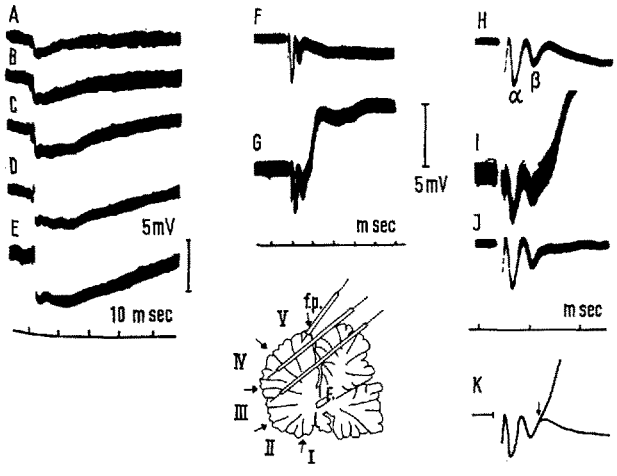
The Cerebellar-Evoked Monosynaptic Inhibition of Deiters' Neurones

The nucleus of Deiters receives rather massive projection from the cerebellum, directly as well as *via* the nucleus fastigii[1]. The cerebellar influence upon Deiters' nucleus has been assumed to be dominantly inhibitory, because ablation of the cerebellum greatly enhances the vestibular-evoked motoneurone discharges which are presumed to be mediated, at least in part, by Deiters' nucleus[2]. Stimulation of the anterior vermis of the cerebellum, indeed, inhibited spontaneous unit discharges in Deiters' nucleus, though there were others facilitated by the same stimulation[3,4]. In the work to be reported, it was further revealed with the intracellular recording technique that the vermian stimulation induces inhibitory postsynaptic potential (IPSP) *monosynaptically* in Deiters' neurones.

Cats were anaesthetized with pentobarbitone sodium. Dissection technique and experimental procedure have already been described[5]. Microelectrodes were filled with solution containing 3 *M* KCl or 2 *M* NaCl. For stimulating the ipsilateral anterior vermis, concentric electrodes with outside diameter of 0.5 mm and with interpolar distance of 1 mm were inserted stereotaxically through, or under direct vision over, the posterior lobe, aiming at lobule III, IV or V (Figure, inset diagram). Square pulses of duration of 0.08 to 0.2 msec were applied between the internal and external poles of each electrode.

So far 52 cells have been impaled in the vestibular nuclei region and identified as Deiters' neurones by the antidromic invasion from the spinal cord[5]. In the majority of them (44), stimulation of lobule III, IV or V by the cathode placed at a depth of 1 to 2 mm from the cortical surface produced a hyperpolarization of the membrane potential (Figure, A–E). At relatively weak stimulation near the threshold, which was usually around 1 V, this hyperpolarization was of simple configuration (Figure, A) with a peak time of about 1 msec and half time decay of about 10 msec. With an increase of stimulus intensity, the IPSP increases not only in its amplitude but also in its duration, which often exceeded 100 msec (Figure, E). The hyperpolarization could be reversed into a depolarizing potential either when the membrane was hyperpolarized by currents applied through the microelectrode or when chloride ions were injected electrophoretically into the cell (Figure, F and G). The inhibitory nature of this hyperpolarization could readily be demonstrated by suppression of spontaneous discharges of Deiters' neurones, which often occurred due to injurious effect of penetration[5]. These observations establish that the cerebellar-evoked hyperpolarization is the IPSP of the same nature as those hitherto studied extensively in cat spinal motoneurones as well as in many other nerve cells[6]. Figure H illustrates the initial part of the potential change of Figure F at a faster sweep velocity. The two negative deflections, α and β, which occurred before the hyperpolarization developed, were not influenced by the change of the membrane potential (Figure, I) and were recorded even in the extracellular position (Figure, J). Hence, they should be field potentials produced by impulses arriving at Deiters' nucleus. In spite of this complexity of the curve, the time of onset of the IPSP can be determined accurately by superimposing the hyperpolarizing and depolarizing responses (Figure, K). The latency of the IPSP thus measured from the onset of the stimulating pulse was as short as 0.9 to 1.1 msec (mean, 1.0 msec) when lobule III was excited.



IPSPs induced in a Deiters' neurone by stimulating the lobule III of the cerebellum. Stimulating voltages, 1.5 (A), 3.3 (B), 4.9 (C), 6.7 (D) and 30 V (E). F–I, IPSPs in another Deiters' neurone. G and I were recorded under hyperpolarization by currents of $2 \cdot 10^{-8}$ and $3 \cdot 10^{-8}$ A, respectively. J, extracellularly recorded field potential. K, traces in H and I are superposed. Downward arrow indicates the time of onset of the IPSP thus determined. Inset diagram, illustrating the positions of the cerebellar electrodes. Arrows indicate fissures dividing lobules I to V; f.p., fissura prima; F, nucleus fastigii.

In cat spinal motoneurones, the latency for producing EPSP (excitatory postsynaptic potential) monosynaptically by a volley along the group Ia muscle afferent fibres is 0.5 msec and that for inducing IPSP disynaptically is 1.3 msec after the impulses enter the spinal cord[7]. The value of 1.0 msec obtained for the latency of the cerebellar-evoked IPSP in Deiters' neurones would suggest that the inhibitory pathway is monosynaptic and is formed of slowly conducting fibres; or alternatively that it is disynaptic, fast conducting fibres being relayed by a synapse at some point in their course. However, the latter possibility was excluded by the fact that, when the stimulating electrode was inserted deep towards the roof of the fourth ventricle, the latency of the IPSP decreased continuously according to the distance between the electrode and Deiters' nucleus. At the extreme it was as short as 0.73 msec, when the region near the nucleus fastigii was stimulated, and on the other hand as long as 1.3 msec when the cortex of lobule V was excited. This variation of the latency can reasonably be accounted for if the pathway is assumed to have a slow conduction velocity of 20 m/sec or even less.

In conclusion, the present results indicate that there exists, in the region including the cerebellum and the brain stem, a type of inhibitory neurones whose axons are long enough to bridge over between the cerebellar cortex and Deiters' nucleus. In consideration of the cerebellar

[1] A. Brodal, O. Pompeiano, and F. Walberg, *The Vestibular Nuclei and Their Connections* (C. C. Thomas, Springfield, Ill. 1962).
[2] E. Gernandt and S. Gilman, Exp. Neurol. *1*, 274 (1959).
[3] R. V. de Vito, A. Brusa, and A. Arduini, J. Neurophysiol. *19*, 241 (1956).
[4] O. Pompeiano and E. Coti, Arch. Sci. biol. *43*, 57 (1959), quoted from [1].
[5] M. Ito, T. Hongo, M. Yoshida, Y. Okada, and K. Obata, Exper. *20*, 295 (1964).
[6] J. C. Eccles, *The Physiology of Nerve Cells* (Johns Hopkins Press, Baltimore 1957).
[7] T. Araki, J. C. Eccles, and M. Ito, J. Physiol. *154*, 354 (1960).

inhibitory action upon the bulbar postural centres, it may be suggested that they are Purkinje cells in the anterior vermis which send long corticofugal axons into Deiters' nucleus[1]. A latency of 0.6 to 0.7 msec was obtained for antidromic invasion of Purkinje cells from the nucleus fastigii over the conduction distance of 10 mm[8]. It is therefrom calculated that the conduction velocity along axons of Purkinje cells is indeed as slow as 15 m/sec or so, in good agreement with the 20 m/sec assumed above for the inhibitory axons. That the IPSP increased its duration with increasing the stimulus intensity (Figure, A–E) would be explained by assuming that Purkinje cells were excited not only antidromically but also orthodromically under relatively strong stimulus which would involve cerebellar afferent fibres.

Résumé. Des enregistrements obtenus à partir de neurones de Deiters au moyen de micro-électrodes intracellulaires ont montré que la stimulation du vermis du lobe antérieur cérébelleux provoque le potentiel postsynaptique inhibiteur monosynaptiquement.

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[8] R. GRANIT and C. G. PHILLIPS, J. Physiol. *135*, 73 (1957).

Antirachitische UV-Aktivierung von Hundehaut *in vitro* und *in vivo*

In früheren Untersuchungen wurde für Haut verschiedener Spezies und Körperregionen die sogenannte maximale antirachitische Aktivierbarkeit durch ultraviolette Strahlen (UV) als Hautkenngrösse festgelegt[1,2]. Nunmehr erfolgten mit der gleichen Zielsetzung Bestrahlungen an Hundehaut. Die Untersuchungen dienten gleichzeitig der Suche nach einer geeigneten Spezies für *in vivo*-Versuche, in denen beabsichtigt war, die Vitamin D-Verweildauer in Haut und die für die D-Abnahme geltende Abnahmekonstante zu ermitteln.

Bei 4 Bastardhunden mit nahezu unpigmentierter Haut wurde die eine Flankenseite rasiert und anschliessend mit dem Strahler U300 im Abstand von 50 cm 7, 8, 15 oder 32 min lang bestrahlt. Sofort nach Beendigung der Bestrahlung exstirpierte man in Hexobarbitalnarkose etwa die halbe bestrahlte Hautfläche (100–200 cm^2). Nach 2 oder 4 Tagen wurde in gleicher Weise die andere Flankenseite behandelt. Weitere 2 oder 4 Tage später erfolgte Tötung der Tiere und Gewinnung der verbliebenen bestrahlten beiden Flankenpartien und auch eines grossen Stückes Rückenhaut. Die Rückenhaut wurde nach Rasieren geviertelt und die einzelnen Viertel wurden 50, 100, 200 und 400 min lang zur Ermittlung der maximalen Aktivierbarkeit UV-bestrahlt. In allen Hautproben wurde sodann der Vitamin D-Gehalt ermittelt (vgl. [2], Tabelle).

Wie die Tabelle zeigt, war in allen Fällen der Gehalt der Haut an Vitamin D so gering, dass er unter der Erfassungsgrenze lag. Es ergibt sich hieraus, dass die Aktivierbarkeit von Hundehaut minimal ist. Die maximale Aktivierbarkeit dürfte höchstens bei 0,0025 μg pro cm^2 liegen. Dieses Ergebnis überrascht insofern, als wir in unseren Untersuchungen bisher niedrige Aktivierbarkeiten nur bei der talgdrüsenlosen Haut von Haushuhn und Hausente, hohe hingegen bei talgdrüsenreichen Häuten gefunden und daraus auf eine gewisse Rolle der Talgdrüsen bei der Provitamin D-Bildung geschlossen haben. Da die Hundehaut sehr wohl Talgdrüsen besitzt, wenn auch solche mit langen, dünnen Ausführungsgängen, scheint dieser Schluss nicht mehr voll gerechtfertigt.

Die Ermittlung einer D-Abnahmekonstante ist infolge des geringen Gehaltes beim Hund mittels der zur Zeit zur Verfügung stehenden Vitamin D-Bestimmungsmethoden nicht möglich.

Vitamin D-Gehalt rasierter Hundehaut nach Bestrahlung *in vitro* und *in vivo* im Strahler-Haut-Abstand von 50 cm mit Strahler U 300

Tier-Nr.	Bestrahlte Region		Bestrahlungszeit min	D-Gehalt $\mu g/cm^2$
1	Rückenhaut	*in vitro*	50, 100, 200 und 400	$< 0{,}0025$
	Flankenhaut	*in vivo*	7	$< 0{,}0050$
2	Rückenhaut	*in vitro*	50, 100, 200 und 400	$< 0{,}0010$
	Flankenhaut	*in vivo*	8	$\leq 0{,}0010$
3	Rückenhaut	*in vitro*	50, 100, 200 und 400	$\leq 0{,}0020$
	Flankenhaut	*in vivo*	15	$\leq 0{,}0015$
4	Rückenhaut	*in vitro*	50, 100, 200 und 400	$\leq 0{,}0025$
	Flankenhaut	*in vivo*	32	$\leq 0{,}0015$

Summary. The antirachitic activation of dog skin by ultraviolet radiation is very small; this indicates a low content of provitamin D in this kind of skin. In contrast with other species and their body regions there is in the dog no parallelism between antirachitic activation and number and function state of sebaceous glands.

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[1] H. BEKEMEIER, Fortschr. Med. *82*, 141 (1964).
[2] H. BEKEMEIER, Habil.-Schrift der Univ. Halle (1962/63).