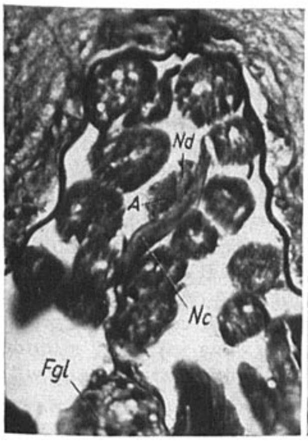

Fig. 1

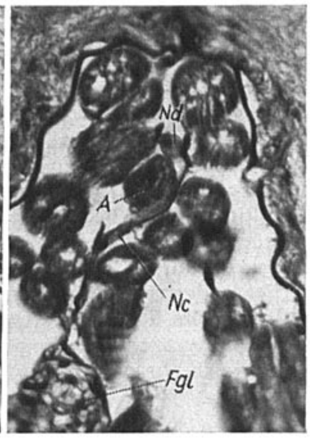

Fig. 2

Figuren 1 und 2. Zwei aufeinanderfolgende Schnitte einer Transversalschnittserie durch den Kopf von *Lithobius piceus*. Susa, Masson. × 800. (A) Aorta cephalica, (Fgl) Frontalganglion, (Nc) Nervus connectivus, (Nd) dorsaler Herznerv.

auch der Ursprung des dorsalen Herznervs im Zentralnervensystem gefunden werden. Vom Frontalganglion, das über eine breite Stomodaealbrücke mit den Tritocerebralganglien beiderseits verbunden ist, zieht dorsal vom Nervus recurrens ein schwacher unpaarer Nervus connectivus caudad. Dieser mündet in den Medianteil des primären Syncerebrum, das Verschmelzungsprodukt von Proto- und Deutocerebrum, ein. Wie Figur 1 zeigt, gibt der N. connectivus auf halber Strecke einen ventralen Nebenzweig ab. Dieser schmiegt sich an das Dach der hier endigenden Aorta cephalica und begleitet diese und später das Herz eben als dorsaler Herznerv (Figur 2). Der dorsale Herznerv von *Lithobius piceus* ist also ein Visceralnerv des stomatogastrischen Systems, der im Ganglion frontale wurzelt. Ausführlichere Untersuchungen werden an anderer Stelle veröffentlicht.

Summary. In *Lithobius piceus* Koch the dorsal cardiac nerve is a branch of the nervus connectivus, and thus a nerve of the stomatogastric system. It arises from the frontal ganglion.

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Reflex Inhibition of Cold Shivering by Pressure to the Skin and the Histological Investigation of its Afferent Spinal Pathway

Considerable interest has been attracted to the question of non-specific inhibition of vegetative and extrapyramidal motor regulatory processes concerned with thermoregulation, such as sweating and cold shivering. Inhibition of sweating in man as a consequence of postural changes[1,2], or mechanical skin pressure applied to the skin[3] has been experimentally studied and has been proved to be the effect of pressure to the skin. The central mechanism of the 'skin pressure reflex' has not yet been clarified conclusively[4]. However, recently, it was reported that cold shivering of the rabbit was markedly inhibited by pressure to the skin or eye-balls[5,6]. To find out the afferent spinal pathway concerned with the reflex inhibition of cold shivering due to pressure to the skin, various kinds of partial cordotomy have been performed in rabbits. The results of acute experiments in rabbits have indicated that the important part in the spinal cord concerned with the afferent pathway of this reflex is not in the dorsal funiculus. This has been confirmed in the present investigation which was performed in 6 chronic rabbits with partial cordotomy.

Results. Figure 1 shows a recording of the reflex inhibition of cold shivering by pressure to the eye-balls and skin in a chronic rabbit which had been submitted to partial cordotomy in the ventral funiculus at Th12 segment in the left side. 14 days after operation, this recording was performed under the following conditions. The chronic rabbit lightly fixed on all fours was exposed in cold environment to produce cold shivering, which was recorded electromyographically from the M. triceps brachii of the left forearm. As is shown in Figure 1 (A), cold shivering was markedly inhibited by bilateral eyeball pressure of about 200 g/cm^2 applied by an ophtalmodyanomometer. Figure 1 (B) shows the inhibitory effect on cold shivering due to mechanical pressure of about 3 kg per 20 cm^2 applied by a paper holder mantled by rubber to the left side of the lumbar skin innervated from below the partial cordotomy. Tonic and phasic discharges of cold shivering were inhibited in these 2 cases. However, the same strong mechanical pressure applied to the right side of the lumbar skin had only a slight inhibitory effect on cold shivering as shown in Figure 1 (C). Identical observations were made in 5 more rabbits with chronic transection of the left ventral funiculus: inhibition of cold shivering by skin pressure to the ipsilateral lumbar region, and almost no inhibition by pressure to the contralateral side. The result indicates that the afferent pathway of the reflex inhibition of cold shivering due to pressure to the skin must cross at the spinal level.

19 days after partial cordotomy, the rabbit was killed to follow up the degenerated fibres ascending in the ventral funiculus. Considerable degeneration was found in the ventral funiculus closely rostral to the lesion (Th12), however, rostral to Th8, the number of the degenerated fibres gradually diminished. A certain amount of the degenerated fibres was found at C8 level, and from here up to C1, no more diminishing of the number of the degenerated fibres was observed. In Figure 2, a lot of dark small dots located in the left ventral funiculus of C7 spinal segment

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represent the transverse sectioned degenerated fibres stained by MARCHI's method. These dots, however, were scanty and almost lacking in the right side of the spinal cord. At the rostral part of the medulla oblongata, these dots are situated in the marginal part of the ventral funiculus and, as shown in Figure 3, some collateral fibres must have extended to the reticular formation, because dark dots representing these degenerated fibres are found in this region. As ascending to the trapezoid body and the superior olive, the degenerated fibres were found between the pyramidal tract and the olive, and a considerable amount of the degenerated fibres terminated in the reticular formation at this level. At the level of the superior peduncle, the degenerated fibres once more diminished in number a little. The rest of the degenerated fibres ascended to the medial part of the lateral lemniscus and terminated in the superior colliculus of the midbrain. Some of them enter into the central grey matter at this level as shown in Figure 4. No degeneration was found above the rostral part of the superior colliculus in this case as well as in the other 5 cases.

Discussion. According to recent investigation, pressure to the skin does not only inhibit cold shivering. It also deactivates the cortical function as determined by the EEG in rabbits[7]. However, the characteristic of the primary afferent fibres stimulated by pressure applied to the skin has not been fully clarified. Similar inhibitory effects on cold shivering and cortical function could be observed during electrical stimulation of cutaneous nerves under the parameters of 8–15 c/sec, 0.1–0.5 msec, and 1–3 volts. The inhibition of cold shivering and cortical function by such low frequency, low intensity stimuli[8] agrees with the investigation of POMPEIANO et al.[9] with

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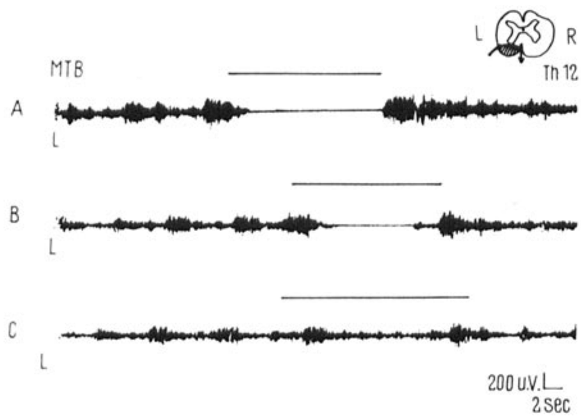

Fig. 1. Reflex inhibition of cold shivering by bilateral eye-ball pressure (A), by mechanical pressure to the left side (B), and right side (C) of the lumbar skin, in a chronic rabbit with partial cordotomy of the left ventral funiculus at the 12th thoracic segment. EMG of cold shivering was recorded from left side (L.) of the M. triceps brachii (MTB).

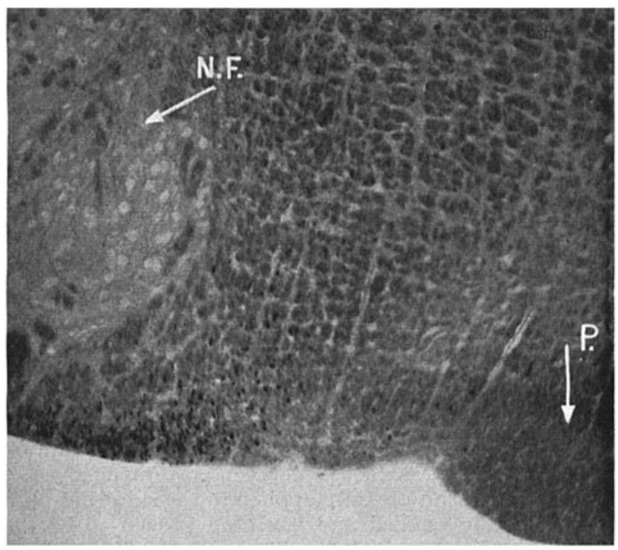

Fig. 3. Transverse section of the rostral part of medulla oblongata showing degenerated fibres situated in the marginal ventral part giving off the collaterals to the Reticular formation in the left side of the spinal cord. N.F., Nucleus n. facialis, P., Tractus pyramidalis. × 20.

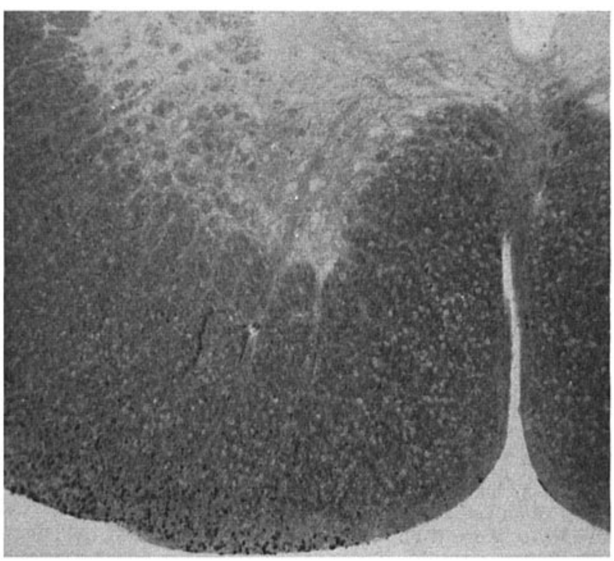

Fig. 2. Transverse section of the spinal cord at the 7th cervical segment showing degenerated fibres located in the left side of the ventral funiculus in the same rabbit as in Figure 1. × 20.

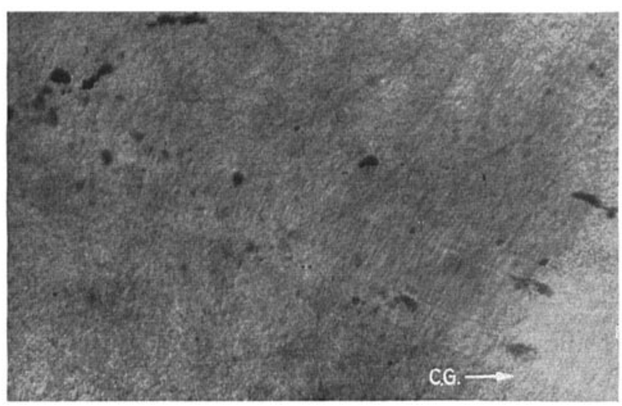

Fig. 4. Degenerated fibres terminating in the area of Superior colliculus with some branches entering into the Central grey matter of the left side. C.G., Central grey matter. × 200.

respect to EEG synchronization. This agreement indicates that the cutaneous fibres concerned with the skin pressure reflex belong to GII fibres.

Recent investigations indicate that proprioception[10–12] as well as pressure and touch impulses[13] have a double pathway in the spinal cord, the uncrossed dorsal and crossed ventral funiculus, and the impulses conducted in the ventral funiculus are activated monosynaptically only from the contralateral afferent nerves. The topographic organization of the dorsal funiculus and its properties are sufficiently elaborated. Pressure sensation controlled by this phylogenetically younger pathway was found to be discriminative and epicritic. On the other hand, pressure sensation served by the phylogenetically older ventral funiculus, the topographic organization of which was described by WALKER[14], seems to be protopathic.

The results of the present experiment indicate that the afferent pathway of the skin pressure reflex passes upward not through the dorsal funiculus but in the phylogenetically older ventral funiculus, which is, in the rabbit, much larger than the dorsal funiculus.

This may be explained by the fact that the rabbit seems to be a considerably primitive animal. This agrees with the observation of BROUWER[15] that the proportional dimension of the ventral funiculus as compared with the dorsal funiculus of various classes of vertebrates, is larger in lower classes than in highly evolved classes.

The present investigation by means of MARCHI's stain has shown that the highest terminations of the degenerated fibres, namely the secondary long ascending fibres in the ventral funiculus, were found in the superior colliculus. This indicates that in rabbits, the so-called ventral spinothalamic tract does not reach the thalamus anatomically[16]. The collaterals running into the reticular formation are obviously identical with the spino-reticular fibres described by BRODAL[16].

Conclusion. The impulses evoked by pressure to the skin are conducted in primary afferent cutaneous fibres (GII). Then the impulses are conducted by neurons ascending in the phylogenetically older ventral funiculus of the contralateral side of the spinal cord. In the course of the pathway to the superior colliculus, the ascending fibres give off a considerable amount of collaterals to the spinal cord, medullary, and midbrain reticular formation. Some of them enter into the superior peduncle. It is concluded that such a pathway belongs anatomically to the spino-tectal and the spino-reticular tract[17].

Zusammenfassung. Am Kaninchen wurde der Einfluss einer chronischen einseitigen Durchschneidung des medialen Vorderstranges bei Th12 auf die reflektorische Hemmung von Kältezittern durch Hautdruck unterhalb der Durchschneidung untersucht. Das Kältezittern wurde nur dann gehemmt, wenn der Druck auf der Seite der Läsion appliziert wurde. Demnach kreuzt die afferente Bahn dieses Reflexes im Rückenmark und verläuft im contralateralen Vorderstrang im sogenannten Tractus spino-thalamicus medialis. Die Verfolgung der degenerierten Axone der durchschnittenen Bahn nach rostral ergab, dass zahlreiche Neurone zur Formatio Reticularis der Medulla ziehen. Degenerierte Fasern konnten rostralwärts bis zum Tectum nachgewiesen werden.

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Experimental Lymphography by Means of a Subarachnoidal Injection of Lipiodol Ultrafluid (Guerbet)

From both the theoretical and the practical point of view, the lymphographic demonstration of lymph vessels participating in the fluid metabolism of the brain and the eye, is of major importance.

Techniques. 8 dogs of both sexes were punctured intracisternally under hexobarbital anaesthesia. 5–8 ml of the cerebrospinal fluid were removed and the same volume of lipiodol was injected slowly intracisternally. 48 h after the injection, X-ray pictures were taken and the animals killed by an overdose of the anaesthetic. Frozen sections stained with oil red were used for histological examinations.

Results. In animals kept in a horizontal posture for several hours after the injection, the contrast material appeared in the form of droplets in the subarachnoidal spaces at the basis cranii and the spinal cord. If, however, the animals were located in a plane tilted 45° cranially, part of the contrast material surrounded sheathlike both Nn. optici, and surrounded, in the form of a sheath, the eyeball, with the exception of the cornea. Also the lymph vessels at the base of the nasal cavity, as well as the angular and retroauricular lymph nodes, could be well seen (Figures 1 and 2).

Histological investigation revealed lipiodol droplets in the subarachnoidal space around the optic nerve, as well as in the leptomeningeal sheaths of the optic nerve, especially around the blood vessels. Lipiodol droplets were found in the retina, too, within the layer between the pigment epithelium and the photoreceptors. Droplets were present episclerally and between the sheets of the sclera, too. In the swollen bulbar conjuctiva, part of the lipiodol was found in lymph vessels lined by endothelial cells (Figures 3–6).