The Action of Tryptamine and 5-Hydroxytryptamine on Muscles of Sea Anemones

Neuromuscular transmission in sea anemones has been investigated so far only by studying the action of ions, drugs and extracts on the quick closing response of the whole animals, *Calliactis parasitica* and *Metridium senile*. It is now possible, using isolated preparations, to conduct experiments separately on 'quick' and 'slow' muscles. Preparations containing 'slow' muscles, e.g., circular muscles of the column, are continuously active; they respond to electrical stimuli by smooth contractions with long latent periods of 0.5 to 2 min. Preparations containing 'quick' muscles, e.g., sphincters of *Calliactis* or *Metridium*, show little spontaneous activity; to electrical stimuli they give the facilitated response described by Pantin in which, after an ineffective first stimulus, quick step-like movements occur, with latent periods of about 0.1 s, on the second and subsequent stimuli in the frequency range 0.2 to 3.0 s (17°C), the height of the steps depending on the frequency of stimulation. 'Quick' preparations also give typical slow responses to stimuli at lower frequencies, a fact that adds interest to the problem of neuromuscular transmission in this case.

In a preliminary survey of the effects of treatments on preparations from *Calliactis* and *Metridium*, the indol-alkylamines, tryptamine and 5-hydroxytryptamine (5-HT), gave interesting results. These are reported here briefly in view of the current interest in this class of substances, and especially in 5-HT because of its powerful neuromuscular action, its widespread occurrence and its possible neurohumoral function in some invertebrates (Erspamer, Welsh).

Unlike smooth muscle from mammalian uterus, intestine or arteries, where 5-HT is 100 to 1000 times more active than tryptamine, anemone preparations are more sensitive to tryptamine than to 5-HT. Untreated relaxed preparations of *Metridium* column ('slow') undergo gentle rhythmical changes of length every 10–15 min; tryptamine (1 × 10⁻⁴) causes this preparation to shorten, usually by stages, until it is almost completely contracted (Fig. 1). Untreated preparations of *Calliactis* sphincter ('quick') show almost no spontaneous activity and do not respond to single stimuli; after tryptamine (1 × 10⁻⁴) the preparation becomes very active, giving quick contractions every few minutes (Fig. 2) and in about half the experiments responding consistently to single stimuli (Fig. 2). Both these effects could be due to a facilitating action by the drug which would allow single impulses of electrical or natural origin to cause responses. However, other explanations based on the possibility of supernumerary or adventitious impulses cannot be excluded.

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Fig. 2.—Records of Calliactis sphincter preparation of 15 min duration (a) before treatment and (b) from 10–25 min after introduction of tryptamine hydrochloride ($1 \times 10^{-4}$). Single stimuli given at signals marked '1' in control and treatment; 2 and 5 stimuli (frequency 1-2 s) given at signals marked '2' and '5' in control.

Tryptamine, 5-HT (serotonin creatinine phosphate [Roche] $1 \times 10^{-4}$) has no direct effects on Metridium circular muscle and rarely causes quick contractions of the sphincter preparations.

Lower doses of both tryptamine and 5-HT enhance the quick and slow responses in preparations of Calliactis sphincter and shorten the latent period of the slow response (Fig. 3). This suggests that tryptamine acts on some fundamental part of the mechanism of the response and not through superficial sensory effects.

The full interpretation of these results must await the outcome of further tests with other substances. Acetylcholine (and its associates), histamine, noradrenaline and many other substances are quite ineffective, but tyramine, $\text{Ca}^{++}$ and possibly adrenaline have limited effects on some preparations which may prove

Fig. 3.—Quick response of Calliactis sphincter preparation to 2 stimuli at frequency of 1 per s (left side) and slow response of same preparation to 5 stimuli at frequency of 1 per 9 s (right side) (a) before treatment and (b) 100 and 173 min after the introduction of tryptamine hydrochloride ($1 \times 10^{-5}$).