Fetuses 12.5 cm. (a) Nerves to the sinus hairs were faintly medullated. (b) The fibres in the mesentery were faintly medullated to their entrance into the Pacinian corpuscles. (c) The fibres of the tendon organs were medullated. (d) Medullated fibres were present in the superior laryngeal nerve. (e) The articular nerve of the knee contained 22 medullated fibres.

Fetuses 13.5 cm. (a) There were about 15 faintly medullated fibres in the depressor nerve.

New born. (a) No medullated fibres were found in the papillae of the tongue. (b) Medullated fibres appeared in the pad of the foot but did not reach the epidermis. (c) Medullated fibres reach the necks of the sweat glands but none can be found in the epidermis of the nose.

The phrenic appears to be the first peripheral nerve to acquire extensive medullation; the spinal accessory is next, followed by the recurrent laryngeal branch of the vagus. Of the spinal nerve roots, those of the brachial segments acquire their sheaths first and most rapidly. The sensory nerves to elaborate end-organs all appear to acquire their sheaths at the same time and earlier than the remaining sensory fibres, whose medullation is not complete until after birth.

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Further Observations on Dorsal Root Components.*

MARION H. STOREY, KENDALL B. CORBIN AND JOSEPH C. HINSEY.
From the Department of Anatomy, Stanford University, California.

Additional evidence, both anatomical and physiological, has been introduced by Barron and Matthews[1, 2] to support the presence of efferent components in the dorsal roots. These investigators believe that their histological evidence in the cat, suggests that collaterals of fibers in the posterior funiculi pass to the periphery through the spinal ganglia without cell stations. Such collaterals are said to constitute about 32% of the fibers in the lumbosacral dorsal roots and are of the myelinated variety. The literature bearing upon this

* This investigation was conducted with the aid of the Rockefeller Foundation Grant for Fluid Research in the Medical Sciences at Stanford University.

1 Barron, D. H., and Matthews, B. H. C., *J. Physiol.*, 1935, **85**, 73.

2 Barron, D. H., and Matthews, B. H. C., *J. Physiol.*, 1935, **85**, 104.

subject was reviewed by Hinsey[3, 4] and, since that time, additional work has been presented by Okelberry,[5] Kahr and Sheehan,[6] and Lugaro.[7]

If approximately one-third of the myelinated fibers in the lumbosacral roots are collaterals of posterior funiculus fibers, it should be possible to demonstrate their degeneration in the distal stumps after section of the dorsal roots, appropriate degeneration times, and staining with the Marchi technic. Hinsey[4] reported that there was no evidence of degeneration of such fibers in serially sectioned Marchi preparations of the distal stumps, ganglia, and peripheral nerves following section of the 6-7 L and 1-2 S dorsal roots in the cat and appropriate degeneration times. He found traumatic degeneration near the point of section but none that passed through the ganglion. This experimental procedure should certainly have shown collaterals of the size which Barron and Matthews illustrate.[2]

We have performed 6 additional experiments bearing on this problem. In young adult cats we sectioned the right 7 L (4 animals), the 6 L and 7 L (1 animal), and the 7 L and 1 S (1 animal) dorsal roots proximal to the ganglia near the spinal cord. Ten days later the animals were killed. The 4-5-6-7 L and 1-2-3 S dorsal root ganglia, with adjoining dorsal and ventral root stumps, were fixed in Müller's solution and stained after the Marchi technic. Each preparation was serially sectioned in the long axis. In addition, various ones of the lumbosacral segments of the spinal cord were fixed, stained, and sectioned.

In the distal segments of the dorsal roots which were sectioned, traumatic degeneration was easily demonstrated in each instance. This degeneration served as an excellent control for the success of our staining procedure. In not one of these preparations was there evidence for any degeneration beyond the traumatic degeneration. In other words, we were unable to demonstrate any degeneration which proceeded through the ganglion. If 32% of the myelinated fibers in these roots were collaterals of posterior funiculus fibers, our section should have severed them from their trophic centers, and typical secondary degeneration should have been present.

Furthermore, when we examined the right dorsal roots of adjacent (4-5-6 L and 1-2-3 S) segments, there was no evidence of the degeneration which might have been expected if the fibers, after

3 Hinsey, J. C., *Quart. Rev. Biol.*, 1933, **8**, 457.

4 Hinsey, J. C., *J. Comp. Neurol.*, 1934, **59**, 117.

5 Okelberry, A. M., *J. Comp. Neurol.*, 1935, **62**, 1.

6 Kahr, S., and Sheehan, D., *Brain*, 1933, **56**, 265.

7 Lugaro, E., *Arch. Suisses de neurol. et de psychiat.*, 1933, **31**, 284.

entering the cord in the 7 L dorsal root, had proceeded up and down the cord in the posterior funiculus with collaterals to adjacent roots. We are forced to conclude that fibers which enter the posterior funiculus of the spinal cord of the cat do not give off myelinated collaterals to the dorsal roots, from either the ascending or descending branches.

Following section of the 7 L dorsal roots degeneration may be seen in March prepartions of the spinal cord as low as the 3 S segment. This indicates that the descending branches may pass as many as 3 segments below their point of entrance. In the upper cervical segments the descending branches may be demonstrated by this method for only one segment below the entrance.[8]

While Okelberry's evidence[5] shows a few myelinated efferent fibers in the dorsal roots of dogs, his own data raise an important question. There is a marked discrepancy in the number of these fibers in Tables I and II (after extradural section), as contrasted with the very few shown in Table III (after intradural section). While Okelberry explains this on the basis of variation in animals, it is very tempting to suggest that, in his extradural sections, he failed to sever scattered neurons of the ganglion from their connections with fibers in the dorsal roots.

In the light of our evidence we are convinced that the antidromic impulses which Barron and Matthews[1] have recorded in the dorsal roots of cats must have some other mediators than myelinated collaterals of posterior funiculus fibers. Lugaro's work[7] substantiates this statement. Furthermore, evidence is available which shows that the number of axons in the dorsal root may equal the number of cells in the ganglion.[9, 10] Such a 1 to 1 ratio would be incompatible with the fibers which Barron and Matthews described.[2]

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8 Corbin, K. B., and Hinsey, J. C., *J. Comp. Neurol.*, 1935, **63**, 119.

9 Ranson, S. W., Droegemueller, W. H., Davenport, H. K., and Fisher, C., "Sensation: Its Mechanisms and Disturbances," *Proc. Assn. Research in Nervous and Mental Disease*, 1935, **15**, 3, Williams & Wilkins, Baltimore.

10 Duncan, D., and Keyser, L. L., *J. Comp. Neurol.*, 1936, **64**, 303.