SYNAPTIC RESPONSES OF CENTRAL NEURONS IN THE TERMINAL ABDOMINAL GANGLION OF CRAYFISH TO SENSORY STIMULATION DURING WALKING

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Crayfish receive mechanosensory information from the cuticular hair receptors on the telson and uropods. However, it has remained largely unknown how the sensory input is affected in the terminal abdominal ganglion when the animal is engaged in various behavior. In this study, we made intracellular recording from the central neurons in the terminal abdominal ganglion of crayfish performing tethered walking on a treadmill to analyze how their synaptic responses to uropod stimulation were affected during walking. Uropod motoneurons were found, when the animal was engaged in walking, to show sustained depolarization (<10mV) during which the sensory input was significantly reduced in its amplitude ($P<0.05$). By contrast, the ascending projection interneurons showed sustained hyperpolarization (<10mV) during walking whereas the identified mechanosensory nonspiking interneuron, the LDS interneuron, that received frequent synaptic inputs when the animal was inactive did not show any sustained membrane potential change but became completely silent when the animal began walking. The synaptic response was also reduced during walking in the projection interneurons. The results suggest that, in contrast to the descending sensory input that is enhanced during walking as revealed in previous studies, the segmental sensory input is suppressed in the terminal abdominal ganglion when the animal is engaged in the walking behavior.

CEREBRAL PHOTOSENSITIVE NEURONS OF THE ORB WEAVING SPIDERS CONVEY INFORMATION TO VARIOUS PARTS OF THE NERVOUS SYSTEM

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Circadian sensitivity oscillation in the eyes of the orb weaving spiders *Argiope amoena* and *A. bruennichii* is mediated by efferent signals via neurosecretary fibers in the optic nerve. Lucifer yellow applied to the cut end of the optic nerve marked efferent neurons that have their soma within the neurosecretary cell group in the contralateral side of the protocerebrum. Transecting the efferent neurosecretary fibers by cutting the brain at the midline abolished the circadian sensitivity change in the eyes. On one hand, efferent optic nerve impulses increased by illumination of the brain even if the brain except the ipsilateral optic lobe was ablated. It is apparent that the cerebral phtotosensitive neurons that have their photosensitive regions in the optic lobe are not identical with the efferent neurosecretary cells. Impulse firings in response to illumination of the optic lobe were recorded not only in the optic nerves, but also in the brain and the circumoesophageal connectives. These results suggest that cerebral photosensitive neurons in the optic lobe convey information to various parts of the nervous system.

PHYSIOLOGICAL ANASYSIS OF SPONTANEOUS NEURAL ACTIVITY OF TENTACULAR GANGLION IN THE TERRESTRIAL SLUG, *Limax marginatus*

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In slugs, the interneurons in the procerebral (PC) lobe, the central olfactory organ, displays spontaneous oscillatory activity at a frequency of 0.7 Hz. Many physiological studies revealed that the spontaneous oscillations are involved in olfactory processing. However, the physiological features of the peripheral olfactory system in the tentacles are still unclear. In the present study, we thus analyzed the neural activity in the *Limax* tentacles, using extracellular recording techniques. The sensory structures in the tentacle comprise a sensory epithelium (SE), a tentacular ganglion, and digit-like extensions of the ganglion (digits). First, we recorded the activity from the ventral surface of the digits by a suction electrode. The spontaneous oscillatory activity which lasted for up to 90 s at frequencies of less than 5 Hz was recorded in both the superior and inferior tentacles. The occurrence rate of the spontaneous oscillations in the inferior tentacles was higher than that in the superior tentacles. The typical wave form was composed of a positive phase followed by a negative phase. The duration of each phase ranged from 20 to 80 ms. The separation of the digits from the PC lobe by cutting the tentacular nerve did not abolish the oscillations. This indicated that an oscillatory circuit exists in the tentacle. Next, we recorded fast triphasic signals from the SE. Because the mean duration of the second phase was about 3 ms, the signals may reflect the firings of olfactory neurons. These results showed that the synchronous oscillations exist in the *Limax* tentacles.

INTERNEURONS RECEIVING SENSORY INPUT FROM HINDWING MECHANORECEPTORS IN CRICKET

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In cricket (*Gryllus bimaculatus*), mechanical stimulation applied to the distal end of hindwings elicits unique escape behavior. There are numerous mechanosensory hairs (Type II) on the dorsal surface of several specific hindwing veins. Their afferent fibers project onto the metathoracic ganglion via the first branch of the second nerve root. As the first step toward understanding the functional roles of Type II hairs in the initiation and control of escape behavior, we identified those neurons that responded to mechanical stimulation of the hindwing tip using intracellular recording and staining techniques. Both local and ascending interneurons were found to show spike responses tonically after a latency of about 20msec: they increased the spike discharge frequency during the stimulation. All of them were spontaneously active when the stimulus was absent. No leg motoneuron was found to show spike or synaptic responses to the same stimulation. Although the current method of stimulation inevitably activated a small number of Type III hairs in addition to Type II hairs, our findings indicated that the Type II hair signals would not be transmitted to motoneurons unconditionally: it is suggested that the sensory signals from the Type II hairs have to make facilitatory interaction with inputs from pathways either descending or ascending to the metathoracic ganglion in order to sufficiently excite motoneurons for the escape behavior.

Three-dimensional analysis on new cone-type pineal photoreceptors and ganglion cells in river lampreys, Lampetra japonica

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In the river lamprey, Lampetra japonica, the previous studies show that the pineal organ possesses rhodopsin-immunoreactive (R-IR) and iodopsin-immunoreactive (I-IR) photoreceptor cells, and that iodopsin immunoreactivity is colocalized in the serotonin-immunoreactive (S-IR) cell which is regarded as a photoneuroendocrine cell. Some pineal cells display the immunoreactivities against visinin, a Ca^{2+}-binding protein, existed in chicken retinal cones. Most of the V-IR cells were iodopsin-immunonegative. The present study was undertaken to understand histological characteristics of the visinin-immunoreactive (V-IR) cells. The R-IR was located at the tip of many V-IR cells. The V-IR cells where R-IR is colocalized may be a new type photoreceptor in the lamprey pineal organ. The ganglion cell contacting with them is globular in shape and large in size (about 15um).

Comparative studies for photoreceptor organs, eyes and pineal organ, of sand lampreys, Lampetra reissneri, by use of histological technique

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One of the characteristic features of larval lampreys is the absence of lateral eyes, but vestigial eye bulbs are buried under the skin in the larval stage. On the other hand, the pineal organ is well developed under the transparent covering tissue. Previous histological studies for the pineal organ and the retina of the adult river lamprey, Lampetra japonica show that they have both rhodopsin-immunoreactive (R-IR) and iodopsin-immunoreactive (I-IR) cells, but also serotonin-immunoreactive (5-HT-IR) cells. The 5-HT-IR cells are modified photoreceptors and amacrine cells in the pineal organ and retina, respectively. Therefore, we investigated the localization of these cells at several larval stages. Both R-IR and I-IR cells were already found in the both organs in the smallest larva used in this study but 5-HT-IR cells were found only in the pineal organ. These results suggest that the larval pineal already developed photoreceptors comparable to adults.