third thoracic ganglion was doubled. In three cases, 'N' right, 'P' left, and 'Q' right, small accessory ganglia existed in the cervical region.

2. *The Annulus of Vieussens.*

This was present so as to form a complete loop around the subclavian artery in nine cases. In subject 'L' the annulus on each side was abnormally long, extending the whole length between the superior and inferior cervical ganglia.

3. *Analysis of the White Fibres in the Sympathetic Cord*— (Table V.).

In ten of the dissections portions of the cord were taken from the links between the ganglia and the portions cleaned and teased out for microscopic examination, in the same manner as

TABLE V.—*Analysis of White Fibres in Sympathetic Cord.*

Subject.	Side.	Between Ganglia III. and II. Thoracic.			Between Ganglia II. and I. Thoracic.			Between Ganglia I. Thoracic and Inf. Cerv.			Annulus of Vieussens.						Between Ganglia Infer. Cerv. and Mid. Cerv.			Between Ganglia Middle and Superior Cervical.		
											Anterior Limb.			Posterior Limb.								
		Mark.	Under 4μ.	4μ and over.	Mark.	Under 4μ.	4μ and over.	Mark.	Under 4μ.	4μ and over.	Mark.	Under 4μ.	4μ and over.	Mark.	Under 4μ	4μ and over.	Mark.	Under 4μ.	4μ and over.	Mark.	Under 4μ.	4μ and over.
M	R	*a*	—	—[1]	*b*	210	15*	*c*	350	55*		—	—		—	—	*d*	25	16	*e*	22	35
	L	*a*	—	—[1]	*b*	250	20*	*c*	50	30*		—	—		—	—	*d*	35	0*	*e*	15	0
N	R	*a*	—	—[1]	*b*	*		*c*	*		*d*	0	0	*d′*	1	2		—	—	*e* *e′*	22 15	17 20
	L	*a*	350	40	*b*	*		*c*	*		*d*	0	0	*d′* *d″*	30 0	5 0		—	—	*e*	0	8
O	R	*a*	300	10	*b*	*		*c*	*		*d*	4	6	*d′*	7	10		—	—	*e* *e′*	15 17	14 22
	L	*a*	250	40	*b* *b′*	175 *	22* *	*c*	*		*d*	6	17	*d′*	2	5*		—	—	*e* *e′*	4 16	14 17
P	R	*a*	—	—[1]	*b*	*		*c*	*		*d*	—	—[1]	*d′*	—	—[1]		—	—	*e*	—[1]	—[1]
	L	*a*	200	40	*b*	*		*c*	*			—	—		—	—	*d*	*		*e* *e′*	21 37	22 51
Q	R	*a*	370	40	*b*	140	5	*c*	*		*d*	0	0	*d′*	10	6		—	—	*e*	0	13
	L	*a*	300	32	*b*	190	37	*c*	*		*d*	10	5	*d′*	0	15		—	—	*e*	5	21

[1] The fibres were not counted in these sections.

* Indicates continuity of ganglion cells in cord.

employed for the rami communicantes, with a view to ascertaining the condition of the white fibres within the cord.

In many cases, indicated in the table by an asterisk, no count of the fibres could be made, owing to the presence of numerous ganglion cells which united the contiguous ganglia.

The fibres were found to bear the same characters as those in the rami, the small white fibres were very numerous in the thoracic portion of the cord, and their numbers rapidly diminished in the upper sections. The coarser fibres were pretty evenly scattered throughout the cord.

III.—The Plan of the Rami communicantes.

In the thoracic region a very uniform plan of arrangement was found to exist. In most cases each spinal nerve had connected with it three rami. The most anterior was a slender ramus, composed of almost wholly small white fibres, which passed from the spinal nerve obliquely upwards across the head of the rib to the ganglion of the nerve above. This ramus is a very delicate one, and liable to be missed unless special care be taken. Connecting the nerve and its own proper ganglion were two rami, which may be distinctly separate at the first fresh dissection. Of these the upper usually proves to contain a large number of the small white fibres, and the lower to be mostly grey fibres.

In some cases the separation of the two parts of the double connection was only distinguished after the staining with osmic acid; in these cases the rami are lettered as one in the figure, and an indication of the double nature made in the analysis. In yet other cases the parts are so firmly united as to constitute only one ramus.

In the upper region of the thoracic cord, the distinction of white and grey rami are fairly sharply maintained. The extreme shortness of these upper thoracic rami must be emphasised.

As regards the rami connected with the cervical nerves, they are variable in number, and in their connections with cord or ganglia. The rami of the first three cervical nerves almost

always sprang from the superior cervical ganglion, that of the IVth cervical nerve from the cord immediately below this ganglion. In one case, 'M' left, the rami of the IIIrd and IVth nerves sprang from a middle ganglion.

The origin of the rami for nerves V and VI has been discussed, and is shown in Table IV.

For nerves VII and VIII there are usually two rami to each nerve, which always spring from an inferior cervical or stellate ganglion.

IV.—The Form of Plexus.

I have used for the classification of the forms of plexuses found, the size of the communication from the IVth to the Vth cervical nerve, and the size and nerve of origin of the intercosto-humeral nerve.

The cases, which were labelled and dissected immediately on receipt through a period of ten months, form a complete series from high to very low forms of plexuses. It may be noted also, that the medium and low forms are the most numerous, and that the extreme forms are in the direction of a downward shifting of the limb plexus; this is in striking contrast to the forms of plexuses dissected in the examination of the lumbar rami and the pelvic splanchnics, where the majority were medium and high, and the extreme forms were those showing an upward shifting of the plexus. These conditions may very well be viewed in connection with the theory of the tendency to the diminution of the extent of the trunk both from below and above.

The plexuses of subject 'Q' are so much out of the ordinary range that some extra details of their arrangements may be given. It appears they form the greatest downward shifting yet recorded (Table VI.).

The plexuses are remarkable in the loss of supply to the limbs from the IVth and partly the Vth cervical nerves, which is compensated for by the absorption of the greater part of the IInd thoracic nerve into the plexus. This supply passed upwards within the thorax across the head of the second rib and the neck of the first rib to join the Ist thoracic nerve on the upper

TABLE VI.—*Forms of Plexuses in Subject 'Q.'*

Nerves.	Right Side.	Left Side.
Cervical Plexus:—		
Com. fr. Cerv. Nerve to XIIth Cranial.	Small communication from I Cervical only.	Same.
Descendens Cervicis.	Very small, from I Cerv. only.	Same.
Communicans do.	From II and III Cerv. No Ansa.	Same.
Phrenic Nerve.	IV and V Cerv., Branch from IV slightly larger.	IV and V in equal proportions. They do not unite until within thorax.
Brachial Plexus:—		
Com. fr. IV to V Cerv.	Absent.	Extremely minute.
Supply to plexus fr. IInd Dorsal.	Two-thirds whole root.	Two-thirds whole root.
Musculo-cutaneous.	$V_{(2)}$ $VI_{(3)}$	$V_{(2)}$ $VI_{(3)}$
Median:—Outer Head.	$V_{(<1)}$ $VI_{(1)}$ $VII_{(7)}$	$VI_{(2)}$ $VII_{(6)}$
Inner Head.	$VII_{(1)}$ $VIII_{(6)}$ $I_{(6)}$ $II_{(1)}$	$VII_{(2)}$ $VIII_{(10)}$ $I_{(2)}$ $II_{(1)}$
Ulnar.	$VIII_{(6)}$ $I_{(8)}$ $II_{(1)}$	$VIII_{(5)}$ $I_{(7)}$ $II_{(2)}$
Internal cutaneous.	$I_{(2)}$ $II_{(3)}$	$I_{(2)}$ $II_{(3)}$
Lesser do.	$II_{(1)}$	$II_{(1)}$
Musculo-spiral.	$V_{(2)}$ $VI_{(10)}$ $VII_{(10)}$ $VIII_{(11)}$ $I_{(3)}$	$V_{(1)}$ $VI_{(7)}$ $VII_{(14)}$ $VIII_{(8)}$ $I_{(2)}$
Circumflex.	$V_{(5)}$ $VI_{(7)}$ $VII_{(5)}$ $VIII_{(3)}$ $I_{(1)}$	$V_{(6)}$ $VI_{(8)}$ $VII_{(3)}$ $VIII_{(1)}$
Intercosto-humeral:—		
From II Dorsal.	One-third Second Intercostal, joins with lesser internal cutaneous twig.	One-half Second Intercostal, joins with lesser internal cutaneous twig.
III do.	Two-thirds Third Intercostal, descends alone to near elbow.	Two-thirds Third Intercostal, ends middle third of arm.
IV do.	Not present.	One-half Fourth Intercostal, ends upper third of arm.
Lumbo-sacral Plexus:—		
Com. fr. XII Dor. to I L.	Absent.	Absent.
Nv. Furcalis.	Com. from IV. L. very minute.	No com. fr. IV. Lumb. Ant. Crural arises from V. L.

The small bracketed letters indicated the approximate proportion of the contributions of the plexus roots to the nerves.

surface of the neck of this rib. The pressure exerted by the sharp bend which these nerves make over the bone might be supposed to be capable of exerting an influence injurious to the growth of the rib; in this case, however, no sign of grooving or defect of nutrition could be discerned. These conditions may be compared with those found by Lane (15, p. 267) in an adult subject, in which, with considerable coincident changes in the skeleton, the IXth nerve "was joined by a large branch of the Xth spinal nerve."

In this subject the conditions of the other plexuses or plexiform connections of the spinal nerves were examined, with the interesting result that the outflow of the spinal nerves in their relation to the column was found to be shifted *en masse* in a caudal direction. The communication from the spinal nerves to the XIIth cranial was from the Ist cervical only, the descendens cervicis derived therefrom was very slender, and was successively augmented by communications from the IInd and IIIrd nerves. There was no loop formed, but merely a multiple origin of a single nerve, which terminated in branches of supply (fig. 12) to the depressors of the hyoid bone. The origin of the phrenic nerve was also depressed, being in both cases only from the IVth and Vth nerves, and on the right side from these nerves in equal proportions. The two branches from these sources ran a separate course in the neck, only uniting within the thorax (*cf.* W. Turner, 22, p. 102).[1]

In the lumbo-sacral region there was found to be no communication from the XIIth thoracic to the Ist lumbar, and on one side all the IVth lumbar was used within the lumbar plexus, and the anterior crural nerve derived a considerable branch from the Vth lumbar nerve.

In the large extent in which the IInd thoracic nerve enters into the formation of the fore-limb plexus, this case resembles the conditions found in lower animals, *e.g.*, cat and ape. It would have been a matter of considerable interest if the contribution which the IInd thoracic nerve made to the ulnar and median nerves could have been traced out to its peripheral distribution

[1] I have since seen two cases of delayed union of the origins of the phrenic in adults. In each of these the contribution from the fifth nerve passed superficially to the subclavian vein.

and compared with the distribution of this connection in the Macacus rhesus, as given by Sherrington (21, p. 741); but this could not be done here, as it would have endangered the safety of the rami communicantes, the white fibres of which break up very early.

There was no abnormality in the arrangements of the ribs, nor yet in the vertebral column.

It is of considerable interest to compare these observations with those of cases 'L,' 'M,' and 'N,' where the brachial and lumbo-sacral plexuses were examined.

In 'L' the plexuses are 'high' forms throughout; in 'M' 'medium' fore-limb and 'low' hind-limb plexuses, and in 'N' 'medium' fore-limb and 'high' hind-limb plexuses are associated together.

The plexuses of 'L' and 'Q' show a shifting *en masse* of the nerves in an upward and downward direction respectively, whilst 'M' shows an expansion from the downward shifting of the hind-limb plexuses, and 'N' a compression from the upward displacement of the same plexuses, whilst both possess the 'medium' form of fore-limb plexuses.

In 'Q' the shifting was ascertained to extend to the upper cervical region as well as to the limb plexuses.

V.—An Inter-thoracic Communication from the IInd to Ist Thoracic Nerve.

This communication was present in seven out of the twelve dissections (including 'Q'); this is a rather smaller proportion than that given by Cunningham (6) from his dissections, but the occurrence is more frequent than that indicated by Herringham (14), who says the communication is too small to be observed in fœtal dissections.

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INDEX TO FIGURES.

Roman numerals—Spinal and Cranial nerve roots.
Arabic numerals—Rami communicantes.
Roman letters *a* to *e*—Sections of Sympathetic cord.
c.c.—Communicans cervicis.
d.c.—Descendens cervicis.
d.h.—Branches to depressor muscles of hyoid bone.
m.h.—Branches to m. genio-hyoideus and thyro-hyoideus.
i.h.—Intercosto-humeral nerve.
ph.—Phrenic nerve.
Greek characters—Branches of distribution of the Sympathetic.
θ—Thyroid branches.
κ—Cardiac nerves.
λ—Twigs to column, ligaments, and aorta.
π—Pulmonary branches.
ς—Do. along subclavian artery.
υ—Do. along vertebral artery.

Analysis.

L. right, ♂, 55 cm.

Nerve Root.	Ramus.	No. of White Fibres.		Description.
		Under 4 μ.	4 μ and over.	
V Cervical	1	0	1	Large grey ramus.
VI ,,	2	0	6	do.
VII ,,	3	0	10	do.
VIII ,,	4	45	3	Large grey ramus, white fibres in two bundles of 20 each.
,, ,,	5	0	0	Large grey ramus.
I Thoracic	6	75	25	Many grey fibres.
I ,,	7	85	10	Very large grey ramus.
II ,,	8	...	...	Many grey fibres.
,, ,,	9	45	5	do.
III ,,	10	120	13	Nearly all white.
,, ,,	11	110	32	$\frac{2}{3}$ grey.
IV ,,	12	230	16	Most white, few grey.
,, ,,	13	170	43	$\frac{3}{4}$ grey.

Analysis.

L. left, ♂, 55 cm.

Nerve Root.	Ramus.	No. of White Fibres.		Description.
		Under 4 μ.	4 μ and over.	
V Cervical	1	...	...	...
VI ,,	2	...	...	...
VII ,,	3	0	6	Very large grey ramus.
VIII ,,	4	45	8	Very large grey ramus, white fibres in one bundle of 40.
,, ,,	5	25	2	Very large grey ramus, white fibres in one bundle of 20.
I Thoracic	6	85	3	...
II ,,	7	75	5	White ramus, with $\frac{1}{4}$ grey.
,, ,,	8	240	70	$\frac{3}{4}$ grey fibres.
,, ,,	9	60	10	Large grey ramus.
III ,,	10	80	5	White, some grey.
,, ,,	11	80	50	$\frac{3}{4}$ grey.
IV ,,	12	...	...	Lost, fine white ramus.
,, ,,	13	200	55	$\frac{2}{3}$ white.

Analysis.

M. ♀, 54 cm. right side.

Nerve Root.	Ramus.	No. of White Fibres.		Description.
		Under 4 μ.	4 μ and over.	
V Cervical	1	0	5	Grey ramus.
VI ,,	2	5	20	Large do.
VII ,,	3	2	8	do.
,, ,,	4	12	6	Very large ramus. White fibres in one bundle.
VIII ,,	5	4	1	Small grey ramus.
,, ,,	6	5	0	Very large grey ramus.
I Thoracic	7	8	0	Small grey ramus.
,, ,,	8	40	2	Large do.
,, ,,	9	70	1	Many grey fibres.
II ,,	10	240	35	do.
,, ,,	11	70	3	Large grey ramus.
III ,,	12	30	4	Many grey fibres.
,, ,,	$13_{(2)}$	115	13	Very do.
IV ,,	14	140	6	Few grey fibres.
,, ,,	15*a*	400	10	do.
,, ,,	*b*	30	7	Large grey ramus.

Analysis.

M. ♀, 54 cm. left side.

Nerve Root.	Ramus.	No. of White Fibres.		Description.
		Under 4 μ.	4 μ and over.	
V Cervical	1	0	6	Grey ramus.
VI ,,	2	0	0	Very large grey ramus.
VII ,,	3	0	0	Small grey ramus.
,, ,,	4	0	0	Large grey ramus.
VIII ,,	5	0	5	do.
I Thoracic	6	10	25	do.
,, ,,	7	40	0	do.
II ,,	8	135	40	White ramus but many grey fibres.
,, ,,	9	110	15	$\frac{2}{3}$ grey.
III ,,	10	45	3	Small white ramus.
,, ,,	$11_{(2)}$	300	50	$\frac{2}{3}$ grey.
IV ,,	12	...	...	White ramus, lost.
,, ,,	$13_{(2)}$	175	10	Many grey fibres.

Analysis.
N. right, ♂, 53 cm.

Nerve Root.	Ramus.	No. of White Fibres.		Description.
		Under 4 μ.	4 μ and over.	
V Cervical	1	0	0	Grey ramus.
VI ,,	2	0	0	Large do.
,, ,,	3	0	5	Grey ramus.
VII ,,	4	0	20	Large do.
,, ,,	5	0	8	Grey ramus.
,, ,,	6	0	4	do.
VIII ,,	7	0	5	Large grey ramus.
,, ,,	8	0	1	Medium grey ramus.
,, ,,	9	20	5	Grey ramus, white fibres in two bundles of 10 each.
I Thoracic	10	120	5	½ grey.
,, ,,	11	150	2	¾ do.
II ,,	12	210	17	⅓ do.
,, ,,	13	0	0	All grey.
III ,,	14	80	8	½ do.
,, ,,	15	230	9	½ do.
,, ,,	16	30	2	Mostly grey.
IV ,,	17	90	1	Few grey.
,, ,,	18(2)	20	15	Large grey.

Analysis.
N. left, ♂, 53 cm.

Nerve Root.	Ramus.	No. of White Fibres.		Description.
		Under 4 μ.	4 μ and over.	
V Cervical	1	0	25	Small grey ramus.
,, ,,	2	0	0	do.
VI ,,	3	0	0	do.
VII ,,	4	0	6	Very large grey ramus.
VIII ,,	5	20	10	Large grey ramus, white fibres scattered.
,, ,,	6	0	6	Grey ramus.
I Thoracic	7	60	20	Many grey fibres.
,, ,,	8	75	25	do.
,, ,,	9	10	0	Large grey ramus.
II ,,	10	80	15	Small white.
,, ,,	11*a*	100	8	Very many grey.
,, ,,	*b*	5	0	
III ,,	12	35	10	Many grey.
,, ,,	13*a*	150	6	⅔ grey.
,, ,,	*b*	20	0	Large grey ramus.
IV ,,	14	100	5	White, few grey.
,, ,,	15	70	10	Large grey ramus.

Analysis.
O. right, ♂, 48 cm.

Nerve Root.	Ramus.	No. of White Fibres.		Description.
		Under 4 μ.	4 μ and over.	
V Cervical	1	0	7	Medium grey ramus.
VI ,,	2	0	0	Grey ramus.
VII ,,	3	15	2	Very large grey ramus, white fibres in one bundle.
,, ,,	4	0	0	Small grey.
VIII ,,	5	0	0	do.
,, ,,	$6_{(3)}$	10	3	Very large grey ramus.
I Thoracic	7	65	5	$\frac{2}{3}$ grey.
,, ,,	8	90	5	Most grey.
,, ,,	9	0	0	Very small grey.
,, ,,	10	0	0	do.
,, ,,	11	0	0	do.
II ,,	12	70	10	$\frac{1}{2}$ grey.
,, ,,	$13_{(2)}$	65	4	Large grey ramus.
III ,,	14	100	20	Few grey fibres.
,, ,,	15	60	0	Large grey ramus.
,, ,,	16	130	6	$\frac{1}{2}$ grey.
IV ,,	17	40	1	Few grey.
,, ,,	18	15	3	Large grey.
,, ,,	19	150	8	Medium.

Analysis.
O. left, ♂, 48 cm.

Nerve Root.	Ramus.	No. of White Fibres.		Description.
		Under 4 μ.	4 μ and over.	
V Cervical	1	0	2	Grey ramus.
VI ,,	2	...	...	Lost.
VII ,,	3	0	4	Very large grey ramus.
,, ,,	4	0	10	Medium grey ramus.
VIII ,,	5	3	7	Large grey ramus.
,, ,,	6	14	3	Grey ramus, white fibres in one bundle of 8.
,, ,,	7	2	0	Grey ramus.
I Thoracic	8	95	20	$\frac{1}{2}$ grey.
,, ,,	9	70	10	do.
,, ,,	10	35	2	$\frac{2}{3}$ do.
II ,,	11	200	11	Few do.
,, ,,	12	120	20	do.
,, ,,	13	20	0	$\frac{2}{3}$ do.
III ,,	14	160	10	Few do.
,, ,,	$15_{(2)}$	0	0	Large grey ramus.
IV ,,	16	80	0	Few grey.
,, ,,	17	200	10	$\frac{1}{3}$ do.
,, ,,	18	20	0	Large grey ramus.

Analysis.
P. right, ♂, 52·5 cm.

Nerve Root.	Ramus.	No. of White Fibres.		Description.
		Under 4 μ.	4 μ and over.	
V Cervical	1	5	30	Grey ramus.
VI ,,				
VII ,,	2	2	1	Large do.
,, ,,	3	0	2	Very large ramus.
VIII ,,	4	1	0	Grey ramus.
,, ,,	5	4	0	Very large do.
,, ,,	6	0	1	Large grey do.
I Thoracic	7	60	20	½ grey.
,, ,,	8	0	2	Very large grey ramus.
,, ,,	9	30	5	½ grey.
II ,,	10	140	12	⅓ grey.
,, ,,	11	150	20	do.
,, ,,	12	20	0	Large grey ramus.
III ,,	13	110	9	½ grey.
,, ,,	$14_{(2)}$	20	0	Large grey ramus.
IV ,,	15	70	0	Few grey fibres.
,, ,,	16	100	10	Very many do.
,, ,,	17	50	3	do.

Analysis.
P. left, ♂, 52·5 cm.

Nerve Root.	Ramus.	No. of White Fibres.		Description.
		Under 4 μ.	4 μ and over.	
V Cervical	1	0	0	With this ramus there runs a muscular branch of 100 fibres of 3–4 μ, past the accessory ganglion.
VI ,,	2	0	0	
VII ,,	3	20	8	Large grey ramus, white fibres scattered.
VIII ,,	4	30	20	Very large grey ramus, white fibres scattered.
,, ,,	5	0	0	Grey ramus.
I Thoracic	6	140	10	Few grey fibres.
,, ,,	7	0	0	Large grey ramus.
II ,,	8	40	0	Few grey fibres.
,, ,,	9	200	13	½ grey.
III ,,	10	140	4	White ramus, some grey.
,, ,,	11	0	4	Grey ramus.
IV ,,	12	150	0	Few grey fibres.
,, ,,	13	80	30	Many do.
,, ,,	14	0	10	Grey ramus.

Analysis.

Q. right, ♂, 54 cm. (14 days extra-uterine).

Nerve Root.	Ramus.	No. of White Fibres.		Description.
		Under 4 μ.	4 μ and over.	
V Cervical	1	0	0	Small grey ramus.
VI ,,	2	8	2	Large grey do.
VII ,,	3(2)	10	0	do. white scattered.
VIII ,,	4	20	10	do.
I Thoracic	5	90	5	⅔ grey.
II ,,	6	85	6	do.
,, ,,	7	80	5	Nearly all white.
,, ,,	8	240	9	⅓ grey fibres.
,, ,,	9	20	0	Mostly grey ramus.
III ,,	10	...	...	Small white ramus—lost.
,, ,,	11	310	6	Few grey fibres.
,, ,,	12	0	9	Grey ramus.
IV ,,	13	65	0	Nearly all white.
,, ,,	14	60	0	¾ grey.

Analysis.

Q. left, ♂, 54 cm. (14 days extra-uterine).

Nerve Root.	Ramus.	No. of White Fibres.		Description.
		Under 4 μ.	4 μ and over.	
V Cervical	1	20	10	Large grey ramus, with scattered white.
VI ,,	2	5	10	Grey ramus.
VII ,,	3	8	2	Large grey ramus.
,, ,,	4	30	3	do. white scattered.
VIII ,,	5	23	7	Large grey ramus, white fibres in one bundle of 20.
,, ,,	6	20	4	Large grey ramus, white fibres in one bundle of 20.
I Thoracic	7	80	1	Nearly all white.
,, ,,	8(2)	70	5	Large grey ramus.
II ,,	9	170	4	Nearly all white.
,, ,,	10(2)	150	20	⅔ grey fibres.
III ,,	11	70	3	Nearly all white.
,, ,,	12(2)	300	40	½ grey fibres.
IV ,,	13	100	0	Nearly all white.
,, ,,	14	220	2	⅔ grey fibres.

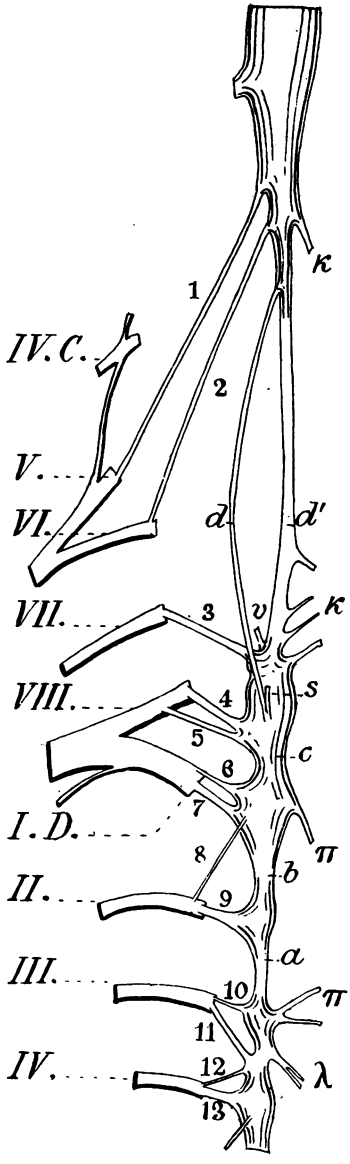

FIG. 1.—Subject, 'L,' right side.
(♂ 55 c.m.)

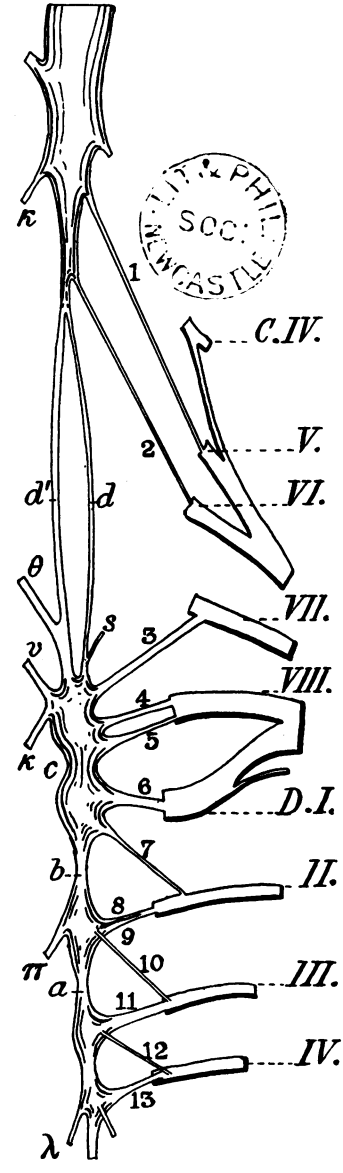

FIG. 2.—Subject, 'L,' left side.
(♂ 55 c.m.)

N. B. H., *del.*

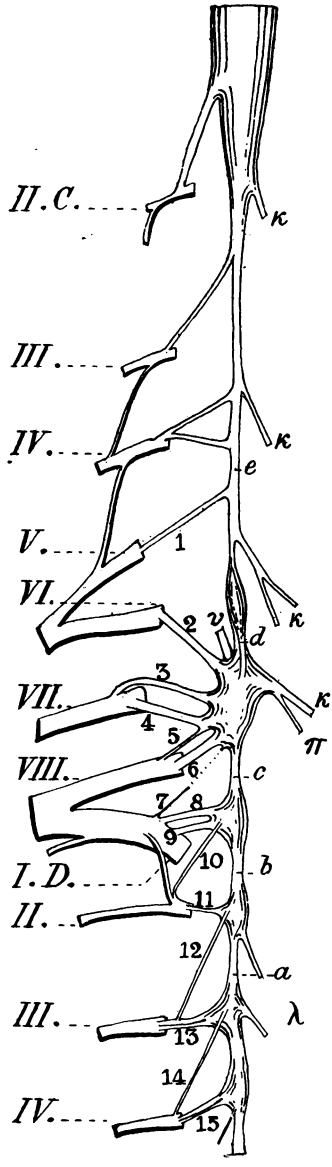

FIG. 3.—Subject, 'M,' right side.
(♀ 54 c.m.)

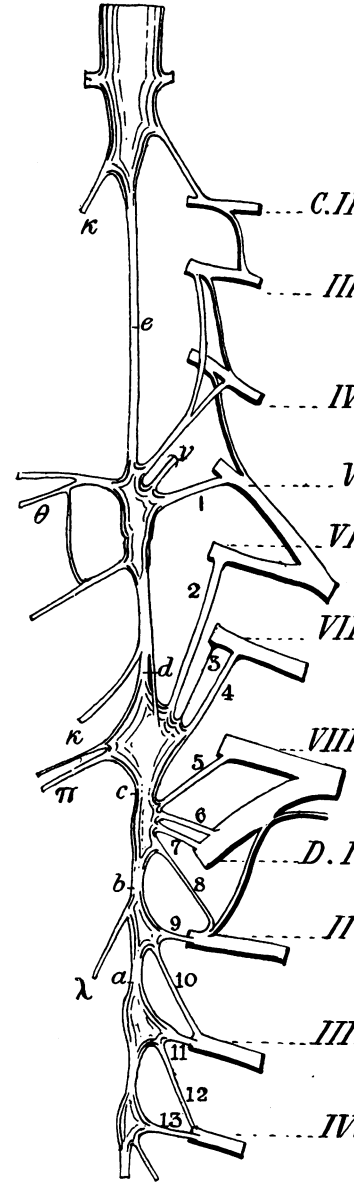

FIG. 4.—Subject, 'M,' left side.
(♀ 54 c.m.)

N. B. H., *del.*

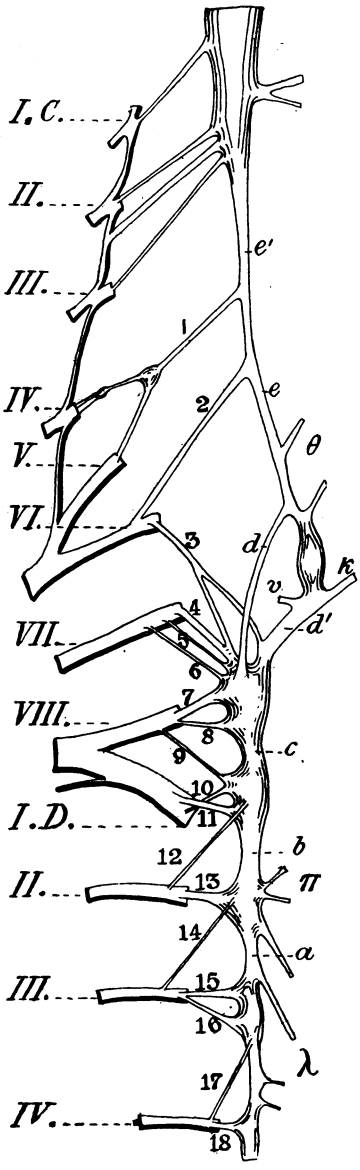

FIG. 5.—Subject, 'N,' right side.
(♂ 53 c.m.)

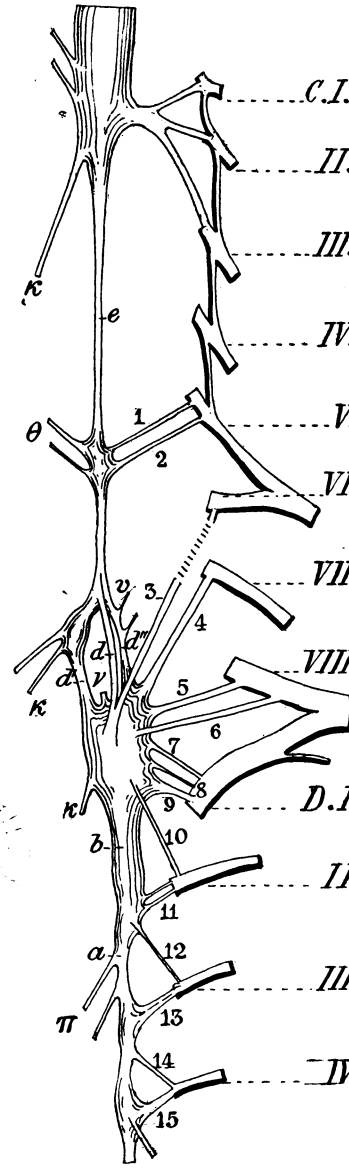

FIG. 6.—Subject, 'N,' left side.
(♂ 53 c.m.)

N. B. H., *del.*

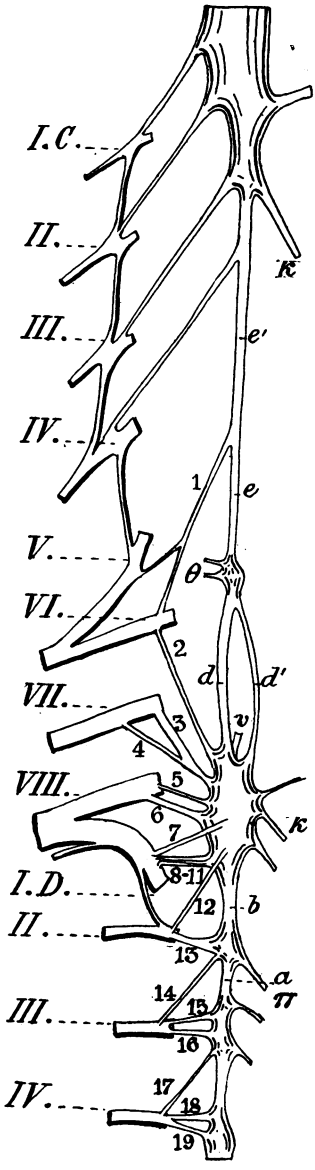

FIG. 7.—Subject, 'O,' right side.
(♂ 48 c.m.)

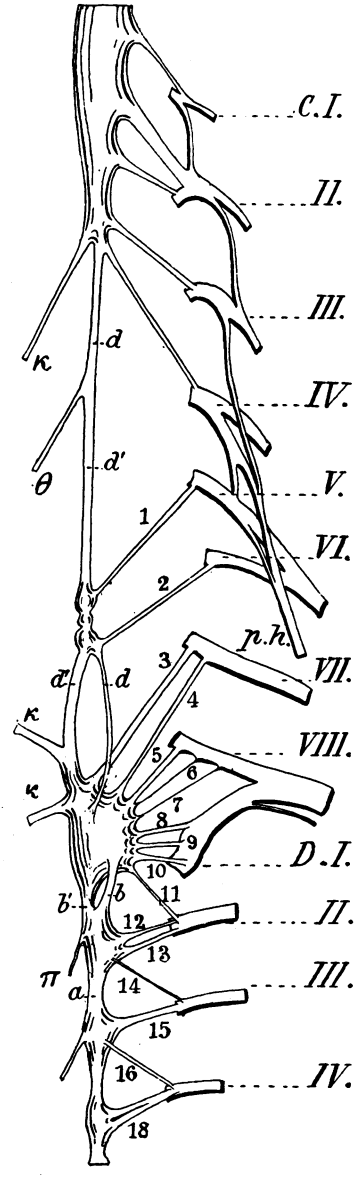

FIG. 8.—Subject, 'O,' left side.
(♂ 48 c.m.)

N. B. H., *del.*

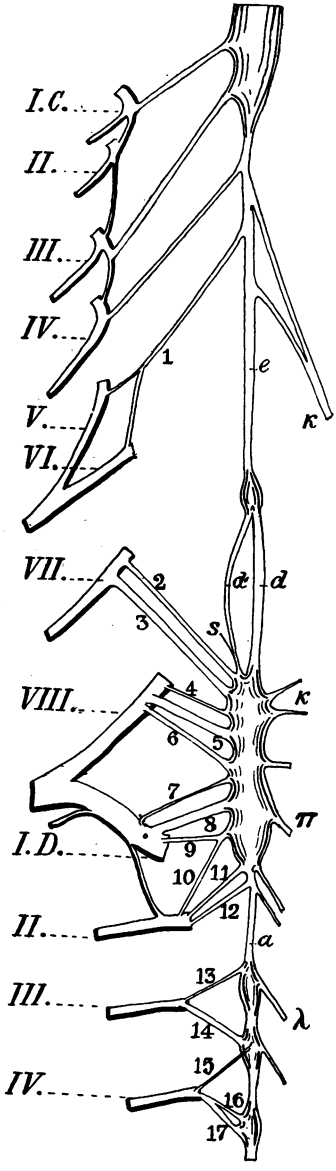

FIG. 9.—Subject, 'P,' right side.
(♂ 52·5 c.m.)

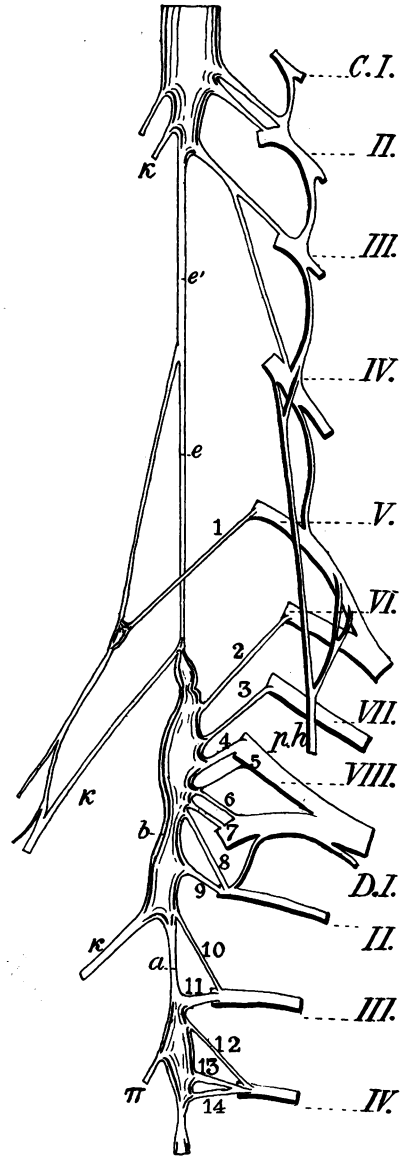

FIG. 10.—Subject, 'P,' left side.
(♂ 52·5 c.m.)

N. B. H., *del.*

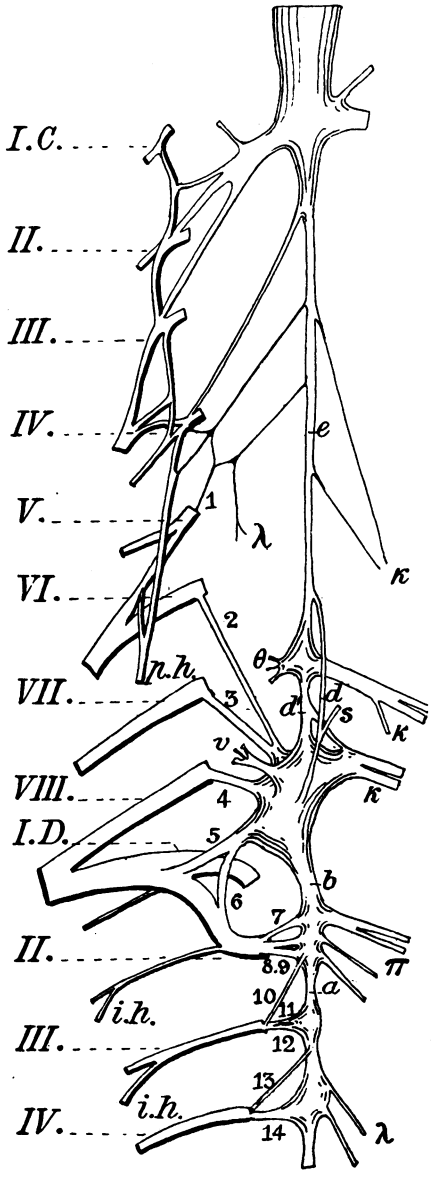

FIG. 11.—Subject, 'Q,' right side. (♂ 54 c.m.) Very low form of plexus, see page 370, Table VI.

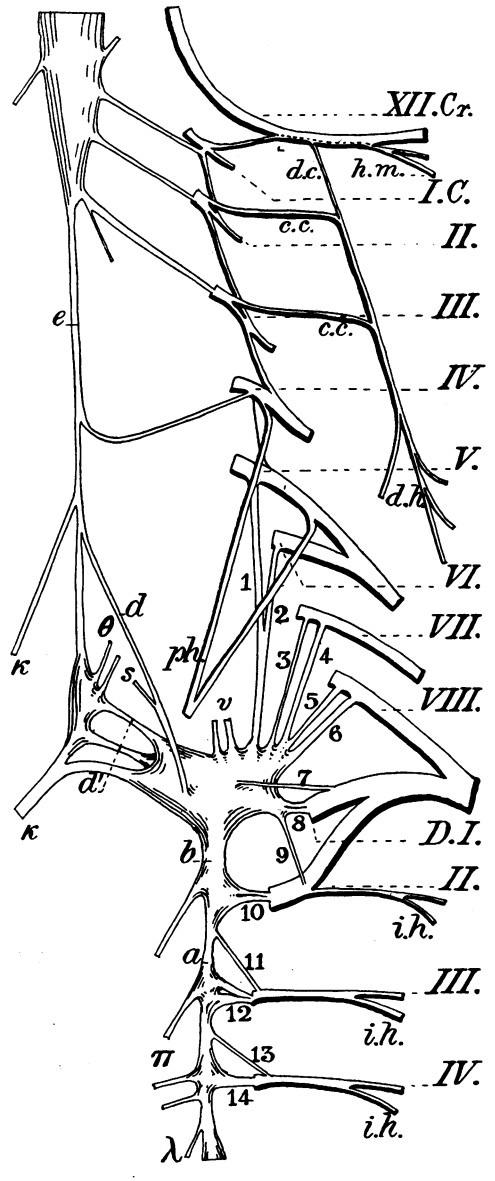

FIG. 12.—Subject, 'Q,' left side. (♂ 54 c.m.) Very low form of plexus, see page 370, Table VI.

N. B. H. *del.*