# EXPERIMENTAL AND HISTOLOGICAL STUDIES OF THE EXTRAPETROUS PORTION OF THE FACIAL NERVE AND ITS COMMUNICATIONS WITH THE TRIGEMINAL NERVE IN THE RABBIT

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## INTRODUCTION

Spindles and other types of sensory ending have been found in the facial muscles of man (Kadanoff, 1956) and in the m. quadratus labii superioris of the rabbit (Bowden & Mahran, 1956), but as yet the source of their nerve supply is unknown. Before these endings had been demonstrated, there were three conflicting views about the afferent innervation of mimetic muscles: its existence was denied; some others considered that it was derived from the facial nerve and the third view was that it was from the trigeminal (Mahran, 1955). If the latter hypothesis were true, the peripheral communications between the trigeminal and facial nerves might provide one path by which sensory fibres could travel centrally from the muscles. On the other hand, Hirschfeld & Léveillé (1866), Hovelacque (1927), Huber (1930) and O'Connell (1936) considered that although communications between the two nerves existed, there was no intermingling of their fibres. Indeed, the two latter authors stated that the facial nerve only served to distribute the trigeminal fibres to the skin and its appendages, and possibly to blood vessels. However, no histological examination appears to have been made, and the present study in the rabbit was designed to count and measure the fibres of the facial nerve below the stylomastoid foramen, to trace the course of the fibres of the trigeminal which communicated with the facial nerve and lastly to determine the number and size of any trigeminal fibres which might enter the m. quadratus labii superioris. The topographical anatomy of the extrapetrous communications between the two cranial nerves is illustrated in text-fig. 1 (based on thirty-two dissections which form part of another study which is in preparation).

## MATERIAL AND METHODS

Eleven healthy adult rabbits were used in this experiment. The animals were divided into four groups. The first group consisted of two healthy intact animals. In the remaining nine animals the right facial nerve was divided below the stylomastoid foramen under ether anaesthesia with full aseptic precautions. The animals were killed at periods ranging from 7 to 53 days after operation. Full details of the operative technique have been given by Mahran (1955). In order to preserve

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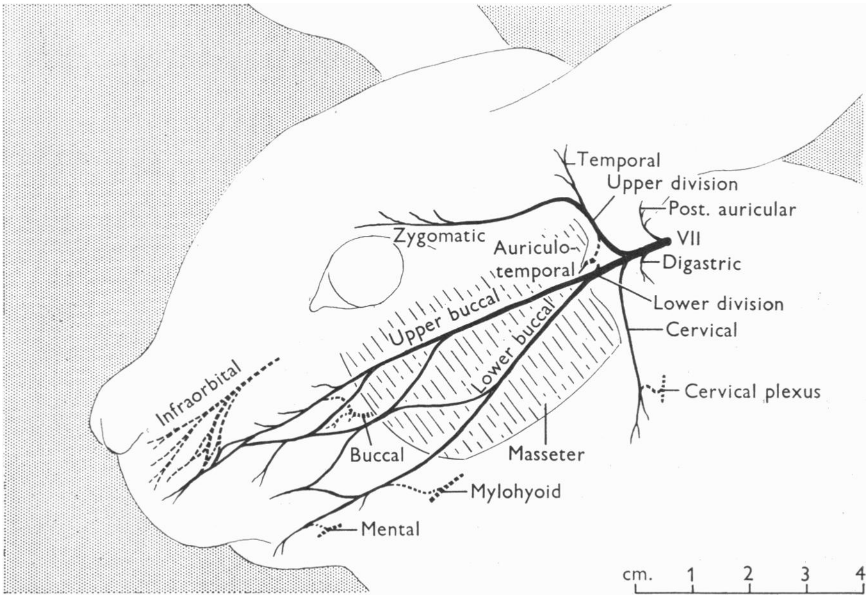
the communications between the facial nerve and the auriculo-temporal nerve, the trunk of the facial nerve was mobilized by dividing the posterior auricular nerve and the facial nerve was cut immediately below the foramen. To prevent regeneration of fibres into the distal end, both proximal and distal stumps were treated with 1% gentian violet (Guttmann & Medawar, 1942). The distal stump was then turned back on itself and sutured to surrounding tissues. Animals 3–6 were placed in group II, 7–10 in group III and number 11 was the sole member of group IV.

Animals in group II were given an overdose of ether and were immediately perfused with normal saline followed by 10% formol saline. The tissues studied were embedded in paraffin, serial sections were cut and stained either by the Holmes (1942) or Romanes (1950) silver techniques. Details of treatment and the histological procedures are given in Table 1.



Text-fig. 1. The facial nerve and its communications with the trigeminal in the face of the rabbit.

In groups I, III and IV, the tissues were dissected out from fully anaesthetized animals which were later killed with an overdose of ether. The nerves from animals in group III were placed on a piece of filter-paper and left in 1% osmic acid for 24–36 hrs.; further treatment of these tissues is given in Table 2. In groups I and IV the nerves were fixed and stained with osmic acid, embedded in paraffin and sectioned serially at 5 $\mu$. The fibres were measured from photographs of transverse sections enlarged 750 times in the manner described by Fernand & Young (1951). Mosaic photographs were constructed for the larger specimens (e.g. Pl. 1, fig. 1; Pl. 2, figs. 6, 7; Pl. 3, fig. 8). In the early stages of the work, prints were made on bromide and on non-shrink paper, but since comparison of the results showed negligible differences, bromide paper only was used in the later stages as it was more economical and easier to handle in constructing the mosaics, the largest of which measured 5 ft. × 2 ft.

Table 1. *Animals in group II*

| Animal serial no. | Post-op. survival period (days) | Material from operated side | Methods: Sectioning and mounting | Methods: Stain |
|---|---|---|---|---|
| 3 | 7 | VII and com. with V (A.T., B. and I.O.) from site of operation to M.Q.L.S. | *15 $\mu$. Every section | Holmes |
| | | VII and com. with V (M.H.) | *15 $\mu$. Every 10th pair | |
| | | M.Q.L.S. | L.S. 15 $\mu$. Every 5th section | Romanes |
| 4 | 14 | VII and com. with V (A.T.) from site of operation to ant. border of masseter<br>VII and com. with V (M.H.) | *15 $\mu$. Every 5th pair | Holmes |
| | | Two branches to m. buccinator | T.S. 15 $\mu$. Every section | Holmes |
| | | M.Q.L.S. | L.S. 15 $\mu$. Every 5th section | Romanes |
| 5 | 21 | VII and com. with V (A.T. and B.) from site of operation to M.Q.L.S. | *15 $\mu$. Every 5th pair | Holmes |
| | | VII and com. with V (I.O.) | L.S. 10 $\mu$. Every section | |
| | | Two branches to M.Q.L.S. | T.S. 15 $\mu$. Every 5th pair | |
| | | M.Q.L.S. | L.S. 15 $\mu$. Every 5th section | Romanes |
| 6 | 31 | Five branches to m. buccinator | T.S. 15 $\mu$. Every 10th pair | Holmes |
| | | M.Q.L.S. | T.S. 15 $\mu$. Every 5th section | Romanes |

Table 2. *Animals in group III*

| Animal | Survival period (days) | Material from operated side | Methods |
|---|---|---|---|
| 7 | 53 | 5 branches to m. buccinator | Paraffin T.S. 15 $\mu$. Every 10th pair |
| 8 | 14 | VII and com. with V (B. and I.O.) | Paraffin L.S. 10 $\mu$. Every section |
| | | VII and com. with V (M.H. and A.T.) | Teased in glycerine |
| 9 | 21 | VII and com. with V (A.T., M.H. and I.O.) | Teased in glycerine |
| 10 | 14 | VII and com. with V (A.T., B. and I.O.) from site of operation to M.Q.L.S. | Paraffin* 15 $\mu$. Every 10th pair |
| | | Three branches to m. buccinator | Teased in glycerine |

*Key to Tables* 1 *and* 2

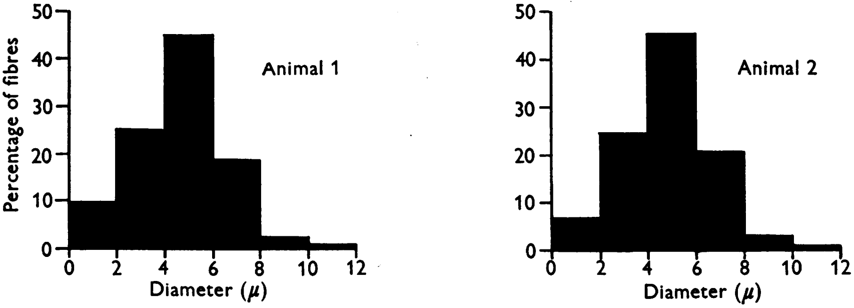
M.Q.L.S. = quadratus labii superioris muscle + skin and mucous membrane.
com. = communication.
A.T. = auriculotemporal nerve.
I.O. = infraorbital nerve.
B. = buccal nerve.
M.H. = mylohyoid nerve.

* The VIIth nerve was cut transversely and the communicating twigs of the Vth nerve were arranged in the paraffin blocks so that they were cut longitudinally.

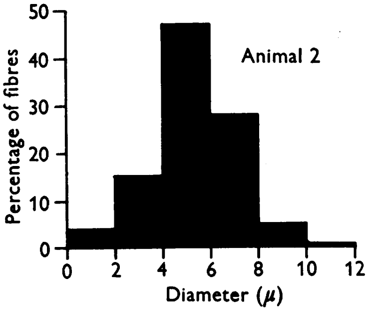
## OBSERVATIONS

### *Normal nerves (group I)*

(*a*) ***Facial nerve trunk immediately below the stylomastoid foramen (Pl. 1, fig. 1) and the posterior auricular branch of the facial nerve.*** The number of myelinated nerve fibres and their size-frequency distribution in nerves of the right side from animals nos. 1 and 2 are shown in Table 3 and Text-fig. 2. In each nerve the distribution is unimodal and there is a marked similarity in the histograms. The largest fibres measured 12 $\mu$ in diameter.



Facial nerve below stylomastoid foramen



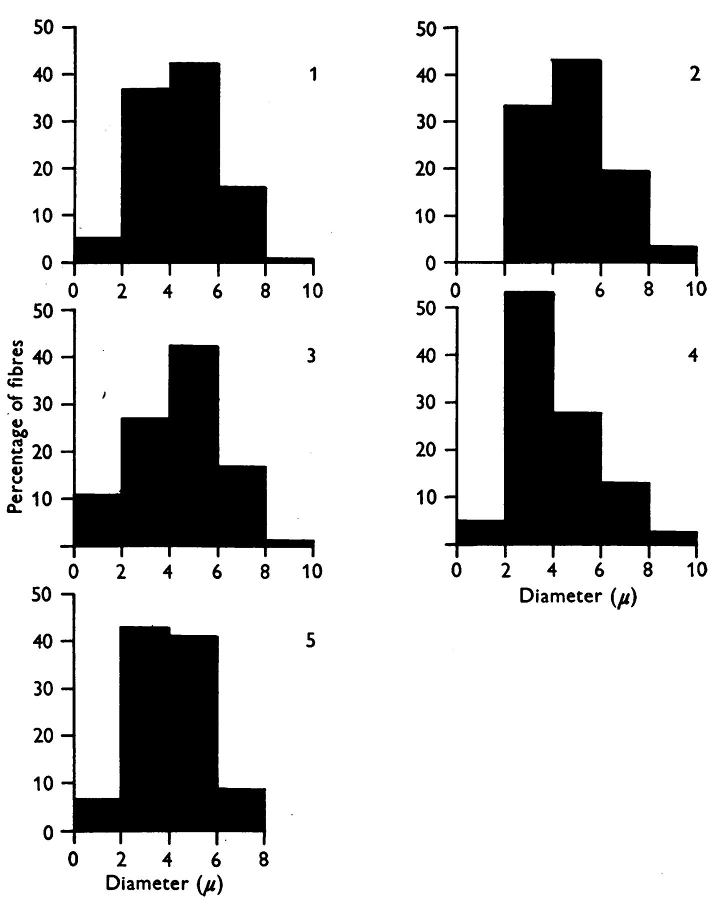
Post-auricular nerve

Text-fig. 2. Histograms representing diameter size-frequency distribution present in the normal facial nerve immediately below the stylomastoid foramen, and in the posterior auricular nerve immediately distal to its origin.

(*b*) *Vibrissal nerves.* Since fibres of the quadratus labii superioris muscle are inserted into the theca of the mystacial vibrissae and stout branches of the infraorbital nerve enter the muscle to supply them as well as other structures, five nerves from the largest vibrissae were examined in animal no. 2. The data are set out in Table 3 and Text-fig. 3. Measurements made 1–0·5 cm. proximal did not differ significantly from those taken immediately proximal to the theca and shown in Table 3. The measurements given for the fifth specimen were made within the sinus (Pl. 1, fig. 2) and the histogram shows a slight shift to the left.

### *Post-operative findings (groups II, III and IV)*

A. Post-operative progress was uneventful and signs of facial paralysis were complete in all animals (Pl. 1, fig. 3). In animals nos. 3–11 inclusive, there was



Text-fig. 3. Histograms representing size-frequency distribution present in five vibrissal nerves in animal no. 2.

Table 3. *Fibre diameter size-frequency distribution in normal nerves of rabbit*

| Animal serial no. | Nerve | Level of measurement | Numbers of myelinated fibres in each size group (μ) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 0–2 | 2–4 | 4–6 | 6–8 | 8–10 | 10–12 | Total |
| 1 | Facial rt. | Immediately below stylomastoid foramen | 524 | 1330 | 2399 | 969 | 107 | 8 | 5337 |
| | | % | 9·8 | 24·9 | 45 | 18·2 | 2·0 | 0·2 | |
| 2 | Facial rt. | Immediately below stylomastoid foramen | 414 | 1552 | 2922 | 1353 | 194 | 11 | 6446 |
| | | % | 6·4 | 24·1 | 45·3 | 21·0 | 3·0 | 0·2 | |
| 2 | Posterior auricular rt. | Immediately distal to point of origin | 52 | 200 | 617 | 368 | 69 | 4 | 1310 |
| | | % | 4 | 15·3 | 47·1 | 28·1 | 5·3 | 0·3 | |
| 2 | Vibrissal N. 1 | Immediately proximal to the theca | 7 | 50 | 58 | 22 | 1 | — | 138 |
| | | % | 5·1 | 36·2 | 42·0 | 15·9 | 0·7 | — | |
| | Vibrissal N. 2 | | 0 | 34 | 44 | 20 | 4 | — | 102 |
| | | % | | 33·3 | 43·1 | 19·6 | 3·9 | — | |
| | Vibrissal N. 3 | | 10 | 21 | 33 | 13 | 1 | — | 78 |
| | | % | 12·8 | 26·9 | 42·3 | 16·7 | 1·3 | — | |
| | Vibrissal N. 4 | | 7 | 82 | 43 | 20 | 4 | — | 156 |
| | | % | 4·5 | 52·7 | 27·6 | 12·8 | 2·6 | — | |
| | Vibrissal N. 5 | In sinus | 12 | 75 | 71 | 15 | — | — | 173 |
| | | % | 6·9 | 43·4 | 41·0 | 8·7 | — | — | |

evidence of complete degeneration of the facial nerve below the level of operation and no nerve fibres from any other sources had reached the cut end of the distal stumps. No intact nerve fibres were found until the first point of communication between the facial and trigeminal nerves.

B. *Communications between the facial and the mandibular division of the trigeminal nerve.* The gross anatomy of these communications is shown in Text-fig. 1. Histological study of serial sections and teased preparations (see Tables 2 and 3) showed that in every case the communications passed from the trigeminal into the facial nerve. There was no evidence of degenerating or degenerated fibres of the seventh nerve within these branches of the trigeminal which contained bundles of intact myelinated fibres. No attempt was made to determine the presence and the number of non-myelinated fibres in the main nerve trunks and communicating branches.

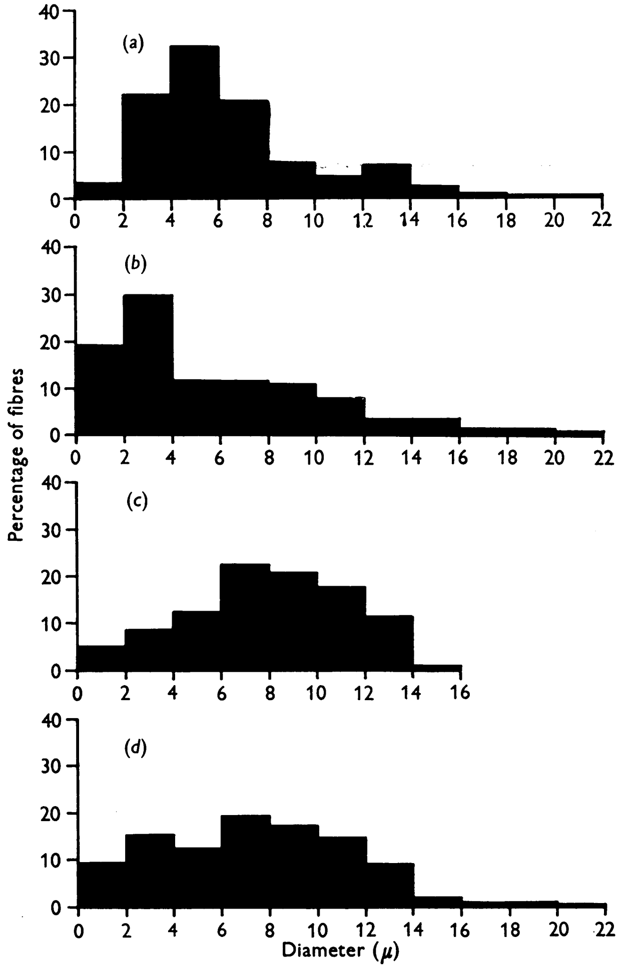
Table 4. *Fibre diameter size-frequency distribution for intact fibres of trigeminal nerve after communication with degenerated facial nerve in animal no.* 11, 28 *days after operation*

| Nerve | Level of measurement | Number of myelinated fibres in each size group ($\mu$) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0–2 | 2–4 | 4–6 | 6–8 | 8–10 | 10–12 | 12–14 | 14–16 | 16–18 | 18–20 | 20–22 | Total |
| Upper buccal branch of VII | After intermingling of fibres from auriculotemporal nerve | 29 | 175 | 253 | 165 | 57 | 36 | 54 | 17 | 4 | 2 | 2 | 794 |
| | % | 3·7 | 22 | 32 | 21 | 17·2 | 4·5 | 6·8 | 2·1 | 0·5 | 0·3 | 0·3 | — |
| Upper buccal branches entering M.Q.L.S. | Immediately proximal to muscle | 36 | 58 | 23 | 23 | 21 | 15 | 7 | 7 | 2 | 2 | 1 | 195 |
| | % | 18·5 | 29·7 | 11·8 | 11·8 | 10·8 | 7·7 | 3·6 | 3·6 | 1·0 | 1·0 | 0·5 | — |
| Intact infraorbital nerve fibres entering m. quadratus labii superioris | | | | | | | | | | | | | |
| Five bundles cut in T.S. | Immediately proximal to M.Q.L.S. | 22 | 35 | 51 | 92 | 85 | 73 | 48 | 5 | — | — | — | 411 |
| | % | 5·4 | 8·5 | 12·4 | 22·4 | 20·7 | 17·8 | 11·7 | 1·2 | — | — | — | — |
| Intact fibres from infraorbital and auriculotemporal nerves entering M.Q.L.S. | | | | | | | | | | | | | |
| Combination of data given above | | 58 | 93 | 74 | 115 | 106 | 88 | 55 | 12 | 2 | 2 | 1 | 606 |
| % | | 9·6 | 15·4 | 12·2 | 19 | 17·5 | 14·5 | 9·1 | 1·9 | 0·3 | 0·3 | 0·2 | — |

Percentage in Tables 3 and 4 is given as correct to the first decimal place.

When the intact fibres of the trigeminal nerve were traced distally, some were found to leave the combined seventh and fifth nerve trunk without further change. Other bundles remained in the combined trunk and broke up along its course. Bundles derived from the two nerves converged and broke up into smaller ones in which they intermingled. Isolated intact fibres were followed into otherwise denervated fasciculi and some of the intermingled fasciculi redivided into smaller mixed ones or into separate denervated and innervated bundles, which in some instances reunited (Pl. 1, figs. 4, 5) or joined other fasciculi to form larger mixed bundles (Pl. 2, fig. 6). In animal 11 the intact fibres were counted and measured in the upper buccal nerve (Table 4 and Text-fig. 4*a*). Seventy-nine fibres measuring over 12–22 $\mu$ in diameter were found distal to the auriculotemporal communication, these represented about a tenth of the population of intact fibres.

C. *Communications with the infraorbital nerve.* Many intact bundles of the infraorbital remained separated from the upper buccal branch of the facial nerve and supplied overlying skin, mucous membrane and vibrissae, but there was an intermingling of a proportion of fibres with the facial nerve and its contained contributions from the mandibular division of the trigeminal (Pl. 2, fig. 7; Pl. 3, figs. 8, 9).



Text-fig. 4. Histograms representing size-frequency distribution of intact trigeminal nerve fibres 28 days after section of the facial nerve immediately below the stylomastoid foramen. (*a*) In the upper buccal branch of the facial nerve distal to the communication from the auriculotemporal nerve. (*b*) In the upper buccal branch to m. quadratus labii superioris. (*c*) In five bundles of infraorbital nerve fibres in the branch to m. quadratus labii superioris. (*d*) Combined findings given in *b* and *c*.

D. *Muscular branches and intramuscular nerves.* Muscular branches from the facial nerve were examined in animals 2–7 inclusive and in 10 and 11. In each animal intact myelinated fibres from the trigeminal were found to enter the muscle, although each individual branch and bundle of supply did not necessarily contain normal fibres. The upper buccal nerve supplying the quadratus labii superioris muscle of animal 11 is shown in Pl. 2, fig. 7 and Pl. 3, fig. 8. Intact intermingled fibres in that nerve were counted and measured (Table 4 and Text-fig. 4*b*). It will be seen that although these were unimodal in their distribution, nineteen fibres measured over 12–22 $\mu$ in diameter. Some intact bundles of infraorbital origin within the muscular nerve were also measured (Table 4 and Text-fig. 4*c*). Fifty-three out of this sample of 411 infraorbital fibres measured over 12$\mu$ in diameter and the largest were 16$\mu$ in diameter (Text-fig. 4*d*). When the findings in this sample were combined with those of the upper buccal nerve, 72 out of 606 fibres entering the m. quadratus labii superioris were found to be over 12 $\mu$ in diameter.

When the intact fibres were followed distally into the intramuscular plexuses, some could be traced to overlying skin, mucous membrane, vibrissae and blood vessels (Pl. 3, fig. 10) (Bowden & Mahran, 1956).

## DISCUSSION

Examination of Text-fig. 1, which represents findings in thirty-two nerves, shows that no communications were found between branches of the ophthalmic division of the trigeminal and the facial; the communications between the infraorbital and facial nerves are limited to the upper buccal branch of the facial. However, it is clear that fibres of the mandibular division of the fifth enter both the upper and lower divisions of the seventh and that the latter receives additional contributions from the third division through the buccal, the nerve to mylohyoid and the mental nerve.

The histological evidence presented here shows that in the rabbit the communications between the two nerves consist of fibres from the trigeminal and that they do not contain any fibres from the facial. As no sympathectomized animals have been studied, the presence of sympathetic fibres cannot be excluded.

The statements of Huber (1930) and O'Connell (1936) that trigeminal nerve fibres travelled with the branches of the seventh to supply blood vessels and overlying skin and its appendages are confirmed; but whilst it is true that some fibres of trigeminal origin are distributed to the periphery without intermingling in any way with those of the seventh, there is clear evidence that some fibres from both nerves take part in forming intraneural and intramuscular plexuses in the rabbit. The finding of these intraneural and intramuscular plexuses is of interest. O'Connell (1936) suggested that in mixed nerves and so-called motor nerves, the intraneural plexuses served to group afferent and efferent fibres together. In discussing the significance of intramuscular plexuses, Feindel, Hinshaw & Weddell (1952) pointed out that plexus formation might be the anatomical basis for scattered, rather than compactly grouped, muscle fibres in a single motor unit, and whilst they did not comment on the possibility of grouping motor and sensory fibres together, it is clear that it is not excluded.

The fact that classical spindles and the spiral type of sensory ending have been found in the facial muscles of man (Kadanoff, 1956) and in m. quadratus labii superioris of the rabbit (Bowden & Mahran, 1956) has put the question of an afferent supply to these muscles beyond dispute for these two species. It remains to discover the source of these afferent nerve fibres. As discussed by Mahran (1955), histological, experimental, electromyographical and clinical evidence has been marshalled in support of each of two conflicting views on their origin either from the trigeminal or the facial nerves. The afferent fibres from skeletal muscles range from 1 to 20 $\mu$ in diameter, with the spindle afferents in the 12–20 $\mu$ group. The motor supply of the intrafusal fibres is certainly derived from the gamma efferents (3–8 $\mu$ diameter) and possibly from the larger motor fibres of 8–12 $\mu$ diameter (Barker, 1948; Cooper & Daniel, 1956).

The previous investigation (Bowden & Mahran, 1956) showed that spiral endings were formed from fibres of varying diameter; the fibres forming the equatorial spiral endings in three out of the four spindles reported were measured subsequently, and found to be approximately 20, 20 and 15 $\mu$ in diameter. However, this observation must be interpreted with caution for the gold chloride technique which was used stained the axons and gave only a faint indication of the outer limit of the sheath and the fibres were measured in longitudinal and not in transverse section. A motor fibre which ran with one of these afferent fibres and then went on to supply adjacent extrafusal fibres in the same section measured 10 $\mu$. Whilst these measurements cannot be regarded as free from uncertainty, they indicate that fibres supplying the nuclear bag region are in the larger size range. There has been a tacit assumption that if spindles existed in the facial muscles, their pattern of innervation would resemble that found in limb and trunk musculature, and since measurements of facial nerve fibres failed to reveal the presence of any in the larger size range, it has been suggested that there were either very few or no spindles in mimetic musculature. The size-frequency distribution of fibres in the facial nerve trunk and posterior auricular nerve reported here is in general agreement with the findings of Wakeley & Edgeworth (1933) who measured the myelinated fibres in the rhesus monkey just distal to the stylomastoid foramen, and also with those of Haggqvist (1938), Bruesch (1944) and van Buskirk (1945) who measured the diameter of fibres in the facial nerve of the cat and found that they ranged from 1 to 11 $\mu$ in diameter. It is not clear whether the last three workers made their measurements proximal or distal to the communications with the trigeminal nerve which were not mentioned but are known to exist in the cat (Mahran, 1955).

Fibres derived from the mandibular division of the trigeminal nerve entered the branches supplying m. quadratus labii superioris and included some of 12–22 $\mu$ diameter. In addition, fibres of 12–16 $\mu$ in diameter entered the nerves and muscles from the infraorbital branches of the trigeminal. Foley & Dubois (1943) working on cat and dog, Bruesch (1944) working on the facial nerve and its muscular branches in the cat and Fernand & Young (1951) working on a nerve to m. depressor labii inferioris in the rabbit, made no mention of communications with the trigeminal, and found no fibres larger than 12 $\mu$ in diameter. At first sight it is difficult to reconcile the findings of these earlier workers with the present observations. A species difference might be invoked as an explanation of the disagreement in the cases of Foley & Dubois and Bruesch, but Fernand & Young were working on the rabbit. The latter measured the fibres in one branch to the m. depressor labii inferioris and in this investigation at least three nerves were found to supply this muscle. It is possible that the large fibres might have entered through another branch, for one of the branches to buccinator studied here after cutting the seventh nerve, was found to be devoid of intact trigeminal fibres, whilst the remaining branches of supply contained them.

The peripheral and central connexions of the large fibres are not yet known. It might be suggested that they supply vibrissae. However, this does not seem likely, since the five large vibrissae studied here had no nerve fibres above 10 $\mu$ in diameter, and the diameter of these fibres was not significantly different 1·0 cm. proximal to the theca. Large fibres supply Pacinian corpuscles, but so far none has been observed in the facial muscles, and they are uncommon in limb and trunk musculature. There is some evidence that these large fibres form the annulo-spiral endings in the m. quadratus labii superioris; a total of nineteen fibres of 12–22 $\mu$ entered this muscle from the mandibular division in animal no. 11 and, in addition, there were at least fifty-three from the infraorbital nerve which measured 12–16 $\mu$. The number of spindles in this muscle is at present unknown. The central connexions presumably would enter the brain stem with the fifth nerve, and if the pattern of proprioceptive innervation of the facial muscles followed that of the muscles of mastication, the cells of origin of these sensory fibres would be in the mesencephalic nucleus of the trigeminal nerve.

The efferent supply of the intrafusal muscle fibres, on purely morphological grounds of fibre size, might be derived from the seventh or fifth nerves. In this context it is interesting to note that Lewy, Groff & Grant (1938) reported chromatolytic changes in the three parts of the mesencephalic nucleus of the fifth nerve after cutting the seventh nerve in the Fallopian canal in the cat. Although they considered this to be evidence of damage to autonomic fibres, another interpretation might be given, namely, that the motor fibres arose in this nucleus and passed out with the trunk of the facial nerve to intrafusal fibres in facial muscles. Should these hypotheses be correct, both the trigeminal and facial nerves would then be involved in the proprioceptive innervation of the facial muscles, and this would resolve the conflict between the two views which have been discussed. Thelander (1924), Kimmel (1941) and Pearson (1947, 1948 and 1949*a*, *b*) have demonstrated synaptic relationships between the mesencephalic and facial nuclei in the cat, rabbit and man respectively. However, until the effect of various operative procedures upon the spindles themselves is known, the full functional significance of the peripheral and central connexions between these two cranial nerves cannot be assessed.

## SUMMARY AND CONCLUSIONS

1. The number and diameter of myelinated nerve fibres in the facial nerve trunk just distal to the stylomastoid foramen were measured in two animals.

The size-frequency distribution was unimodal and ranged from 1 to 12 $\mu$ diameter. Similar findings were made in the post-auricular nerve of one animal.

2. The nerve fibres supplying five mystacial vibrissae were counted and measured. These also were unimodal in distribution and no fibres larger than 10 $\mu$ in diameter were found.

3. In nine animals the right facial nerve was cut below the stylomastoid foramen and the animals were left to survive for periods ranging from 7 to 53 days after

operation. In all animals the facial paralysis was complete and there was no evidence of re-innervation of the distal stump.

4. Fibres of the trigeminal nerve were followed through the combined nerve trunk and branches.
5. The communications between the fifth and seventh nerves were derived wholly from the former and contained myelinated nerve fibres ranging from 1 to 22 $\mu$ diameter.
6. Some of the trigeminal fibres left the combined nerve trunk without change, others intermingled with the denervated bundles of the seventh nerve and formed intraneural and intramuscular plexuses.
7. Some intact trigeminal fibres were traced to skin, mucous membrane, mystacial vibrissae and the adventitia of intramuscular blood vessels.
8. The significance of finding large diameter fibres (12–22 $\mu$) in the branches supplying muscles is discussed.

Grateful thanks are due to the Medical Faculty of Ein Shams University of Cairo, for a grant covering the early part of this work, and to the Trustees of the Wellcome Foundation for a generous personal grant to Z. Y. Mahran for completion of the work. Our thanks are due to Mr W. Matthews for technical assistance, to Miss F. Ellis for her great patience and skilled photography, to Mr J. M. Crane for Pl. 1, fig. 2, and to Mr V. Willmott for Pl. 1, figs. 4, 5, and Pl. 3, fig. 10, and to Mrs A. Besterman for the text-figures.

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## EXPLANATION OF PLATES

(Figs. 1 and 6–8 are mosaics.)

### PLATE 1

Fig. 1. Transverse section of facial nerve trunk (animal 2) below the stylomastoid foramen. 5 μ thick, stained with osmic acid ( × 100).

Fig. 2. Transverse section through the theca (*a*), sinus (*b*) and vibrissa (*c*) of animal 2, showing bundles of myelinated nerve fibres and a few isolated myelinated nerve fibres (e.g. at ↑) within the sinus. (These constitute vibrissal nerve no. 5.) 5 μ thick, stained with osmic acid ( × 100).

Fig. 3. Animal 4 showing signs of complete right-sided facial palsy.

Fig. 4. Transverse section of a degenerating bundle of VIIth nerve fibres (*a*) approaching one mostly containing intact auriculotemporal nerve fibres (*b*), from animal 10, 14 days post-operative. 15 μ thick, stained with osmic acid ( × 165).

Fig. 5. Bundles seen in fig. 4 now in same sheath ( × 165).

### PLATE 2

Fig. 6. Transverse section of right upper buccal nerve of animal 11 (28 days post-operative) distal to the communication with the auriculotemporal nerve. Note: the intermingling of intact Vth nerve fibres within large and small bundles of degenerated VIIth nerve; the convergent bundles at *a*; two mixed fasciculi within a single sheath at *b*; large diameter fibres (22 and 20 μ) at *c*. 5 μ, stained with osmic acid ( × 100).

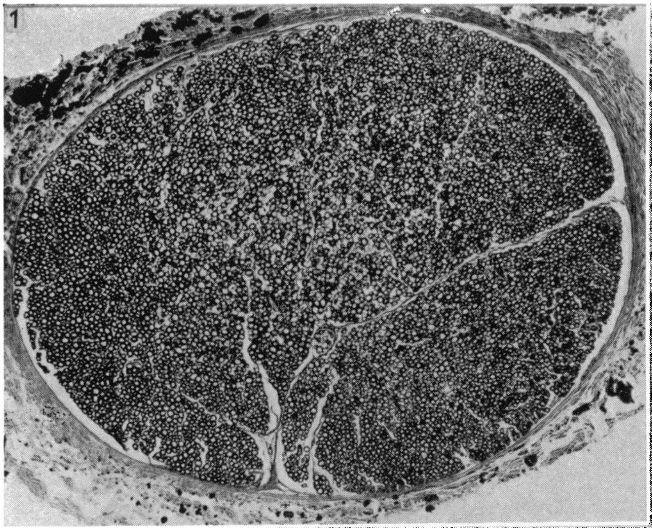
Fig. 7. Transverse section of right upper buccal nerve (animal 11) supplying m. quadratus labii superioris (*a*). Note intact bundles from the infraorbital nerve (*b*); mixed bundles with degenerated VIIth nerve and intact trigeminal fibres in the remainder of the section. 5 μ, stained with osmic acid ( × 100).

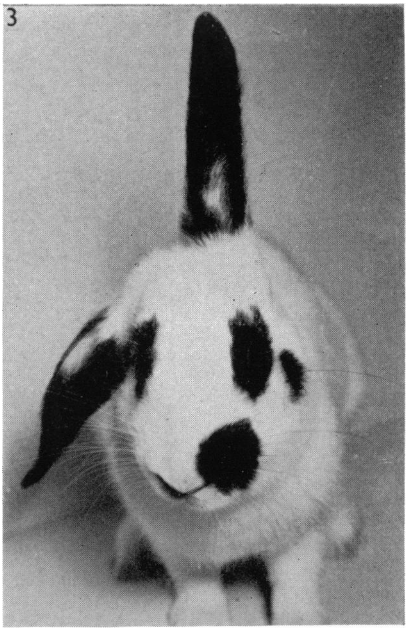
### PLATE 3

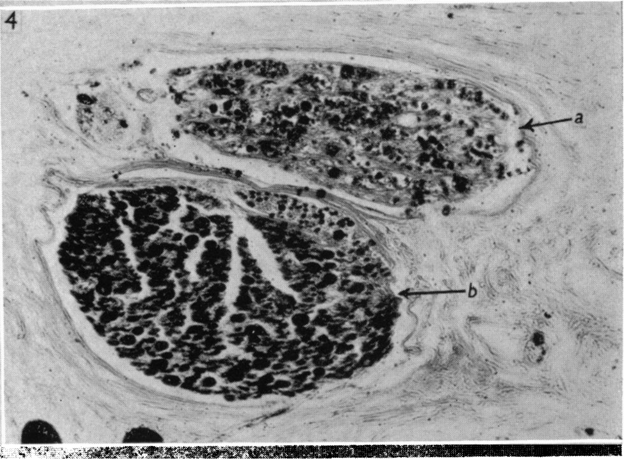
Fig. 8. More distal transverse section of nerve shown in fig. 7. The intact bundles (*a*) from the infraorbital nerve entered m. quadratus labii superioris and the fibres were counted and measured. 5 μ, stained with osmic acid ( × 100).

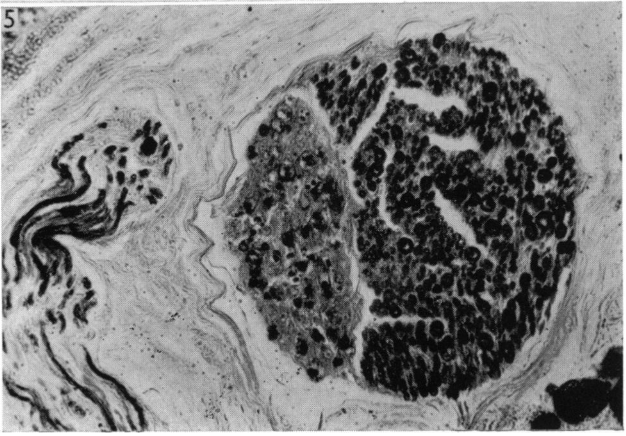
Fig. 9. Section taken between those shown in figs. 7 and 8 from the nerve to quadratus labii superioris. Note intact bundle (*a*) and small bundle (*b*) containing intact and degenerated fibres. 5 μ, stained with osmic acid ( × 750).

Fig. 10. Healthy branch of infraorbital nerve (*a*) sending intact fibre, (*b*) into a degenerating bundle of VIIth nerve fibres (*c*) in the intramuscular plexus of m. quadratus labii superioris, animal 10, 14 days post-operative. Gold chloride stain ( × 57).









**BOWDEN** AND **MAHRAN**—STUDIES OF THE EXTRAPETROUS PORTION OF THE FACIAL NERVE

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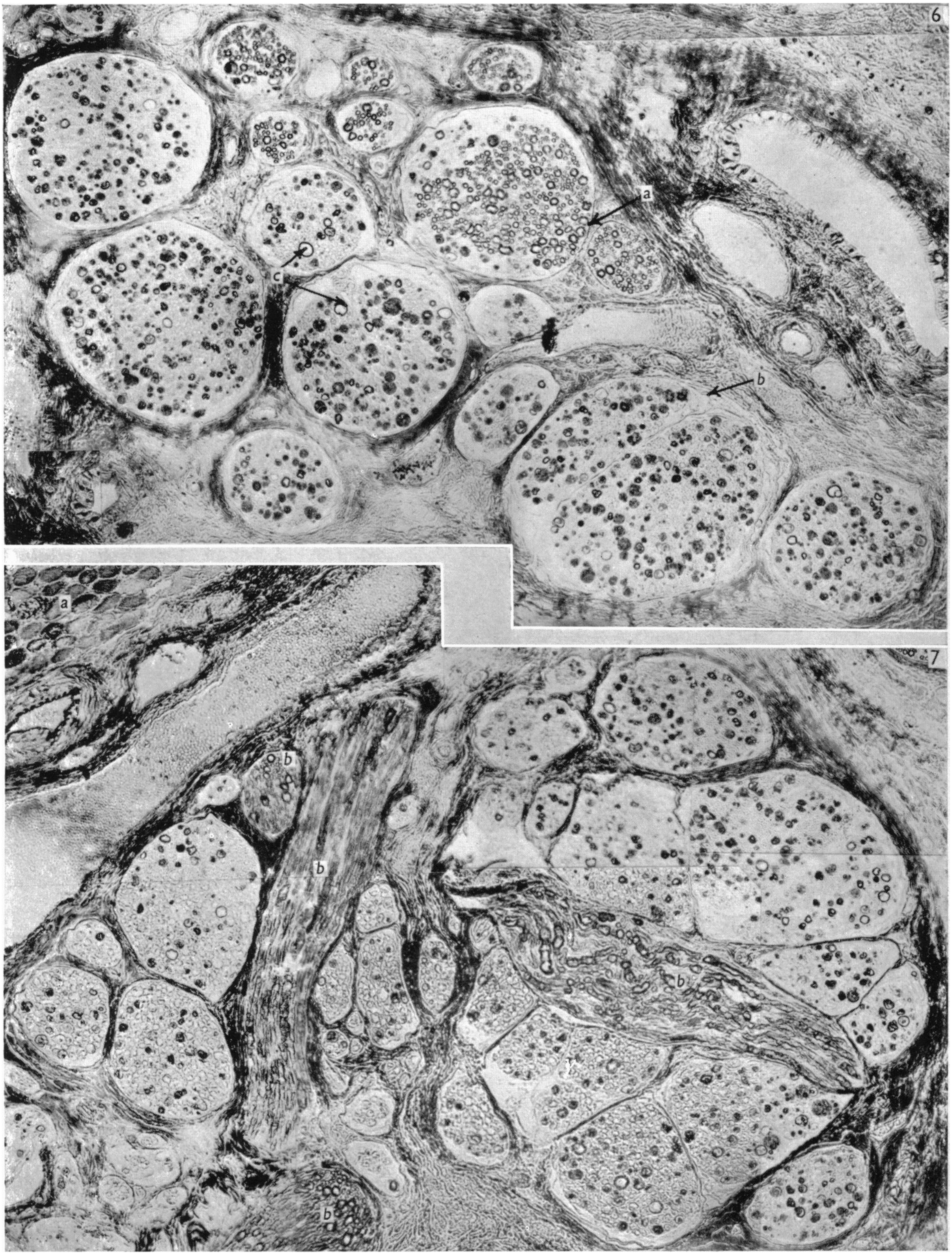

BOWDEN AND MAHRAN—STUDIES OF THE EXTRAPETROUS PORTION OF THE FACIAL NERVE


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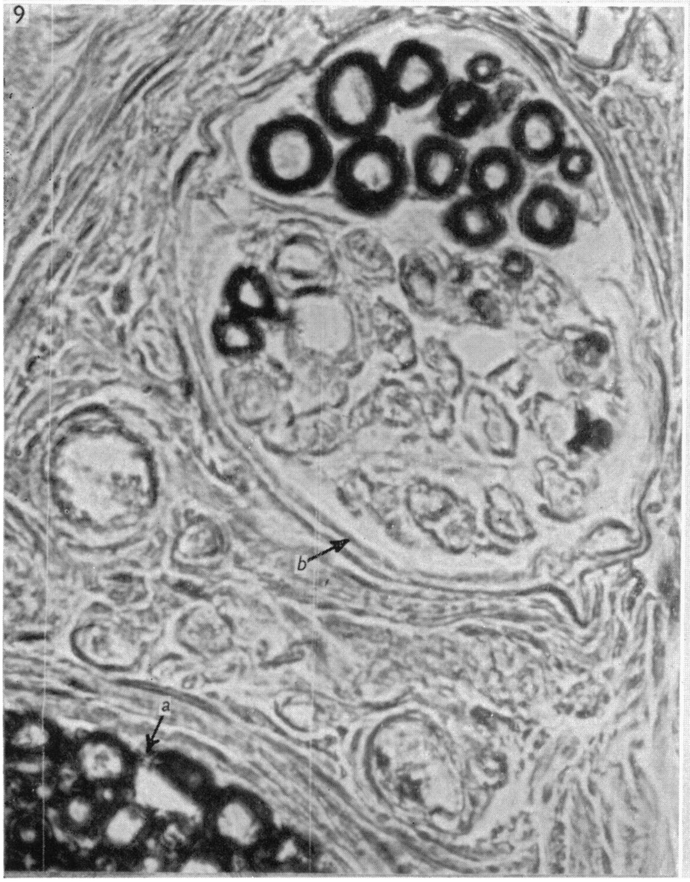
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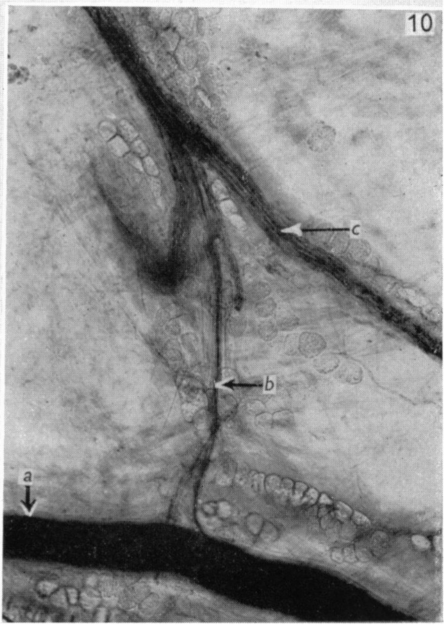
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