stimulation with wavelengths in the region of 530 nm of the spectrum, was not significantly altered by the angle of incidence.

Since it is known that a class of cones containing a pigment with maximum sensitivity at 540 nm exists in the cyprinidae retina, it could be argued that they are dominant in the production of the S-potential in the dark adapted state. For this to be true, the class of cones in question would have to be unique in that they did not exhibit a marked directional sensitivity.

Conclusion. By means of the Stiles-Crawford effect it has been possible to demonstrate the existence of a class of cones which are sensitive to the blue end of the spectrum and contribute to the S-potential measured in the dark adapted state. It has also been shown that either the rods are dominant in the production of the S-potential in the dark adapted retina or there exists a class of cones with a similar spectral sensitivity which are not directionally sensitive[8].

Zusammenfassung. Mit Hilfe des «Stiles-Crawford»-Effektes gelingt es, die Existenz blau-empfindlicher Zäpfchen in der Fischretina nachzuweisen, die teilweise für die S-Potentiale verantwortlich sind.

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Neuronal Properties of the Neurosecretory Cells in the Fly *Sarcophaga bullata*

Neurosecretory cells (NSC) are specialized neurons which function as endocrine glands. They retain the general morphology of neurons, but end blindly in swollen termini serving as storage and release organs for the hormones produced in the cell bodies. In several poikilotherms the NSC have been found to spontaneously produce action potentials of long duration[1–7]. However, despite much histological and endocrinological interest in the neurosecretory system in insects[8,9] there has appeared only one report of an electrophysiological examination[10].

In *Sarcophaga* the perikarya of the protocerebral NSC are located just under the neurilemma in the dorsal midline of the brain. The axons decussate before leaving the brain posteriorly to end in the corpus cardiacum located in the neck region. To gain access to the brain the head capsule was cut open and the 2 large tracheal branches which pass over the brain were removed. The perikarya of the NSC appear now as 2 small whitish clusters of cells (somata 20 μ in diameter) on either side of the midline of the brain at the base of the ocellar nerve. Intracellular recordings were made with 3*M* KCl filled micropipettes having resistances between 8 and 35 $M\Omega$. Activity was recorded with a Grass P-6 amplifier at unity gain and Hewlett Packard Model 132 oscilloscope direct coupled. In all figures, unless otherwise noted, upward deflections are positive.

The resting potentials of NSC recorded on initial penetration varied from 2–40 mV (inside negative) but mostly were about 20 mV. Action potentials recorded from the perikarya varied in amplitude from 1–40 mV (Figure 1), but were never greater in amplitude than the resting potential of the cell. In all except a few cases the cells were endogenously active. Action potentials recorded from the NSC characteristically were of a duration of

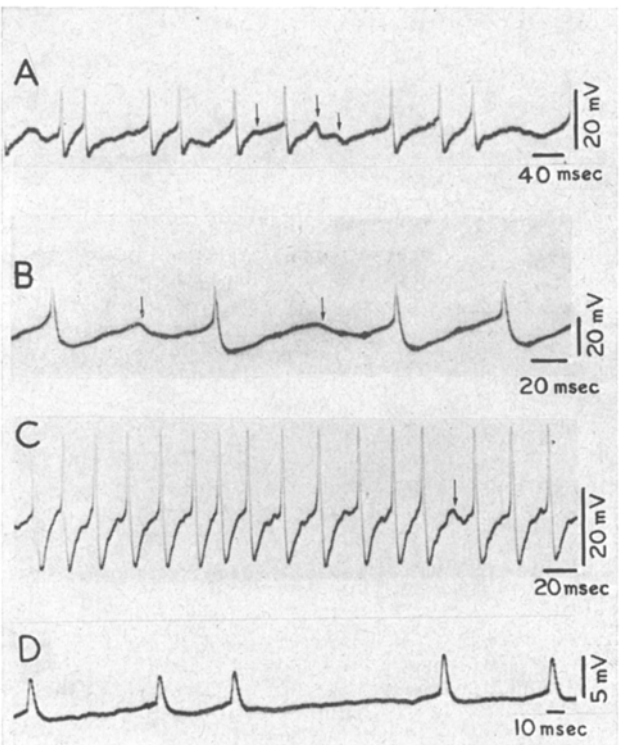

Fig. 1. Intracellular recordings of action potentials from the perikarya of NSC. (A) to (C) show spikes rising from endogenous waves of depolarization and followed by negative afterpotentials. IPSP's (arrows) were frequently seen in these records. (D) Intracellular recording of low amplitude spikes showing no synaptic activity.

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about 5 msec (2–20 msec), whereas spikes recorded at other locations in the brain and from the medulla of the optic lobe were < 1 msec (Figure 2D). Monophasic and biphasic action potentials were recorded intracellularly (Figure 1) from the so ma. The difference in wave-form is probably a function of where in the cell the electrode was, whereas extracellular recordings (Figure 2, A and B) made with saline-filled suction electrodes had a biphasic wave-form. The biphasic action potentials rose from the peak of a wave of depolarization and were followed by a prominent afterpotential.

No neuronal activity of similar characteristics to that described above was found immediately around the NSC clusters nor below them. Also, after the NSC were removed and the flies allowed to recover for several days, no activity resembling that shown above was detectable. These findings, coupled with the visual placement of the electrodes, have led us to attribute the activity described to the NSC of the protocerebrum.

The neurosecretory neurons appeared to fire endogenously, but the interspike interval was variable. In those recordings where biphasic action potentials were seen one also observed inhibitory postsynaptic potentials (IPSP's) (Figure 1). The small hyperpolarizations of the IPSP's were often associated with intervals in the record when spikes did not occur but when they might have been predicted.

The corpus cardiacum in Diptera is known to contain both the swollen termini of the cerebral NSC and intrinsic secretory cells[11]. Swollen, whitish terminal-type endings were found to have resting potentials between 40 and 60 mV (inside negative), but were generally silent. In the numerous penetrations of cardiacum cells, electrical activity was recorded only 6 times (Figure 2C). When activity was recorded, depolarizations were always small (0.5–1.0 mV) and of long duration (10–20 msec). Action potentials recorded here were not preceded by a wave of depolarization, but were followed by a small negative after-potential.

The data presented here agree with the observations made on *Periplaneta americana*[10] with respect to resting potentials, spike durations and the endogenous nature of NSC depolarizations. The simple wave-form and low amplitude of depolarizations recorded from the somata in *Periplaneta* led these authors to agree with others[12,13] that regenerating action potentials probably did not invade the somata of unipolar insect nerve cells. However, the appearance of large amplitude action potentials of biphasic wave-form in records made from NSC perikarya of *Sarcophaga* suggest active spike propagation at least part way into the soma, although the monophasic wave-forms probably recorded in the distal parts of the cells tend to indicate that such invasion is not complete. Similar observations on *Aplysia*[14] indicate that axonal spikes may invade part, but not all, of the soma.

In insects there is no neurophysiological information available showing how hormone release from the neuroendocrine system is timed. The data presented here strongly suggests that the NSC receive synaptic inhibitory interactions at sites near the perikarya. Dendritic arborizations occurring near the perikarya have been described in *Periplaneta*[13] and if similar areas exist in *Sarcophaga* they would be the logical sites for the reception of the inhibitory influence. Research now in progress is attempting to define the significance of the inhibitory influences to the electrical activity of and hormone release from these neurosecretory cells[15].

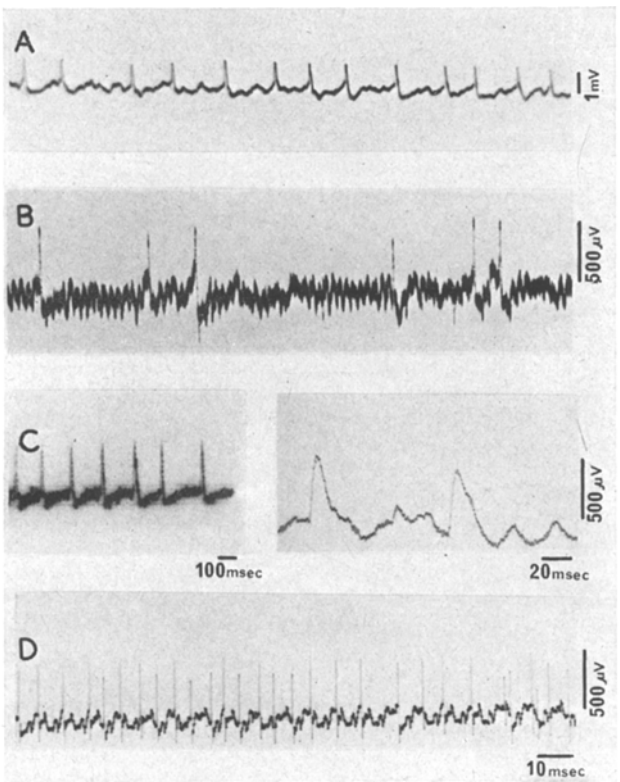

Fig. 2. (A)–(B) Extracellularly recorded potentials from NSC made with a saline-filled suction electrode (negative upward). Time calibration not recorded. (C) Intracellular potentials recorded from the corpus cardium. Both pictures are of the same cell; however, the first is at a slow film speed to show negative afterpotentials. (D) Intracellular recordings of a non-neurosecretory cell recorded from beneath the NSC cluster in the brain.

Zusammenfassung. Endogene Erregungspotentiale wurden von den Perikarya der protozerebralen, neurosekretorischen Zellen der Fleischfliege *Sarcophaga bullata* abgeleitet. Diese Potentiale scheinen nur teilweise in die Perikarya einzudringen. Erregungshemmende postsynaptische Potentiale wurden ebenfalls festgestellt. Sie scheinen ihren Ursprung nahe der Somata zu haben. Potentiale wurden selten von den geschwollenen Endungen der neurosekretorischen Neuriten des Corpus Cardiacum abgeleitet.

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