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OBSERVATIONS ON THE FIBRE CONTENT OF NERVES REACHING THE CAROTID BODY OF THE CAT

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The region of the carotid sinus and body is innervated principally by the carotid nerve, a branch of the glossopharyngeal nerve. It also receives nerve branches from the superior cervical ganglion (ganglio-glomerular nerves). The principal afferent innervation reaches the carotid sinus and glomus through the carotid nerve (Adams, 1958). This nerve contains about 650 myelinated fibres, the majority being from presso- or chemoreceptors. Some of the myelinated fibres have been considered, however, to be efferent to a small number of nerve cells located near the termination of the carotid nerve in the glomus (de Castro, 1926, 1951). Physiological studies have indicated the presence of non-myelinated (C) fibres in the carotid nerve as well. Douglas & Ritchie (1956) recorded potentials conducting at C-fibre velocity when stimulating and recording from the carotid nerve. Also, stimulation of the ganglio-glomerular nerves gives rise to an action potential in the carotid nerve which also is propagated at a velocity characteristic of C fibres (Eyzaguirre & Lewin, 1961*b*). Anatomical evidence that the ganglio-glomerular nerve is mainly comprised of non-myelinated fibres originating in the superior cervical ganglion has been presented by de Castro (1926).

The purpose of the present study is to analyse further the innervation of the carotid-body region, since several details have remained uncertain: (1) the course followed by the carotid nerve once it reaches the carotid-body–sinus area to innervate the glomus and the sinus; (2) how the ganglio-glomerular nerve fibres reach the glomus and how they join the carotid nerve; (3) whether or not non-sympathetic C fibres occur in the carotid nerve. Also (4) no anatomical studies have appeared indicating either the presence of C fibres in the carotid nerve or their diameter ranges and distributions; similarly, data on the fibre size and diameter distribution of

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the non-myelinated axons in the ganglio-glomerular nerve are not available. A preliminary report has already been published (Eyzaguirre, Uchizono & Lewin, 1961).

METHODS

The carotid body and its own nerve in addition to the ganglio-glomerular connexions were excised from cats under sodium pentobarbital, (Nembutal; Abbott Laboratories) 40 mg/kg I.P. For direct observation the tissues were placed in a Petri dish containing Locke's solution and examined with a dissecting microscope under transmitted polarized light. For examination under the phase-contrast and electron microscopes the tissues were excised from the animal and immediately immersed in 2 % (w/v) ice-cold OsO_4 buffered to pH 7·4 with veronal acetate (Palade, 1952). They remained in the osmium for about 15 min. Afterwards the tissues were dehydrated by successive passages in alcohol (75–100 %). After dehydration the tissues were processed by Luft's method (1961): they were soaked in propylene oxide for 60 min and then passed into a mixture containing equal parts of epoxy resin (Epon 812, Shell) and propylene oxide. They remained in the mixture for 1–2 hr. Finally, they were embedded in the epoxy resin. The block obtained was trimmed and sectioned transversely with a Porter-Blum ultramicrotome. For observation and photography with the phase-contrast microscope (Carl Zeiss) the sections (1–2 μ) were mounted on a glass plate, covered by a drop of Canada balsam and a microscope cover-slip. Observations with the electron microscope (Akashi-Bendix Tronscope) were performed on sections which had a silver or gold colour. Some preparations were stained with uranium acetate.

The myelinated nerve fibres were measured from enlarged phase-contrast photomicrographs (total magnification 1000–1500 times) and the non-myelinated fibres from enlarged electron micrographs (total magnification 4800–40,000 times). In both cases the photograph was laid flat (face upwards) on the stage of the Zeiss microscope. The eyepieces and objectives were removed. The microscope illuminator was turned on and the light spot was focused on the emulsion side of the picture. The diameter of the spot was adjusted by opening or closing the diaphragm of the illuminator. In all cases the spot diameter was first adjusted to cover the smallest fibres in the photograph (0·1 μ in the electron micrographs and 1·0 μ in the phase-contrast pictures) and the picture was scanned by manual displacement; whenever the area of a fibre clearly matched that of the light spot an electric counter was triggered and an ink mark made on the picture. Once all fibres of a given diameter were counted the procedure was repeated after increasing the diameter of the spot in steps of 0·1 μ for electron micrographs and of 1·0 μ for phase-contrast micrographs until all the fibres in a given photograph were measured. The diameter of fibres too large to be within the light-spot range was calculated by measuring two diameters at right angles and averaging the results obtained.

Physiological experiments were conducted *in vitro* in a manner similar to that already described (Eyzaguirre & Lewin, 1961*a*, *b*). In short, the carotid body and its own nerve in addition to the ganglio-glomerular connexions were excised from the animal and placed in a chamber through which flowed Locke's solution equilibrated with 100 % O_2 at pH 7·4. The saline was covered with mineral oil. The nerves or the whole preparation were lifted into oil for stimulation and recording.

RESULTS

The carotid-body–sinus region, the carotid nerve and the ganglio-glomerular nerve were examined under a low-power stereo-microscope. The tissues under observation were cleaned from surrounding connective tissues and the course of the nerves followed.

The carotid nerve was followed to its termination on the carotid-body–sinus region and was found to divide into two branches shortly before reaching this region. One branch reached the carotid body, clearly going to innervate the glomerular tissues, while the other nerve branch reached the carotid sinus. This finding permits the possibility of selective severance of either nerve branch, although *in vivo* such a procedure is difficult owing to the dense vascularization of the region and because of the presence of abundant connective tissue around the bifurcation of the nerve.

Usually two or three nerves were found to link the superior cervical ganglion with the carotid-body–sinus area. One of them clearly went to the sinus while the others connected the ganglion with the glomus. A common arrangement was the presence of a relatively thick nerve which divided in two branches before reaching the glomus. One of the branches seemed to penetrate the glomerular capsule; the other coursed toward the glomus, bypassed the organ and joined the carotid nerve. Sometimes the nerve branch which joined the carotid nerve could be followed as a separate entity from the cervical sympathetic ganglion. Occasionally, still another nerve was found leaving the ganglion; it coursed toward the carotid body, which it bypassed, and then ran separate from the carotid nerve to innervate, apparently, other organs in the neck. At times this nerve could not be followed as a separate entity, since it originated as a branch of the ganglio-glomerular nerve.

Physiological observations

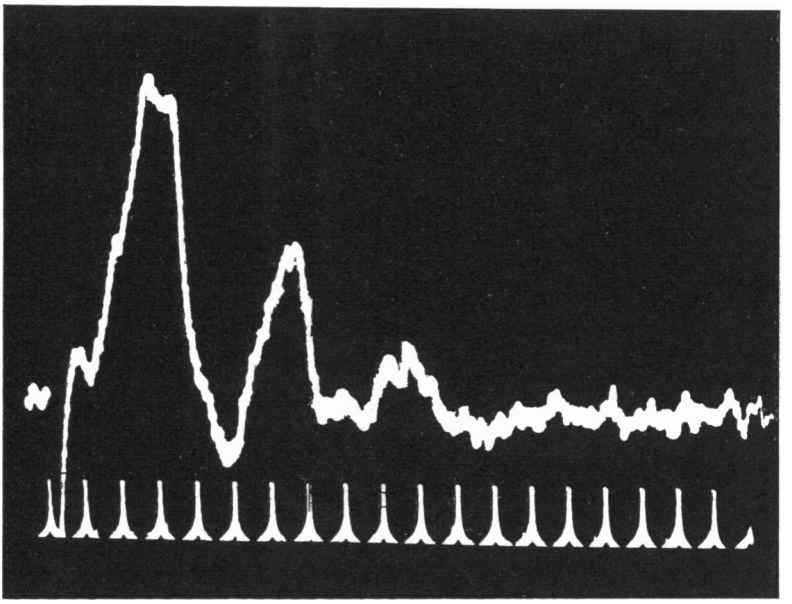
The non-myelinated fibres in the carotid nerve

It is well known that the majority of myelinated fibres in the carotid nerve subserve either presso- or chemoreceptor functions. The presence of non-myelinated fibres in this nerve is less well established. The only available evidence is that of Douglas & Ritchie (1956), who found during stimulation and recording from the carotid nerve a potential conducted at C-fibre velocity. They estimated that the conduction velocity of the fibres responsible for the recorded potential was from 1·0 to 1·3 m/sec at 37° C.

The present series of experiments was designed to study further the C-fibre activity of the carotid nerve under conditions similar to those employed by Douglas & Ritchie. The glomus and the carotid nerve were lifted into oil. One stimulating electrode was placed on the glomus while the other was placed on the carotid nerve 1 mm from the first electrode; recording leads were placed at the other end of the nerve. Text-figure 1 illustrates such an experiment. In this particular instance the myelinated fibre potential was not recorded, presumably owing to injury. Maximal stimulating shocks elicited three distinct deflexions and the conduction

velocity was calculated as 1·75, 0·61 and 0·38 m/sec for the fibres responsible for the onset of the first, second and third C-fibre potential complexes.

The diameters of the fibres involved may be calculated by using Gasser's (1955) formula, i.e. dividing the conduction velocity by a factor of 1·7. With this method one may estimate that the first group of C fibres had a diameter of about 1·03 μ, while the other two groups had diameters of 0·36 and 0·22 μ respectively. If the physiological results just described are

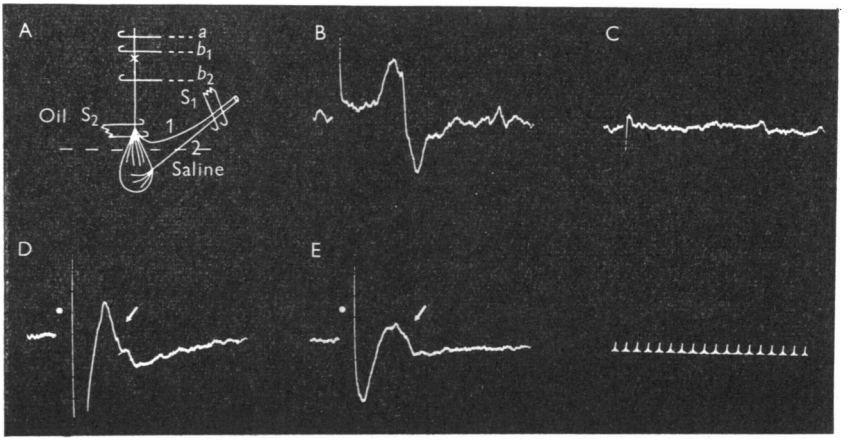


Text-fig. 1. Non-myelinated fibre potential complexes evoked in carotid nerve by stimulation of carotid nerve near glomus. Recording leads at other end of nerve. Distance between cathode and proximal recording electrode 3·5 mm. Temp. 36·8° C. Myelinated fibre activity was not recorded. Following artifact three non-myelinated fibre potentials may be seen. Time marker, 1 msec.

correlated with the diameter distribution curve of non-myelinated fibres in the carotid nerve (see Text-fig. 3A), it is clear that the first and larger potential complex was apparently elicited by fibres which are not abundant in the carotid nerve. The larger amplitude of this potential may have been due to several factors such as larger diameter of the fibres involved, less temporal dispersion and more pronounced summation of the potentials produced by individual fibres. The second and third potential complexes, conducted at 0·61 and 0·38 m/sec were, on the other hand, elicited by fibres (0·36 and 0·22 μ) which are very numerous in the carotid nerve.

Presence of non-sympathetic C fibres

The results presented in the preceding section confirmed and extended Douglas & Ritchie's (1956) observations in the sense that C-fibre potentials may be detected in the carotid nerve upon stimulation. However, it remained uncertain whether or not C fibres other than those of sympathetic origin (Eyzaguirre & Lewin, 1961*b*) occurred in this nerve.



Text-fig. 2. Non-myelinated fibre potentials recorded from carotid nerve by stimulation of same nerve and of ganglio-glomerular connexions. A, anatomical arrangement and position of electrodes; glomus immersed in saline covered by paraffin oil, nerves lifted into oil for stimulation and recording. 1 and 2 represent two branches of ganglio-glomerular nerve; S_1, stimulating electrodes on ganglio-glomerular nerve; S_2, stimulating electrodes on carotid nerve; *a*, distal recording electrode on cut end of carotid nerve; b_1 and b_2, two different positions of proximal recording electrode. About 1·5 mm between *a* and b_1, and about 3·0 mm between *a* and b_2. In position b_2 recording electrode at about 1·5 mm from carotid body. B, carotid-nerve potential elicited by maximal stimulation of ganglio-glomerular nerve and recorded between *a* and b_2. C, disappearance of potential after moving proximal lead from b_2 to b_1. D, potentials evoked in carotid nerve by stimulation of same nerve by S_2; proximal recording lead at b_2. Myelinated fibre potential indicated by dot (most of it off screen); non-myelinated fibre potential marked by arrow. E, same as D, but this time proximal recording electrode at b_1 position. Time marker, 1 msec.

In this series the glomus and the carotid nerve in addition to the ganglio-glomerular connexions were set up for stimulation and recording. Care was taken to leave the carotid body in the saline equilibrated with 100 % O_2 in order to decrease the sensory discharges. Both the ganglio-glomerular and carotid nerves were lifted into oil for stimulation and recording. Such an experiment is shown in Text-fig. 2. A represents the anatomical situation and the position of the stimulating and recording leads. B shows the potential complex evoked in the carotid nerve by maximal shocks

applied through leads S_1 to the ganglio-glomerular nerve. The carotid-nerve potential was recorded by placing one recording electrode (a) at the cut end of the nerve while the second recording lead (b_2) was placed at 1·5 mm from the carotid body. The potential obtained was a C-fibre complex (cf. also Eyzaguirre & Lewin, 1961*b*). The proximal recording lead was then moved to b_1, and the previously obtained potentials disappeared as illustrated in C. Afterwards the proximal recording lead was moved back to position b_2, and the carotid nerve was stimulated by leads S_2. Results obtained are illustrated in D. Single nerve shocks elicited a large myelinated-fibre potential (most of it off the oscilloscope screen and marked by a dot) and a later deflexion (arrow) clearly produced by C-fibre activity. In E, the proximal recording electrode was moved back to position b_1, where again the large myelinated-fibre deflexion may be seen followed by a C-fibre complex, which this time was smaller than that obtained in D.

In the experiment just described it is not known why the C-fibre potential elicited by ganglio-glomerular stimulation was not recorded when the proximal recording electrode was moved from position b_2 to position b_1. A possible explanation is that a fortunate and selective injury of the carotid-nerve C fibres of sympathetic origin occurred at this point. In any case, the fact that a C-fibre potential was obtained while the carotid nerve was stimulated by S_2 leads and potentials recorded by leads at a and b_1 positions clearly indicates that non-sympathetic C fibres occur in the carotid nerve.

At the end of the above experiment an effort was made to determine, in the same preparation, the pathway of sympathetic C fibres which are found in the carotid nerve. As is illustrated in Text-fig. 2A, the nerve linking the superior cervical ganglion with the carotid body divides into two branches, one going to the carotid body (branch 2) while the other bypasses the organ (branch 1) to join the carotid nerve at about 0·5 mm from the point where the carotid nerve penetrates into the glomus. The ganglio-glomerular nerves were stimulated and potentials recorded from the carotid nerve as illustrated in Text-fig. 2B. Immediately after obtaining the carotid-nerve potential of sympathetic origin, nerve branch 1 was severed and the potential previously obtained could no longer be recorded. This finding has been obtained also in other similar experiments. It may be concluded, therefore, that carotid-nerve sympathetic potentials are obtained from stimulation of sympathetic nerve fibres that join the carotid nerve near the carotid body and not from fibres that apparently penetrate into the glomus. The latter presumably correspond to those fibres described by de Castro (1926) which course in the interstitial spaces of the organ. These fibres may contribute to the vascular innervation of the organ and

be responsible for the small increase in chemoreceptor discharges that is obtained in the animal, apparently due to vasoconstriction (Eyzaguirre & Lewin, 1961*b*).

Anatomical observations

A series of observations were made to study the fibre content of the carotid nerve, carotid body and ganglio-glomerular nerve by means of phase-contrast and electron microscopy. Results presented below show that the carotid nerve possesses numerous non-myelinated fibres besides the well known myelinated axons. They also show the distribution of both myelinated and non-myelinated axons within the carotid body and the diameter distribution of non-myelinated fibres in the ganglio-glomerular nerve.

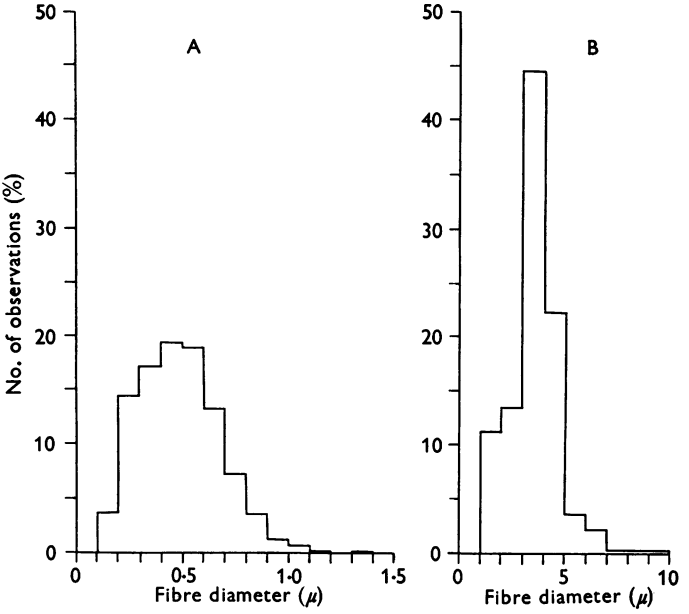
The carotid nerve

Plate 1A illustrates a cross-section of the carotid nerve near its central portion, as examined with the phase-contrast microscope; the abundance of myelinated fibres is evident. The spaces between the myelinated fibres are occupied by tissue bundles which are better seen in Pl. 1B and C. These are phase-contrast micrographs obtained from carotid-body sections at the point of carotid-nerve penetration. The tissue bundles observed between the myelinated fibres correspond to groups of non-myelinated (C) fibres, as was evident on examining the specimens under the electron microscope. Plate 2 shows an electron micrograph obtained from a section of the carotid nerve near the glomus. It may be noticed that the myelinated fibres are outnumbered by the non-myelinated axons (arrows). The latter are grouped in bundles enveloped by Schwan-cell sheaths. In several instances the Schwan-cell nucleus (S) may be seen surrounded by groups of C fibres.

The diameter distribution of non-myelinated fibres was obtained from 30 sections derived from two different nerves. A total of 2037 non-myelinated fibres were measured and their diameter distribution curve is presented in Text-fig. 3A. This unimodal curve shows that non-myelinated fibres in the carotid nerve have diameters ranging from 0·1 to 1·3 μ, the mode of the frequency distribution being 0·3–0·5 μ.

The myelinated fibres in the carotid nerve number from 600 to 700 fibres (de Castro, 1951). De Castro indicated that 17·5% of these fibres had diameters of from 1·5 to 2·8 μ; 79% of the fibres from 3 to 5 μ and 3·5% had diameters of 6–8 μ. However, since no diameter distribution curve seemed to be available all the myelinated fibres (578) in one carotid nerve were measured. The diameters of these fibres ranged from 1·0 to 9·0 μ and their diameter distribution is presented in Text-fig. 3B. From the illustration it may readily be seen that the values obtained from this nerve are similar to those presented by de Castro.

The proportion of non-myelinated fibres relative to myelinated ones was estimated indirectly, since the former could not be counted from the phase-microscope photographs and the electron micrographs did not include a sizeable portion of the nerve. Consequently, fifteen electron micrographs (total magnification 4800–8400 times) were used in the counting of



Text-fig. 3. Diameter distribution curves of fibres in the carotid nerve of the cat. A, measurements obtained from 2037 non-myelinated fibres analysed from 30 sections made in two nerves. B, measurements from all myelinated fibres (578) from one carotid nerve.

TABLE 1. Ratio of non-myelinated to myelinated fibres in the carotid nerve. Sections made at three different levels; at the origin of nerve in the glomus, at 1·0 mm from the origin and at the middle of nerve

Section level	No. of non-myelinated fibres	No. of myelinated fibres	Ratio
Origin	603	122	4·94
1 mm from origin	725	160	4·53
Middle	404	191	2·11

myelinated and non-myelinated nerve fibres. The photographs were obtained from sections made at three different levels, namely, at the glomerular origin of the carotid nerve (same region as that illustrated in Pl. 1 B and C), at 1 mm from the glomerular origin and also at a point close to the middle of the carotid nerve. Table 1 shows the ratio of non-myelinated to myelinated fibres obtained at these three different levels.

From the Table it is clear that non-myelinated fibres are more numerous than myelinated ones. However, the ratio becomes smaller at the middle of the nerve than it is near the glomus. The number of fibres counted is small and, therefore, it is difficult to draw definite conclusions as to the reason for the reduction in the ratio of non-myelinated to myelinated fibres. A possible explanation is that near the middle of the carotid nerve the section includes both the glomerular and sinus branches of the nerve. It is possible that the sinus branch may have a larger proportion of myelinated axons than the glomerular branch. Serial sections of the region will be necessary in order to elucidate this point. The fact that in the carotid nerve the non-myelinated axons outnumber the myelinated ones is not unusual. In other nerves something similar occurs (Davenport & Ranson, 1931).

The carotid body

The glomus was serially sectioned starting from the point of entry of the carotid nerve, and specimens were examined by phase-contrast and electron microscopy. Particular attention was paid to the nerves in the organ, since the distribution of nerve fibres in the organ has not been clearly defined.

Near the pole of carotid-nerve entry the nerves are grouped in bundles containing large numbers of myelinated and non-myelinated nerve fibres (Pl. 1B and C). Sections nearer to the equator of the organ revealed myelinated nerve fibres interspersed between the glomerular tissues. Sometimes it was possible to detect at the centre of the organ nerve bundles formed by myelinated and non-myelinated nerve fibres. Also, near the periphery of the equatorial region, well defined nerve bundles with both types of nerve fibres were clearly recognized. The centrally located nerve bundles became less conspicuous as sectioning proceeded toward the other pole of the organ, although the peripherally located bundles were still clearly seen.

Plate 3A and B shows electron micrographs obtained from sections performed near the equatorial region of the carotid body. A shows a cross-section of a nerve bundle located at the periphery of such a region. A number of myelinated fibres (M) may be seen, some of which clearly show the Schwan-cell (S) nucleus. The Schwan-cell membrane of these fibres is distinctly seen in all instances. In addition, numerous non-myelinated fibres (arrows) may be seen, some of them around a Schwan-cell (S) nucleus; they clearly outnumber the myelinated axons. It is not known whether or not some (or all) of these fibres have a sympathetic origin. Plate 3B shows a cross-section made at the same level as that shown in A, but this section covered the centre of the glomus. Two 'chief' cells (G) may be seen with their large nucleus (Gn); one of them is enveloped by a sustentacular

process (Sp) similar to those described by Ross (1959). The cell cytoplasm is abundantly supplied by mitochondria and by small osmiophilic granules, as described previously by other authors (Garner & Duncan, 1958; Lever, Lewis & Boyd, 1959). An interesting feature of this illustration is that myelinated (M) and non-myelinated (arrows) fibres are interspersed among the cells. The non-myelinated fibres may be either non-myelinated C fibres (either of medullary or sympathetic origin) or the non-myelinated endings of myelinated fibres. It is known that a number of myelinated fibres from the carotid nerve lose their myelin as they approach the glomerular cells (de Castro, 1951). If those fibres are responsible for the transmission of chemoreceptor impulses they would be similar to sensory fibres of other receptors.

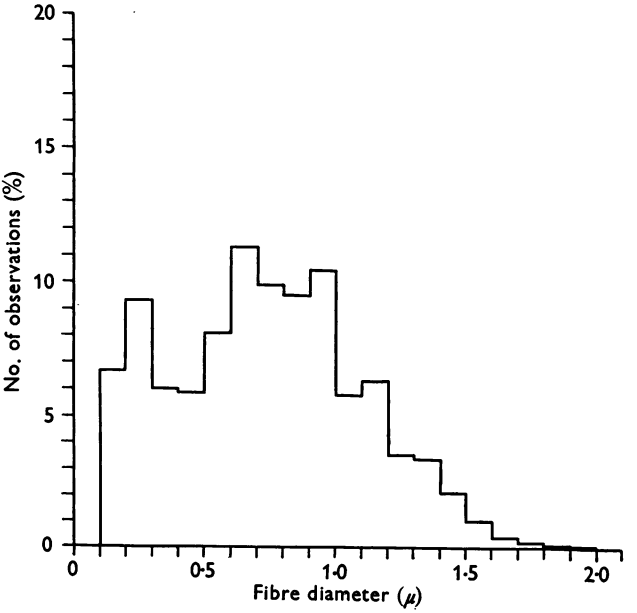
In summary, it may be said that cross-sections of the carotid body reveal the presence of numerous myelinated and non-myelinated fibres. These fibres tend to be rather dispersed and less numerous near the pole opposite to that of carotid-nerve entry. They tend to be more numerous and grouped in bundles as they approach the carotid-nerve pole.

The ganglio-glomerular nerve

This nerve was also examined by phase-contrast and electron microscopy. The sections were made at a level where the ganglio-glomerular nerve appeared as a single bundle. At times, however, the section showed the presence of two distinct nerve bundles which corresponded to the two nerve branches of this nerve (see above). Both branches showed a similar type of fibre content, namely, very abundant C fibres and very few myelinated axons. Plate 4A shows a cross-section of the ganglio-glomerular nerve as examined with the light microscope. The nerve is well encapsulated and within the capsule numerous C fibres may be seen. Only very few myelinated fibres (marked by arrows) seem to be present in this nerve (about 30 in the photograph). A few blood vessels are also apparent in this picture. Plate 4B is an enlarged electron micrograph obtained from the same nerve for the purpose of showing the numerous non-myelinated fibres. These fibres are grouped in small bundles enveloped by the Schwan-cell membrane. A few Schwan-cell nuclei (S) may be seen surrounded by non-myelinated axons.

The non-myelinated fibres of the ganglio-glomerular nerve were measured from electron micrographs obtained from sections made at a point where the nerve had not yet divided into the two branches described before. A total of 2390 non-myelinated fibres were analysed from 26 sections obtained from two nerves. Their diameter distribution curve is presented in Text-fig. 4. The fibre diameters range from 0·1 to 2·0 μ. The curve shows a possible tendency to bimodality with a peak at 0·2 μ and a second pro-

minence with a not-too-well-defined peak at 0·6 to 0·9 μ. The section covered, in all likelihood, the nerve fibres going to the glomus in addition to those joining the carotid nerve without entering the carotid body (see above). It is possible, therefore, that a selective section of the sympathetic carotid-nerve branch may reveal a clear bimodal distribution, as one would expect from physiological recordings (see Physiological observations, p. 270; also Eyzaguirre & Lewin, 1961*b*).



Text-fig. 4. Diameter distribution of non-myelinated nerve fibres in ganglio-glomerular nerve. Measurements from 2390 fibres from 26 sections made in two nerves.

DISCUSSION

De Castro (1951) has indicated, on the basis of histological evidence, that the larger carotid-nerve myelinated fibres probably convey presso-receptor impulses, while the smaller ones are probably chemoreceptor fibres. This suggestion has been frequently accepted as valid, since carotid-nerve action potentials elicited by pressoreceptor fibres are usually larger than those evoked by chemoreceptor fibres. However, this is not always the case, since small action potentials may be elicited by pressoreceptor fibres (Landgren, 1952) and often it is possible to record action potentials from chemoreceptor fibres which may be larger than pressoreceptor ones (cf. Heymans & Neil, 1958). However, the available physiological evidence does not provide a definite answer to this question, since it is based on action-potential magnitude which is dependent on local recording condi-

tions. The anatomical evidence presented in this study does not by itself solve this problem even if large myelinated fibres may be found in the carotid body (see Pl. 1B and C); de Castro (1926, 1951) has shown that myelinated fibres penetrate the glomerular capsule to innervate the arteries and arterioles of the glomus. Conduction-velocity studies are necessary in order to determine the relative diameters of presso- and chemoreceptor fibres present in this nerve. In this connexion it is worth noting that Paintal (1953) has shown that aortic chemoreceptor fibres conduct at 7–12 m/sec while pressoreceptor fibres conduct at 12–53 m/sec, the assumption being that the former are smaller than the latter.

The above picture is complicated by the finding of numerous non-myelinated fibres in the carotid nerve. Some of these fibres originate from the superior cervical ganglion, but a number of them have, presumably, an intracranial origin. The functional role of either type of C fibre is unknown. It is possible, however, that some C fibres of cranial origin may subserve either sensory or efferent functions and participate in reflex responses originating either in the carotid body or sinus. Any discussion concerning the possible role of the carotid-nerve sympathetic C fibres will have to wait until the central connexions of this pathway are determined.

The finding of numerous C fibres in the carotid nerve of the cat brings into focus the observation of Douglas & Ritchie (1956), who found that cardiovascular reflexes may be elicited in the rabbit upon stimulation of carotid-nerve C fibres. But it is not known whether the carotid nerve of the rabbit has more than one type of non-myelinated fibre as is the case in the cat. Consequently, until this point is established it will not be clear whether they stimulated sympathetic C fibres or other non-myelinated axons.

SUMMARY

1. The innervation of the carotid body and the fibre content of nerves reaching this organ was studied by examining fresh specimens under a dissecting microscope and polarized light, by stimulation and recording from the nerves and by studying fixed specimens under phase-contrast and electron microscopes.

2. Examination of fresh tissues showed that the carotid nerve divides near the glomus into two branches: one goes to the sinus while the other innervates the glomus. The glomerular branch undergoes further subdivisions in order to innervate different glomerular lobules. Usually two or three nerves link the superior cervical ganglion with the carotid-body-sinus area. One nerve goes to the sinus while one or two reach the carotid body. From the latter a nerve branch leaves the nerve close to the glomus to join the carotid nerve, bypassing the carotid body.

3. Physiological experiments have shown the presence of two types of non-myelinated fibres in the carotid nerve; the fibres of one type come from the superior cervical ganglion and travel in the carotid nerve via the branch that bypasses the glomus. Other non-myelinated fibres have, presumably, an intracranial origin.

4. The fixed specimens showed that the carotid nerve possesses abundant myelinated fibres and very numerous non-myelinated axons which outnumber the myelinated fibres. The non-myelinated axons have diameters ranging from 0·1 to 0·3 μ and the myelinated ones of from 1·0 to 9·0 μ. Serial sections of the carotid body indicate the presence of numerous myelinated and non-myelinated fibres within the organ capsule. Some of these fibres are interspersed among the glomerular cells while others are grouped in bundles near the periphery of the organ. Fibre grouping tends to become more conspicuous near the pole of carotid-nerve penetration. The ganglio-glomerular nerve(s) consists mainly of non-myelinated fibres with diameters ranging from 0·1 to 2·0 μ; myelinated fibres are few.

5. The possible role of different fibres in the carotid nerve is discussed.

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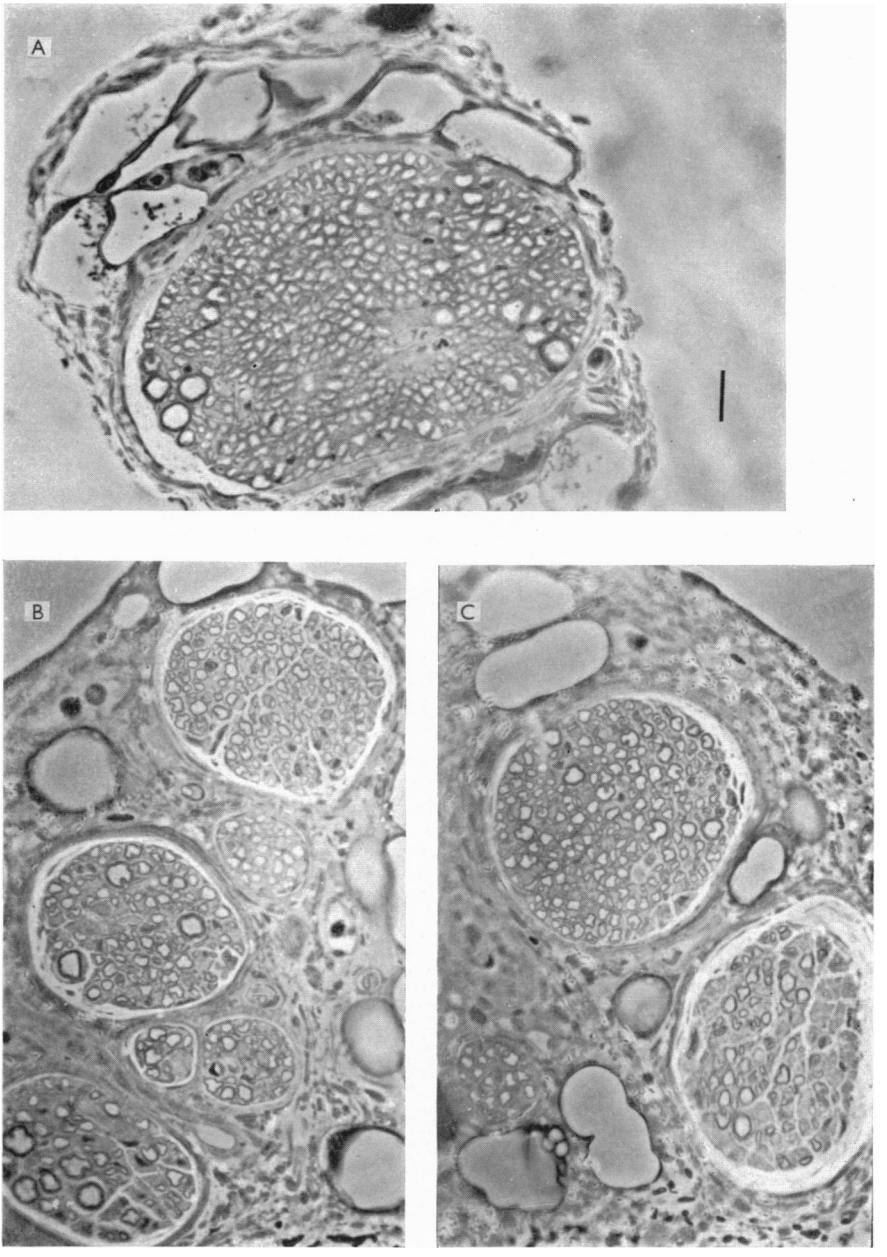

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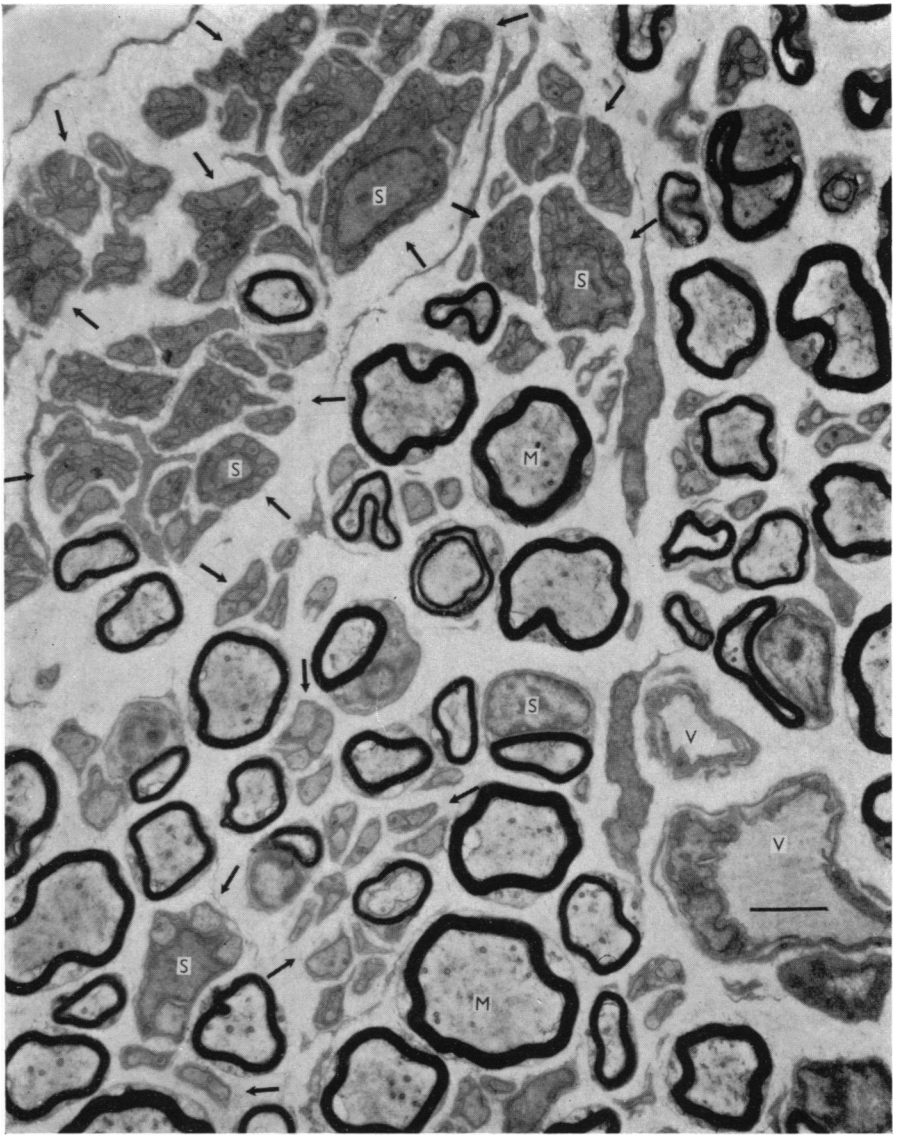

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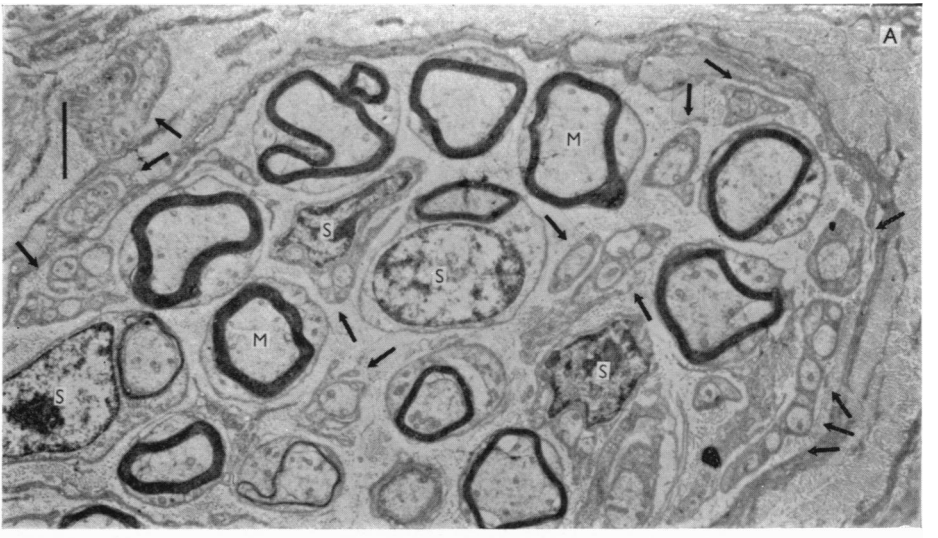
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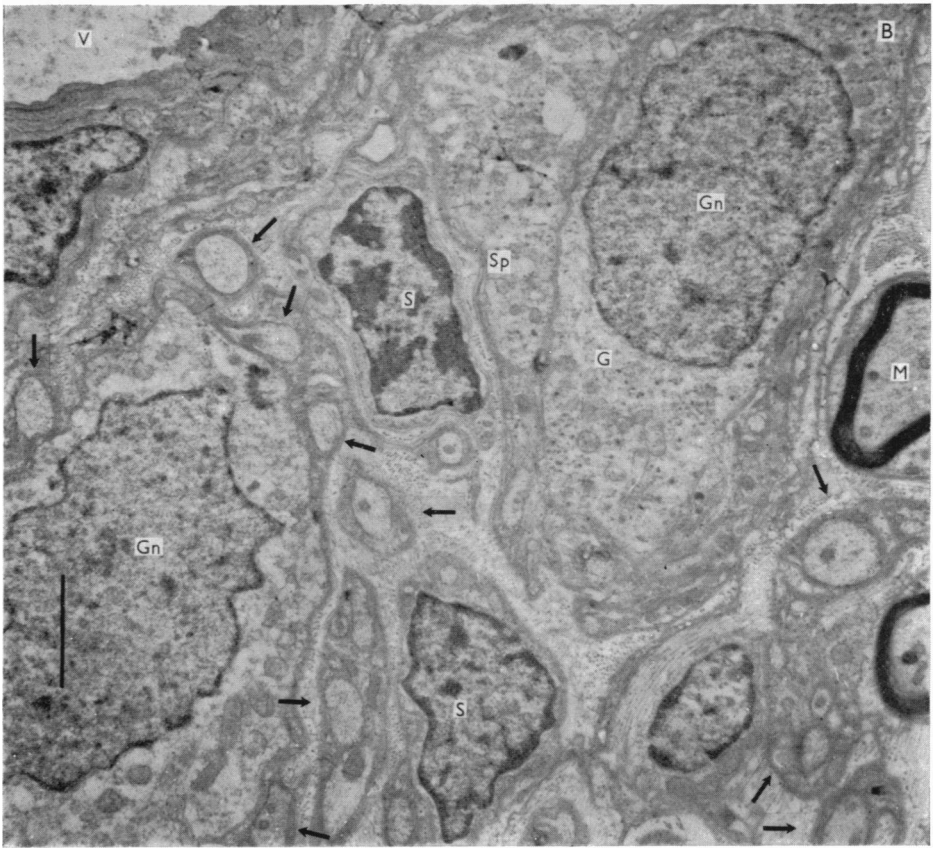
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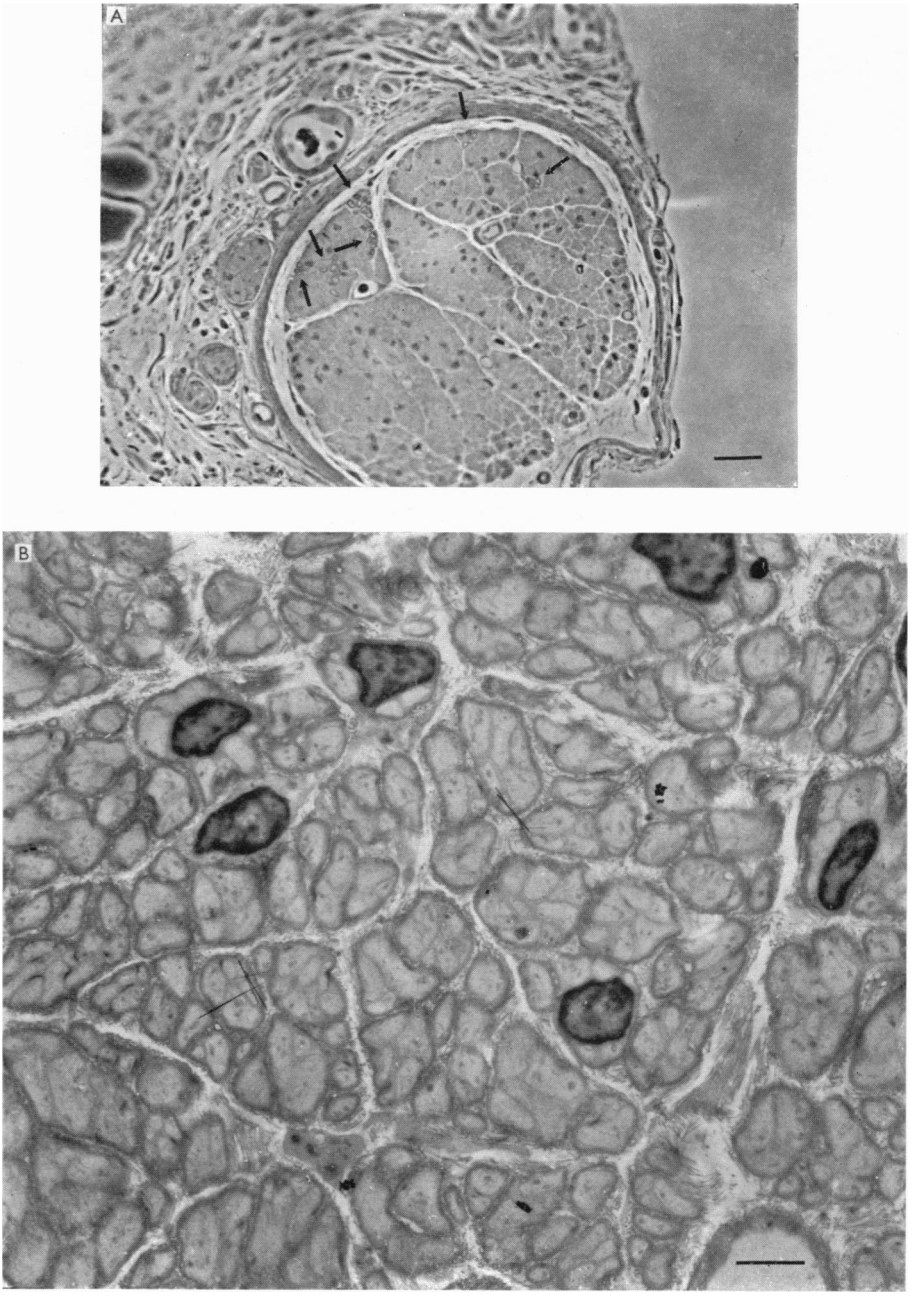

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EXPLANATION OF PLATES

PLATE 1

Phase-contrast micrographs of carotid nerve in the cat. A, cross-section near middle of nerve. B and C, cross-sections of glomus at point of carotid nerve penetration. Note the different nerve bundles. Vertical bar in A = 14·1 μ.

PLATE 2

Electron micrograph obtained from carotid-nerve section (unstained) near its point of origin. Note myelinated fibres (M) and numerous C-fibre groups indicated by arrows. Sometimes clusters of C fibres are surrounding a Schwan-cell nucleus (S). At the lower right-hand corner two capillary vessels may be seen (V). Horizontal bar = 2 μ.

PLATE 3

Electron micrograph obtained from cross-section at the middle of the carotid body; specimen stained with uranium acetate. A, section of nerve bundle near glomerular capsule. Several myelinated fibres (M) outnumbered by non-myelinated axons (arrows). Some Schwan cells (S) envelop either myelinated or non-myelinated axons. B, cross-section of glomus at centre of organ. Two myelinated fibres (M) may be seen at right-hand edge of picture. Two 'chief' cells (G) are present, showing their large nuclei (Gn). The upper 'chief' cell is enveloped by a sustentacular process (Sp). Numerous non-myelinated fibres (arrows) may be seen interspersed among the cells. Three Schwan cells (S) are clearly seen. At the upper left corner a blood vessel (V) is seen. Vertical bars = 2 μ.

PLATE 4

Cross-sections of the ganglio-glomerular nerve. A, phase-contrast micrograph showing most of the nerve which is formed mainly by non-myelinated fibres. Arrows indicate small clusters of myelinated fibres. Horizontal bar = 15 μ. B, electron micrograph from section of the same nerve, stained with uranium acetate. Note clusters of C fibres. The dark bodies represent Schwan-cell nuclei. Horizontal bar = 2 μ.