Morphology and immunohistochemistry of brain of oval squid (Sepioteuthis lessoniana)

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概要 (Abstract)

Among invertebrates, cephalopods have one of the most well-organized nervous systems. Coleoid cephalopods, including squid, cuttlefish, and octopus, possess the largest and most complex brain in the invertebrates and show remarkable behavioral abilities similar to vertebrates. These remarkable behaviors are reflected in aspects of the well-developed brain. Because of these characters of cephalopod brain, I targeted them to study the involvement between complex behaviors and the brain. The oval squid, *Sepioteuthis lessoniana* is a coleoid cephalopod and form well-structured schools. From formation of school and body pattern abilities changing very quickly for interspecific and intraspecific communication, I assumed that *S. lessoniana* show social interactions. However, little is known about how this brain develops and the neuronal system involved the higher brain functions, such as learning ability or sociality or cognition, in *S. lessoniana*. To reveal the functional neural system, I focused on one of the major inhibitory neurotransmitters in the CNS, γ-aminobutyric acid (GABA). GABA is highly conserved in evolution among invertebrates, suggesting the involvement in various higher functions in the brain of *Sepia officinalis* and *Octopus vulgaris.* I first reviewed studies of cephalopod brain (Chapter Ⅰ). Based on this review, I first investigated the development of the brain of captive oval squid *Sepioteuthis lessoniana* during the post-hatching phase (Chapter Ⅱ). The effects of results of this chapter are discussed in this study in relation to the onset of squid behaviors during post-hatching. The vertical lobe, superior frontal lobe, and anterior subesophageal mass drastically increase in relative volume as the squid grows. In contrast, the middle subesophageal mass and posterior subesophageal mass did not increase in volume. The database on neurotransmitter distribution during central nervous system development of cephalopod mollusks is still scarce. In Chapter Ⅲ, I focused the distribution of neurotransmitter in the cephalopod brain and described distribution of GABAergic elements using glutamic acid decarboxylase (GAD), which is a marker protein of GABA neurons, immunoreactivity within the brain of *S.lessoniana*. GABAergic signalings were abundant and widely distributed throughout the brain of the adult *S. lessoniana*. These are detected in the lobes that are major integrative centers contributing to information processing and controlling movements in particular. In Chapter IV, I described ontogeny of GAD immunoreactivity within the brain of *S. lessoniana.* I found the remarkable change in the distribution of GABAergic elements during growth. In Chapter V, I investigated the relationship between bran morphology among 5 species of cephalopod living in Okinawajima islands. I found they have a brain adapted their own life styles. For the first time I described the brain of *S. lessoniana* focused on a neurochemical basis not only the structure. This study is pioneering work and the findings of this study will be important to understand the complex behavior of *S. lessoniana.*