Durch polarisiertes Licht hervorgerufene Optomotorik bei *Uca tangeri*

Im Zuge der Bearbeitung von Sehschärfe und Farbwahrnehmung von *Uca tangeri* am Golf von Cadiz wurden bei 10 Versuchstieren (Vt) (5♀♀, 5♂♂) mit Carapaxbreiten von 21–31 mm die Reaktionen auf Drehung der Schwingungsebene (e-Vektor) des polarisierten Lichtes untersucht. Die Vt befanden sich in einem ruhenden runden Glasgefäss von 9,5 cm Höhe und 9,5 cm Durchmesser, um welches eine weisse Metalltrommel von 40 cm Höhe und 35 cm Durchmesser gedreht werden konnte. Die Versuchsanordnung war so gewählt, dass nur die apikalen Ommatidien der Augenkalotten vom direkten polarisierten Licht getroffen wurden. Zur Erzeugung des polarisierten Lichtes wurde eine Polarisationsfolie (Polaroid Corporation) auf die Metalltrommel gelegt, dass nur polarisiertes Licht in die Trommel einfiel. In dieser mass ich die Beleuchtungsstärke nach oben mit 2000 Lux und zur Wand mit 700 Lux. Auf blosse Drehung der Trommel ohne Polarisationsfolie zeigte keins der 10 Vt eine optomotorische Reaktion, womit bewiesen ist, dass keine visuellen Schlüssel von der Trommel ausgingen. Ebenso war keine Reaktion zu beobachten, wenn über den apikalen Ommatidien eine Holzscheibe von 40 cm Durchmesser mit 8 schwarzen und 8 weissen gleichgrossen Sektoren gedreht wurde, obwohl auf der Trommelwand gebotene Schwarzweiss-Streifen dieser Dimension immer optomotorische Reaktionen der Tiere auslösten. Visuelle Objekte sind demnach für diese apikalen Ommatidien wohl wenig relevant. Wurde die Trommel mit der Polarisationsfolie bei indirektem Sonnenlicht mit 6 Umdrehungen pro min gedreht, so zeigten 8 von 10 Vt eine optomotorische Reaktion, d.h. sie drehten ihren Körper so, dass ihre Körperquerachse immer parallel zur Ebene des polarisierten Lichtes stand. Dieses Verhalten erfolgte entweder nach kurzem Zögern oder sofort bei Drehbeginn der Polarisationsfolie. Damit ist durch einen leicht reproduzierbaren Versuch bewiesen, dass die Hauptfunktion der apikalen Ommatidien in der Wahrnehmung des polarisierten Lichtes liegt. Dagegen dürften die lateral gelegenen Ommatidien im Freilandleben von *Uca tangeri* für diese Fähigkeit nicht benutzt werden, was die negativen Dressurbemühungen auf polarisiertes Licht an *Uca tangeri*[1] bzw. an *Panulirus*[2] verständlich macht.

Summary. Optomotor reactions were tested in 10 *Uca tangeri* (5♂♂, 5♀♀) of intermediate body size, by slowly rotating the plane of polarized light entering the apical ommatidia of the animal; 8 out of 10 animals showed definite optomotor reactions immediately at, or a short time after, the beginning of the rotation. There were no such reactions when the apical ommatidia were stimulated by a rotating black and white disc.

R. KORTE

Zoologisches Institut der Universität Münster i.W. (Deutschland), 8. September 1964.

[1] R. ALTEVOGT, Zool. Beitr. N.F. *9*, 447 (1963).
[2] H. SCHÖNE, Biol. Bull. *121*, 354 (1961).

Peripherally Located Adrenergic Neurons Innervating the vas deferens and the Seminal Vesicle of the Guinea-Pig

Recent findings have indicated the existence of a peripheral synapse located in or near the effector organ, and belonging to the adrenergic innervation of the accessory male genital organs of the guinea-pig. Thus, the response of the vas deferens to hypogastric nerve stimulation is blocked by ganglion agents[1], and section of the hypogastric nerve does not overtly reduce the noradrenaline content of the vas deferens and the seminal vesicle[2]. Moreover, the hypogastric nerve fibres evoking responses from the smooth muscle cells of the guinea-pig vas deferens seem to be B fibres[3]. After treatment with reserpine, no measurable amounts of noradrenaline are found in the vasa deferentia and the seminal vesicles[2].

A method allowing the direct demonstration of noradrenaline in adrenergic nerves has recently been reported[4,5]. By means of this method an abundant occurrence of adrenergic terminal nerves has been demonstrated in the vas deferens of the guinea-pig[5]. The amount of adrenergic nerve fibres corresponds well with the high noradrenaline content of this organ[2]. Further, adrenergic nerve cell bodies have been found in the distal part of the hypogastric nerve[6]. This report deals with the effect of hypogastric denervation on these adrenergic nerves.

Methods. Ten guinea-pigs, weighing about 500 g, were submitted to hypogastric denervation during nembutal anaesthesia supplemented when necessary with ether. The animals were laparotomized, and the hypogastric nerves were removed from their origin below the kidneys to a point close to the seminal vesicles. After removal of about 5 cm of the hypogastric nerve on each side of four animals and on only the left side of six animals, the abdomen was closed. The animals were sacrificed 12–20 days after denervation.

All animals were killed by decapitation under light ether anaesthesia. Pieces from the seminal vesicles and the proximal, middle, and distal parts of each vas deferens, as well as epididymis, were excised, freeze-dried and then treated in formaldehyde gas according to FALCK[5]. This procedure transforms certain biogenic monoamines into highly fluorescent condensation products[5,7,8]. Sections (8 μ) were taken from different levels of the excised tissue pieces and mounted for fluorescence microscopy.

[1] N. O. SJÖSTRAND, Acta physiol. scand. *54*, 306 (1962).
[2] N. O. SJÖSTRAND, Acta physiol. scand. *55*, 376 (1962).
[3] C. B. FERRY, J. Physiol. *166*, 16P (1963).
[4] B. FALCK and A. TORP, Med. exp. *6*, 169 (1962).
[5] B. FALCK, Acta physiol. scand., Suppl. 197 (1962).
[6] B. FALCK, quoted by OHLIN and STRÖMBLAD, Brit. J. Pharmacol. *20*, 299 (1963).
[7] B. FALCK, N.-Å. HILLARP, G. THIEME, and A. TORP, J. Histochem. Cytochem. *10*, 348 (1962).
[8] H. CORRODI and N.-Å. HILLARP, Helv. chim. Acta *46*, 2425 (1963).

Results. In the normal vas deferens, an abundance of intensely green-fluorescent varicose nerve terminals was found in a very dense plexus within both the circular and longitudinal muscle layers (Figure 1). The terminals ran along the muscle cells, chiefly following their direction. Thus, in the circular layer the major part of the varicose terminals ran circularly, and in the longitudinal layers they ran longitudinally. In the peripheral parts, and just outside the vas deferens, several nerve bundles were present, containing mainly intensely fluorescent varicose fibres but also smooth preterminal axons emitting a weaker fluorescence. Somewhat more proximally these bundles consisted only of smooth, faintly fluorescent nerve fibres. The bundles ran parallel to the vas deferens, branching off small fascicles, which penetrated the wall to ramify in the organ. Small radial bundles issued from the outer longitudinal layer into the circular one, where they contributed to the circular plexus. In a similar manner the plexus of the inner longitudinal layer received its supply from the circular layer. No clear difference in the amount of innervation could be seen comparing the distal and middle levels of the vas deferens, but in the proximal section there was an overall tendency towards a decreasing density of the nerve plexuses (Figure 1, a vs. b).

Sections from the epididymis showed that the heavy innervation started concomitantly with the appearance of a muscle layer. The muscle innervation persisted along the entire extent of the ejaculatory ducts. A sphincter-like structure was not found. Only rarely were fluorescent terminals seen in the mucosa, and those present appeared to accompany minute vessels rather than serving the mucosal cells. Outside, and running along the vas deferens, a great number of blood vessels, surrounded by rather dense plexuses of adrenergic nerves, were seen.

The distribution pattern of fluorescent nerves in the seminal vesicles was similar to that of the vas deferens, although it was not so extensively innervated as the latter organ (Figure 2).

In the terminal parts of the hypogastric nerve, where it joins the vessels to the accessory genital organs and ramifies, masses of nerve cell bodies occurred, generally arranged in clusters (Figure 3). The nerve cells were rather

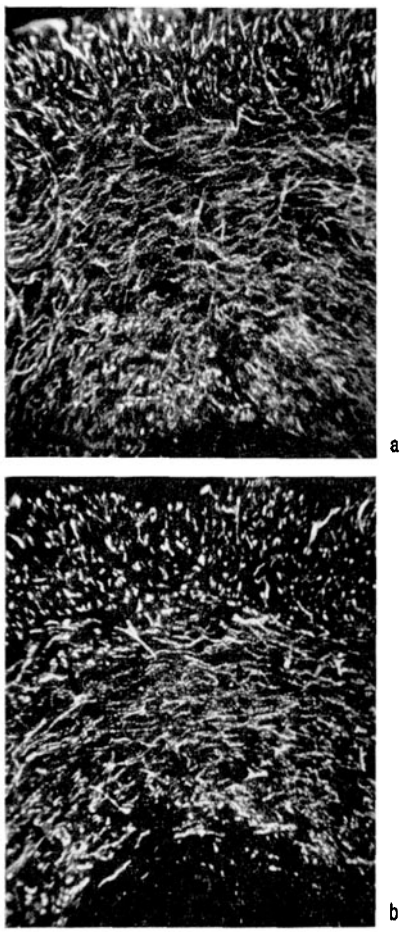


Fig. 1. Fluorescence photomicrographs of transversely sectioned guinea-pig vas deferens. Heavy adrenergic innervation of muscle coat, especially the circular layer. × 75. a, distal vas deferens. b, proximal vas deferens; note the less overall density of fluorescent nerves.

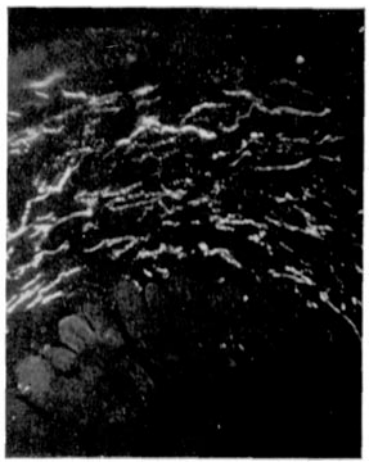


Fig. 2. Seminal vesicle, transverse section. Innervation of similar pattern as vas deferens, but much more sparse. × 75.

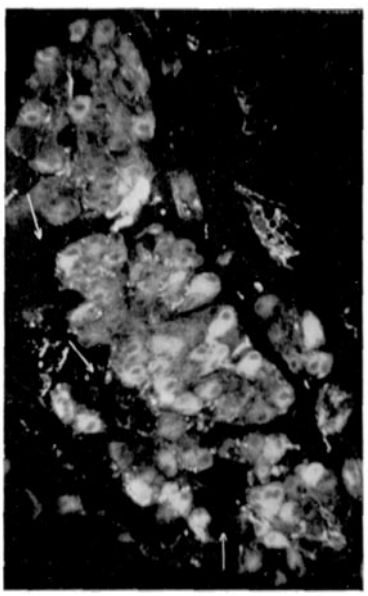


Fig. 3. Peripheral adrenergic ganglion located near coagulating gland. Nerve cells showing varying degree of green fluorescence. Some groups of nerve cells lack fluorescence (arrow). Highly fluorescent varicose terminals surround some of the nerve cells. Small group of intensely fluorescent cells with processes is visible. × 75.

uniform in size, and showed varying degrees of fluorescence, from very faint to quite high intensities. Among the fluorescent cells, groups of completely non-fluorescent nerve cells occurred. They were visible only because of the faint non-specific background fluorescence of the tissue, but appeared clearly when the sections were studied by phase-contrast microscopy. Around some of the cells, both of the fluorescent and the non-fluorescent types, adrenergic terminals were seen. However, the majority of cells did not receive any nerve terminals. Scattered in these ganglia small, intensely green-yellow fluorescent cells, isolated or more frequently collected in groups, were located. Several long and richly branching processes extended from the cells. Leaving the peripheral ganglia, bundles of smooth, moderately green-fluorescent as well as non-fluorescent axons could be seen. Furthermore, the peripheral bundles outside the vas deferens and the accessory genital glands could be traced back to them. The nerve cells were dispersed over a rather wide area in the vicinity of the accessory male genital glands, and were regularly seen in the walls of the prostate and the coagulating gland, too. They could not be found within the vas deferens or in the seminal vesicle.

No visible reduction of the peripheral innervation was observed in structures from the side where the hypogastric nerve was cut, as compared with the non-denervated side or with unoperated control animals. No reduction in the vascular innervation was seen, nor could any decrease in the amount of adrenergic nerve terminals around the peripheral nerve cells be estimated with any certainty.

Further studies on the monoamine-containing structures of the internal accessory male genital organs in different species will appear elsewhere[9].

Conclusion. The present results confirm the previously mentioned evidence for a peripheral synapse in the adrenergic innervation of the vas deferens and seminal vesicle of the guinea-pig[1-3].

Zusammenfassung. Samenleiter und Samenblase vom Meerschweinchen besitzen eine besonders kräftige adrenergische Innervierung, die von Nervenzellen, die in unmittelbarer Nähe der Organe liegen, ausgeht.

B. FALCK, CH. OWMAN, and N. O. SJÖSTRAND[10]

Departments of Histology and Anatomy, University of Lund; and Department of Physiology I, Karolinska Institutet, Stockholm (Sweden), August 28, 1964.

[9] CH. OWMAN and N. O. SJÖSTRAND, Z. Zellforsch., in press (1964).

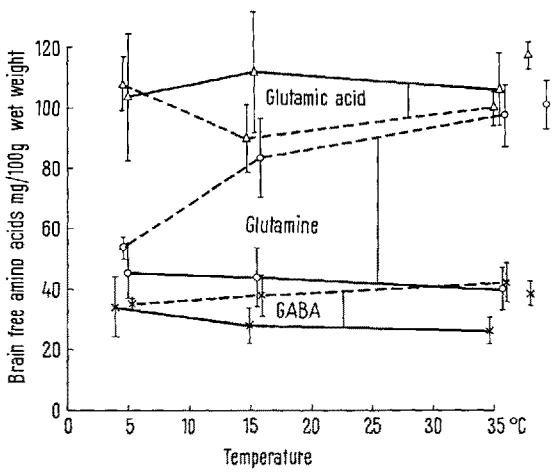
[10] This work has been supported by grants from the United States Public Health Service (NB 02854-04) and from Stiftelsen Magnus Bergvalls Minne.

Changes of Cerebral Glutamine, Glutamic Acid and GABA during Arousal from Hibernation

The hibernating state, and especially its most dramatic phase, arousal from hibernation, being highly dynamic and coordinated physiological events, during which the excitability of the brain undergoes profound but reversible modifications, provides exceptional possibilities for evaluating the assumed role of glutamate-GABA system in the regulation of cerebral excitability. Starting from these considerations, the changes in glutamine, glutamic acid, and GABA concentrations of the brain during arousal from hibernation have been investigated and compared to the corresponding alterations occurring during spontaneous reanimation from an artificially induced state of hypothermia.

49 European ground squirrels were used. Arousal from hibernation was initiated by transferring the animals from the cold room (5–10°C) to the laboratory (at a higher temperature). Hypothermia was induced according to the well known method of GJAJA[1]. The time needed to cool an animal below 5°C ranged from 2 to 3 h. The container to which an animal was confined in the ice-box was opened and the air was allowed to circulate for 10 sec at each 10th min during the first half hour, at each 20th min during the next hour of refrigeration, and at each 30th min later on, until the desired temperature was attained. Both hibernating and hypothermic animals were decapitated in groups of seven at 5–7°, 15° and 35–37°C respectively, their rate of reanimation being approximately the same. Cerebral amino acids were separated and quantitatively estimated as previously described[2].

As illustrated in the Figure, the content of all the investigated compounds in the brain of ground squirrels killed while deeply hibernating, with a rectal temperature of 5–7°C, was significantly lower than the corresponding values found in the brain of control non-hibernating animals sacrificed at the same time of the year. During



Values for hibernation are represented by heavy lines, while those for hypothermia are marked by dotted lines. Symbols at the far right end of the Figure indicate concentrations estimated in the brain of control, non-hibernating animals. o = glutamine, △ = glutamic acid; × = GABA.

[1] J. GJAJA, Bull. Acad. Royale Serbe *6*, 65 (1940).

[2] LJ. KRŽALIĆ, V. MANDIĆ, and LJ. MIHAILOVIĆ, Exper. *18*, 368 (1962).