

though eosinophiles and monocytes are included in the total granulocyte count, they were identified separately and are affected in the same manner as the polymorphonuclear leukocytes.

Regarding dosage it was found that 1.04 millicuries of radiophosphorus per pound of body weight was fatal (monkey No. 3). However, dosages of .76 and .71 millicuries of radiophosphorus per pound of body weight were tolerated by monkeys No. 2 and No. 4. These monkeys are still alive and appear to be in good health. This level of radiophosphorus dosage would be roughly equivalent to 114 millicuries in one dose to a 150-pound man, this being 10 or more times the dosage used therapeutically in this laboratory. The lethal dosage in small mammals also appears to be comparable. Mice will tolerate as much as 1.36 millicuries of radiophosphorus per pound (unpublished work).

Conclusions. 1. Radiophosphorus lowers the absolute numbers of red cells, lymphocytes, and granulocytes in monkeys. 2. The degree of effect is about the same in lymphocytes and granulocytes, red cells being less affected. 3. Monkeys tolerated dosages of .76 and .71 millicuries of radiophosphorus per pound of body weight, 1.04 millicuries per pound being fatal. 4. The tolerance levels of radiophosphorus are about 10 times that usually used therapeutically.

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Regulation of Skin Temperatures after Lesions of Spinal Nerve Roots.

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The observation has been made that after deafferentation of a hindlimb, the skin temperatures recorded from the footpads of that limb are lower than those in the opposite normally innervated extremity.^{1, 2, 3} However, it was found that when such animals were subjected to bilateral abdominal sympathectomy, there was no significant difference in the skin temperatures recorded from the

¹ Hinsey, J. C., and Cutting, C. C., *Anat. Rec.*, 1932, **52**, 57.

² Hinsey, J. C., *Am. J. Physiol.*, 1934, **109**, 53.

³ Zuckerman, S., and Ruch, T. C., *Am. J. Physiol.*, 1934, **109**, 116.

footpads of the two hindlimbs.⁴ The conclusion was made that such experiments did not support a tonic reflex control of the blood vessels of the skin via the dorsal roots, as evidenced by skin temperatures in the cat.

The experiments to be reported here represent an accumulation of observations made on cats prepared in our laboratory for various purposes. Dr. Hardy modified his radiometer⁵ to make it available for skin temperature studies on animals by reducing the area of skin required for accurate measurement ($\pm 0.1^{\circ}\text{C}$) to 0.75 sq cm. The animals were examined after having been in a constant temperature room for at least an hour. They were placed in a hammock in such a manner that the circulation to the extremities was not obstructed. After a time, the animals were trained so that they submitted to temperature recordings in a satisfactory manner. This was facilitated by feeding them about 15 minutes before the readings were to be made. Readings were recorded until a plateau was reached. Differences of less than 1°C between the corresponding pads of the two sides have not been considered significant.

Three types of experiments were performed: (1) the forelimbs were deafferented, either by section of appropriate dorsal roots or by removal of the ganglia, (2) the hindlimbs were deafferented by section of appropriate dorsal roots, and (3) a considerable portion of the ventral roots to one hindlimb were sectioned. Bilateral sympathectomies were carried out in some of the animals at intervals following deafferentation.

Four animals in which the left forelimbs were deafferented were studied in detail. With the exception of the early postoperative period, the skin temperatures of the left deafferented forepads were not found to be lower than the opposite normally innervated ones, in fact at times they were higher. These observations are illustrated in Figs. 1 and 2. In Cat No. 13, the left dorsal roots were cut from C_4 through T_3 with a resultant anesthesia of the distal portion of the forelimb and yet the temperatures of the forepads of the two limbs were remarkably close together 3 months later (Fig. 1). Following section of the C_3 through T_2 left dorsal roots in Cat No. 3, sensation persisted over the medial surface of the arm as far as the elbow.⁶ One month later, there was no significant difference in the pad temperatures in the 2 forelimbs (Fig. 2). Seven days after

⁴ Corbin, K. B., and Hinsey, J. C., *Proc. Soc. Exp. Biol. and Med.*, 1932, **29**, 473.

⁵ Hardy, J. D., *J. Clin. Invest.*, 1934, **13**, 593.

⁶ Hare, K., *Am. J. Physiol.*, 1941, **134**, 251.

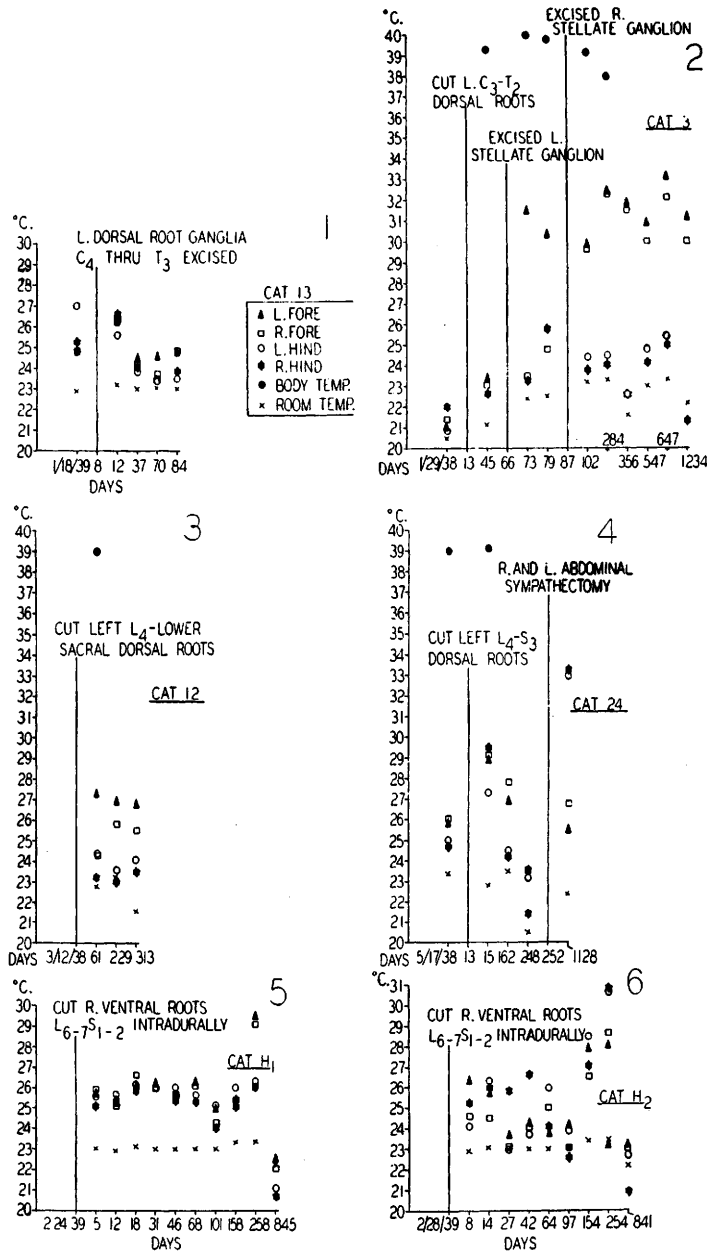


FIG. 1.

removal of the left stellate ganglion, the left forepad was pale and warm (31.5°C) and the right one was pink and cool (23.5°C). Following excision of the right stellate ganglion, the footpads on

the 2 forelimbs remained high and close together for a period of 9 months. Later, the deafferented pad was 1°C warmer, possibly due to an abnormal posture of the limb or to some other factor not clear at present. However, the temperatures of the pads of both limbs remained high in comparison with those of the hindlimbs for a period of 3 years after removal of the stellate ganglia.

In Cat No. 12 (Fig. 3), the pad temperature in the 2 hindlimbs were close together 10 months after the deafferentation of the left hind extremity. In Cat No. 24 (Fig. 4), the deafferented pad was colder than the normally innervated one 2 days after the operation. Five months later they were close together, but, after 3 more months, the deafferented pad was warmer. The temperatures on the 2 sides were 33 and 33.3°C 2½ years after bilateral abdominal sympathectomy. This animal has not been necropsied as yet but the chains were probably removed from L₁ through L₇. Apparently, regeneration has not occurred here.⁷

In 3 cats, the 6-7L and 1-2S ventral roots were cut on the right side. At the end of a year, there was sufficient regeneration so that the right limbs were used in walking with little abnormality (Cats H1 and H3). In Cat H2, a marked contracture developed so that the limb was held in extension. By section of these roots below L₅, the thoracolumbar preganglionic fibers escaped^{8, 9} and most, if not all, of the somatic motor fibers in the sciatic nerve were separated from their cells of origin.¹⁰ In the presence of paralysis in the distal portion of the right hindlimb, the skin temperatures of the pads on the 2 sides showed no significant differences in 2 of the animals (Fig. 5). In Cat H2, the operated limb showed higher temperatures (1.2 to 2.9°C) for about 5 weeks and then after 8 weeks became significantly colder (1.9°±) than the normally innervated extremity (Fig. 6). The explanation of the early deviations in temperature is difficult to make unless the operative procedure interfered with a part of the pre- or post-ganglionic supply to the limb. The presence of a contracture later may have contributed to the decreased temperature on the operated side. However, the absence of significant differences in 2 of these animals makes doubtful any visceral innervation to the vessels of the skin by way

⁷ Hinsey, J. C., Phillips, R. A., and Hare, K., *Anat. Rec.*, 1941, **79**, Suppl. No. 2, 32.

⁸ Sheehan, D., and Marrazzi, A. S., *J. Neurophysiol.*, 1941, **4**, 68.

⁹ Geohegan, W. A., Wolf, G. A., Jr., Aidar, O. J., Hare, K., and Hinsey, J. C., *Am. J. Physiol.*, 1941, in press.

¹⁰ Langley, J. N., *J. Physiol.*, 1891, **12**, 347.

of the ventral roots distributed to the distal portion of the extremity. Paralysis of the skeletal muscles supplied by the sciatic nerve may not produce measurable variations in the footpad temperatures when comparison is made with the opposite normally innervated side. The experiments demonstrate the validity of the interpretation that the hyperthermia caused by section or crushing of the sciatic nerve is due to interruption of postganglionic nerve fibers coursing in the nerve.¹¹ Evidence¹² has been presented that such a hyperthermia is restricted to the skin.

In the presence of substantial evidence for dorsal root reflexes,^{13, 14} it is disappointing to fail to find some control of the peripheral blood vessels which would depend upon efferent conduction via the dorsal roots. Although earlier papers presented evidence for such control,^{15, 16, 17} more recent work has questioned this interpretation.¹⁸ On the basis of carefully controlled plethysmographic studies on cats and dogs, it has been concluded, "that the existing evidence does not favor the concept of reflex activation of the dorsal root dilators."¹⁹

The vascular bed may function in the absence of sensory impulses to the local region studied in a manner similar to that in an innervated region. This cannot be interpreted to mean that sensory impulses from a particular region may not have local sign as far as vasomotor reflexes are concerned. In man there are observations which indicate that afferent impulses arising in the leg influence the vasomotor responses of the toe vessels.²⁰ The absence of sensory impulses may conceivably explain the lower temperatures which have been found in deafferented hindlimbs and the higher temperatures recorded for some deafferented forelimbs. The vascular beds in the pads of 2 corresponding limbs are so similarly distributed that when the thoracolumbar sympathetic pathways on both sides are interrupted and the sensory pathways on one side are cut, the tem-

¹¹ Reichert, F. L., *PROC. SOC. EXP. BIOL. AND MED.*, 1932, **29**, 473.

¹² Friedlander, M., Silbert, S., Bierman, W., and Laskey, N., *PROC. SOC. EXP. BIOL. AND MED.*, 1938, **38**, 150.

¹³ Toennies, J. F., *J. Neurophysiol.*, 1938, **1**, 378.

¹⁴ Toennies, J. F., *J. Neurophysiol.*, 1939, **2**, 515.

¹⁵ Freeman, N. E., and Rosenblueth, A., *Am. J. Physiol.*, 1932, **98**, 454.

¹⁶ Rosenblueth, A., and Cannon, W. B., *Am. J. Physiol.*, 1934, **108**, 599.

¹⁷ Pinkston, J. O., Partington, F., and Rosenblueth, A., *Am. J. Physiol.*, 1938, **115**, 711.

¹⁸ Brown, G. L., and Maycock, W. d'A., *J. Physiol.*, 1940, **97**, 273.

¹⁹ Dole, V. P., Jr., and Morison, B. A., *Am. J. Physiol.*, 1940, **130**, 304.

²⁰ Doupe, J., Robertson, J. S. M., and Carmichael, E. A., *Brain*, 1937, **60**, 281.

peratures of the two sides are extremely close together. To be sure, humoral mechanisms are present here but they must be acting upon an anatomical substrate that is closely alike on the two sides.

Summary. 1. Deafferentation of a cat's forelimb does not lower the skin temperature of the footpad which may remain similar to the contralateral normally innervated one or may be warmer. 2. Deafferentation of a hindlimb may not affect the pad temperature, or it may be lowered or raised. 3. Any differences present in the forelimbs or in the hindlimbs disappear after bilateral sympathectomy. 4. Section of the L_6 - L_7 and S_1 - S_2 ventral roots of a cat may not significantly affect the pad temperatures.

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Separation of Tobacco Necrosis Virus and Tobacco Mosaic Virus.

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Introduction. During a study of the properties of tobacco necrosis virus, occasional batches of Turkish tobacco plants were encountered which developed not only the non-systemic tobacco necrosis on the lower inoculated leaves, but also through contamination the systemic tobacco mosaic disease. The yield of tobacco mosaic virus (TMV) may be between 2-3 mg per cc of juice,¹ or 100 times that of tobacco necrosis virus (TNV), the average yield of which is about 0.02 mg per cc.² Therefore, a single plant carrying a mixed infection in a batch of 100 plants diseased with tobacco necrosis will eventually yield a preparation of TNV containing approximately an equal amount of TMV. In order to avoid the complete loss of TNV in such contaminated preparations, it was considered desirable to attempt the removal of TMV.

TNV is completely soluble over the entire pH range in the absence of large amounts of salt. Since TMV is almost completely insoluble in the region of the isoelectric range, preparations containing very large amounts of TMV were first isoelectrically precipitated. Pirie,

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¹ Stanley, W. M., *J. Biol. Chem.*, 1937, **121**, 205.

² Cohen, S. S., and Stanley, W. M., unpublished data.