incubation of the treated animals prolonged, but the duration of the disease with symptoms was prolonged to 2, 3, and 4 days. These data indicate that numerous X-ray treatments either prevent or cure encephalitis in a number of mice inoculated intranasally with the virus.

7775 P

Nerve Impulses from Receptors in the Cornea.

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The central portion of the human cornea yields, to any form of stimulation, only the sensation of pain. The reactions of laboratory mammals to stimulation of this field recapitulate those of the human. Therefore it may be inferred that the sensation evoked is likewise pain. The site thus offers the possibility of investigating the mechanism of this sense, unconfused by other modalities. To this end arrangements were made to amplify and record action potentials in the long ciliary nerves. In some experiments the active fibers of one of these nerves were reduced to 2 or 3. The animals, cats, were decerebrated, the second to sixth cranial nerves cut, and the ciliary ganglion removed. The stimulators employed included a set of von Frey needles (⅛ to 10 gm.), a corresponding set of hairs, a mechanical stimulator delivering prick of variable intensity, and blunt glass rods.

The responses obtained from the cornea using these different instruments were essentially the same—trains of impulses of rapidly diminishing frequency, or occasionally, from the extreme fringe of a fiber's field, a single impulse only. Initial frequency and duration of the discharge were functions, both, of the intensity of the stimulation. In the first hundredth-second frequencies exceeding 500 per second were obtained. Thereafter, with continued stimulation, the discharge fell off precipitately, sometimes to cease entirely in a few seconds, sometimes to establish a sustained activity at one to 5 impulses per second. Removing the stimulus then commonly caused a second small outburst. Not infrequently a single stimulation of the cornea caused 2 fibers to respond, one of which adapted completely, the other, not.

The single corneal ending was isolated, not by attack on the cornea, no part of which is supplied by a single fiber, but by attack on the nerves. One nerve fiber was then found distributed over roughly a quadrant of the cornea and extending onto the adjacent sclera. Yet within this large field were islands not supplied by the fiber in question, but perhaps, in a 2-fiber preparation, by the second of the survivors.

The question arises, what constitutes a nerve ending—each of the numerous small terminals on one nerve fiber, or the sum total of these? When mechanical stability was achieved, the trains of impulses were quite regular in a single fiber, making it unlikely that individual terminals were firing off independently. Yet stimulation anywhere except at the periphery of a fiber's distribution must deform many of these. Clearer evidence that the whole terminal ramification acts together, was given by another observation. From time to time preparations were obtained, in which an ending discharged spontaneously 2 to 4 times a second, for hours. Stimulation of the corneal terminals of such a "ticker" elicited the usual outburst of impulses, but following this the spontaneous firing slowed or ceased, sometimes for seconds. Stimulation anywhere within the extensive field of such a fiber produced this depression, and in proportion only to the amount of the discharge called forth. And excitation of other fibers within the area was quite without such effect. Moreover, the fatigue which the corneal endings showed as diminishing response in a series of stimulations was unequivocably shared by a "ticker" And similarly, spontaneous and excited activity suffered together in the progressive slow deterioration throughout the course of a long experiment.

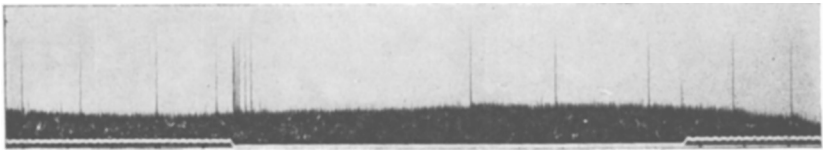

FIG. 1.

Action potentials in a 2-fiber preparation of a long ciliary nerve, one of the fibers of which was discharging spontaneously. The upper marker indicates the interval of application of a prick in the corneal field of this fiber. An initial discharge of impulse was followed by cessation of the spontaneous firing, which resumed later. The lower marker gives time in 1/5 sec.

On the other hand, within the terminal ramification local conditions determined both the initial frequency and the duration of the discharge resulting from a given stimulation. To begin with, all

parts of a fiber's distribution were not equally responsive. From point to point the discharge varied, but always with a general gradient of increasing activity from the periphery toward the center of the field. Again, the fatigue of repetitive stimulation of one point certainly acted most intensely at that point, as did the denial of access of aqueous humor to any portion of the cornea. Finally, adaptation was appreciable only at the point stimulated, for a second stimulus applied as closely as possible to a first to which adaptation was complete, resulted in a second vigorous discharge in the same nerve fiber.

Putting these facts together, the sensory ending in the cornea emerges as all the terminal tissue of one nerve fiber. This is a unit, activity in any part of which probably involves the whole. Moreover, there is no evidence that activity in this unit influences in any way the activity of closely associated units. Functionally, the total corneal sensory mechanism appears as an aggregate of units, and not as a continuum. No evidence has been forthcoming of the presence of more than one sensory mechanism in the cornea. By analogy with the human, this should be pain. More convincingly, the wide extent of the ending, and the spread of activity throughout it, reflect one of the characteristics of the pain sense as subjectively studied, its lack of any but the most general localization. Likewise, the initially rapid, but then often incomplete adaptation of the mechanism repeats another aspect of the same subjective experience. Therefore, perhaps, one may see in the properties of the sensory mechanism studied in the cornea, peripheral determinants of the central processes resulting in the sensation of pain.

7776 C

Oral Toxicity of Ortho-n-alkylphenols to White Rats.*

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In a search for an active non-toxic ascaricide which has been going on in this department for several years, several series of alkylphenols have been studied for their ascaricidal action as well as

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