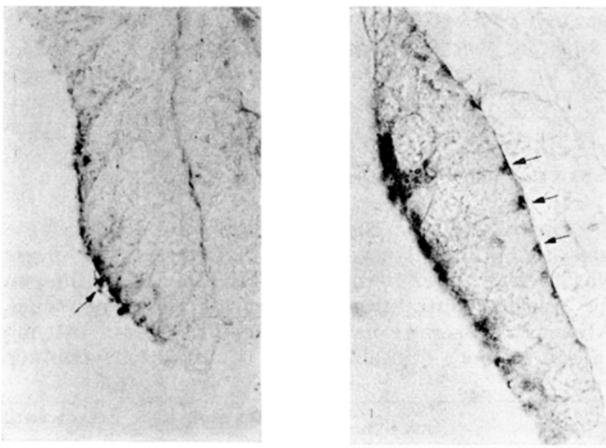
25–26 (Länge der Embryonen ca. 4,5–6,0 mm). Die Ependymzellen von FO und SCO erscheinen in ihrer typischen schlanken, hohen Form. Im KS 27 (Länge der Embryonen ca. 6–7 mm) verschiebt sich die Sekretmenge zugunsten des SCO. Neben Granulaansammlungen in den apikalen Zellbereichen und im Ventrikel, dem SCO dicht anliegend, sind fadenartige Elemente sehr auffällig (Figur 1a). Im KS 27 muss also die aktive Beteiligung des SCO an der Bildung des RF erfolgen. Bis KS 27 konnte keine eindeutige Fadenbildung zwischen SCO und FO beobachtet werden. Bei den Embryonen der KS 28–29 (Länge ca. 7,0–8,5 mm) lässt sich schliesslich diese Verbindung gut verfolgen. Das FO ist noch sekretorisch aktiv und zeigt neben einer schwach violetten Tingierung im supranukleären Bereich zahlreiche apikale Granula (Figur 2). Um das KS 30 beginnt das Schlüpfen der Tiere. In den bisher beschriebenen Stadien ist immer eine apikal gerichtete Sekretion zu beobachten, dagegen fehlen Granula in den basalen Bereichen von FO und SCO. Kurz nach dem Schlüpfen tritt im SCO eine deutliche Umstellung ein. Das SCO zwei Tage alter Larven (Länge 9–10 mm), die in ihren äusseren Kriterien dem KS 30 noch durchaus entsprechen, zeigt neben sehr starken Sekretanreicherungen im apikalen Bereich noch auffällige Sekretmengen basalwärts, die an der Membrana limitans externa sekretgefüllte Endfüsse bilden (Figur 1b). Im FO sind in diesem Stadium nur noch wenige Sekretgranula zu beobachten. Das FO verliert nunmehr seine sekretorische Aktivität, so dass bei acht Tage alten Larven keine Granula mehr nachweisbar sind und nur noch das SCO als alleiniger Bildner des RF fungiert[7].



a b

Fig. 1. a, SCO im KS 27. Beginn der Bildung fädiger Elemente →. b, SCO einer Larve 2 Tage nach dem Schlüpfen. Sekretgefüllte Endfüsse an der Membrana limitans externa →. Bouin, Aldehydfuchsin. Vergr. 700:1.

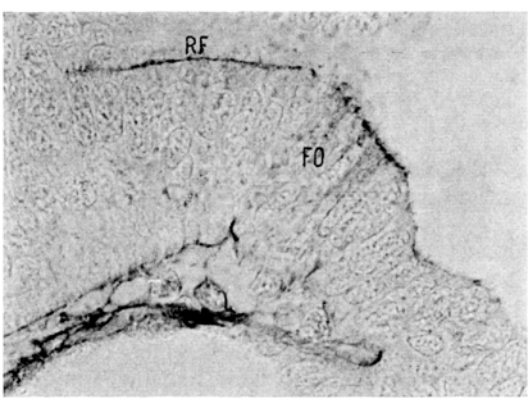


Fig. 2. FO im KS 28 mit RF. Der vom SCO kommende Abschnitt des RF liegt nicht in der Schnittebene. Bouin, Aldehydfuchsin. Vergr. 500:1.

Summary. The development of Reissner's fibre (RF) by secretory activity of the flexural and subcommissural organ was studied in early ontogenetical stages of *Triturus alpestris*. In young stages RF arises from the flexural organ, which gradually reduces its secretory activity in the following stages. Now the secretion of the subcommissural organ becomes predominant and begins to form the RF. After the hatching of larvae, only the subcommissural organ produces the RF.

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[7] Durchgeführt mit Unterstützung durch die Deutsche Forschungsgemeinschaft.

Initiation of Shivering in Unanaesthetized Dogs by Local Cooling within the Vertebral Canal

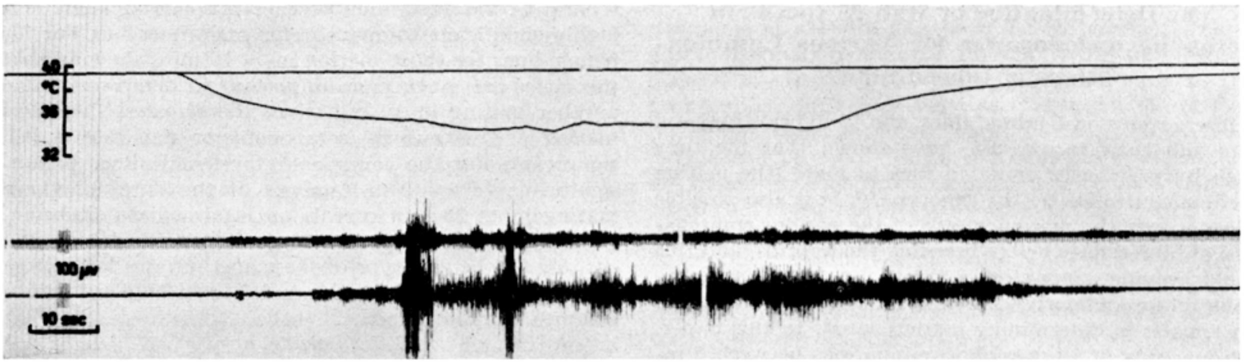
Former observations indicating that cold sensitive structures may exist in the extracerebral deep body tissues have been confirmed by the finding that in dogs with normal or elevated core, brain, and skin temperatures, shivering was induced by cooling within the vertebral canal (SIMON, RAUTENBERG, THAUER and IRIKI[1,2], RAUTENBERG and SIMON[3], THAUER[4]). This first evidence for the existence of cold sensitive structures in the extracerebral body core was obtained in anaesthetized animals. Since thermoregulatory reactions are known to be impaired by anaesthesia, experiments were carried out to investigate the effect of cooling within the vertebral canal on muscular activity in unanaesthetized dogs.

[1] E. SIMON, W. RAUTENBERG, R. THAUER, and M. IRIKI, Naturwissenschaften *50*, 337 (1963).

[2] E. SIMON, W. RAUTENBERG, R. THAUER, and M. IRIKI, Pflügers Arch. ges. Physiol. *281*, 309 (1964).

[3] W. RAUTENBERG and E. SIMON, Pflügers Arch. ges. Physiol. *281*, 332 (1964).

[4] R. THAUER, Naturwissenschaften *51*, 73 (1964).



Shivering induced by local cooling within the vertebral canal in an unanaesthetized dog at indifferent ambient temperature. Rectal temperature (1), extradural temperature in the thoracic vertebral canal (2), electromyogram of foreleg (3) and hindleg (4).

Method. In dogs weighing 16–27 kg, a U-shaped thermode of polyethylene tubing, about 1.5 mm in external diameter, was chronically implanted into the peridural space of the vertebral canal between the 4th cervical and the 7th lumbar vertebra. Cooling within the vertebral canal was performed in the unanaesthetized resting animal by perfusing the thermode with cold water. The rectal temperature and the temperature in the thoracic vertebral canal were measured with thermocouples. Electromyograms of one foreleg and one hindleg were picked up by needle electrodes. Temperatures and electromyograms were recorded by UV-direct writing galvanometers (Galvomat, CEC). In some cases, the temperature in the vertebral canal at the level of the second cervical vertebra was controlled.

Results. A recording obtained during a cooling period in an unanaesthetized 16 kg dog is shown in the Figure. At an ambient temperature of 23°C cooling within the vertebral canal was performed by perfusing the thermode with water at 22°C. Shivering appeared about 10 sec after the beginning of cooling, when the temperature in the thoracic vertebral canal had fallen below 37.3°C. While this temperature dropped to 34.2°C, shivering became more vigorous. The rectal temperature remained unchanged. Within 47 sec after the termination of cooling shivering ceased, when the temperature in the thoracic vertebral canal had risen to 38.4°C.

Shivering was observed in 25 cooling periods in 5 dogs at ambient air temperatures between 22°C and 30°C.

Rectal temperatures and temperatures in the vertebral canal during shivering evoked by cooling within the vertebral canal. Mean values of 25 cooling periods in 5 dogs (for details see text)

	Time	Rectal temperature	Temperature in the vertebral canal	
			At 2nd cervical vertebra	Thoracic part
	sec	°C	°C	°C
Start of cooling	0	39.17 $n = 25$	38.82 $n = 12$	38.95 $n = 25$
Start of shivering	49	39.16 $n = 25$	38.83 $n = 12$	35.37 $n = 25$
End of cooling	221	39.13 $n = 25$	38.75 $n = 12$	34.39 $n = 25$
End of shivering	295	39.12 $n = 25$	38.77 $n = 12$	38.22 $n = 25$

Cooling was performed by perfusing the thermode with water at 18–27°C at a rate of flow between 20 and 40 ml/min. The mean values of the parameters measured in these experiments are given in the Table. The onset of shivering was found to occur 50 sec after the beginning of cooling, when the temperature in the thoracic vertebral canal had fallen by 3.6°C. Shivering ceased 75 sec after the end of cooling, when this temperature had reached 38.2°C.

According to the results of former experiments in anaesthetized animals with the same technique, cooling was found to be restricted to the vertebral canal. Core temperature was not affected by cooling. No significant fall of the temperature in the vertebral canal at the level of the second cervical vertebra – only a few centimetres rostrally from the entrance of the thermode – could be detected in the 12 cooling periods in which this temperature had been measured. HAMMEL, STRØMME, and CORNEW[5] have reported that, in unanaesthetized dogs at indifferent ambient temperatures, shivering was induced by hypothalamic cooling only, when hypothalamic temperature fell to about 37°C. This observation confirms the interpretation that hypothalamic thermosensitive structures were not involved in the initiation of shivering by cooling within the vertebral canal.

The reactions observed in unanaesthetized dogs during local cooling within the vertebral canal prove, therefore, the existence of cold sensitive structures in this area of the body core, which may participate in the physiological shivering mechanism.

Zusammenfassung. Bei unnarkotisierten Hunden konnte durch lokale Kühlung im Wirbelkanal bei indifferenter Umgebungstemperatur Kältezittern ausgelöst werden. Dieser an Tieren mit nicht beeinträchtigter Temperaturregulation erhobene Befund weist darauf hin, dass im Wirbelkanal temperaturempfindliche Strukturen lokalisiert sind, die an der Regelung der Wärmeproduktion mitbeteiligt sein können.

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W. G. Kerckhoff-Institute of the Max Planck-Gesellschaft, Bad Nauheim and Institute of Physiology of the University of Giessen (Germany), May 26, 1965.

[5] H. T. HAMMEL, S. STRØMME, and R. W. CORNEW, Life Sci. *12*, 933 (1963).