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Opinion

Short Overview of Not a Short Way to Reveal the Molecular Mechanisms of Molluscan Catch Muscles Contraction

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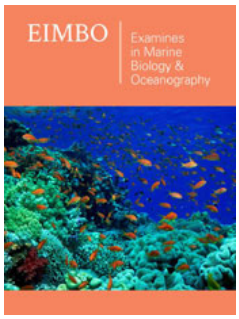

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Opinion

This article is dedicated to the memory of DSc. Nikolay S. Shelud'ko (23.09.1946-16.07.2021), the head of the Laboratory of Cellular Biophysics in the Institute of Marine Biology, Vladivostok, Russia. Studies conducted in the laboratory are aimed at identifying the molecular mechanisms of catch muscle contraction in smooth muscles of bivalve mollusks. The smooth muscles of bivalve mollusks have a specific ability to be in a state in which a high and prolonged mechanical stress is maintained at a very low level of ATP hydrolysis. In vertebrate smooth muscles, this state is known as latch. In the smooth muscles of mollusks, this condition is known as a locking tonus or catch. For many years, this specificity of the mollusk muscle contraction was associated with the presence of the thick filament protein paramyosin. Dr. Shelud'ko and his colleagues had shown, for the first time, that twitchin, a titin-like protein of catch muscle, interacts with fibrillar actin, and this interaction is regulated by twitchin phosphorylation.

According to the "twitchin-actin cross-links" hypothesis, the catch muscle tonus of bivalve molluscs is based on the formation of "twitchin-actin cross-links" between thick and thin filaments [1-3]. These concepts were refined after the discovery of a new protein of the catch molluscs muscles, myorode. Myorode, located on the surface of thick filaments along with twitchin and myosin, is an alternative splicing product of the myosin heavy chain gene, which contains the C-terminal portion of myosin and a unique N-terminal domain. The N-terminal domain is phosphorylated by myosin and twitchin light chain kinases [3-5]. There is an assumption that in the twitchin-myosin-myorode complex, myorode is a force cross-link, while twitchin plays a regulatory role. The role of twitchin in the catch-state formation has been further studied [6].

Along with these results, important achievements of the laboratory have been the development of a new method for obtaining Ca_2^{+-} regulated thin filaments from the smooth muscles of bivalve mollusks; the discovery of calponin in the thin invertebrate muscle filaments and a detailed study of its physico-chemical properties [7] and a preparative method to isolate molluscan catch muscle calponin [8]; study of the proteins of the catch muscles of the mussel Crenomytilus grayanus providing Ca_2^+ sensitivity to thin filaments, isolation of these proteins and their identification [9]. The laboratory's pioneering achievement is the development of an original method for isolating "natural", "non-Straub-type" fibrillar actin and comparison of its properties with those of skeletal and smooth muscle actins obtained by the classical method [10]. Comparative investigation of the natural mussel actin and the straub-type rabbit skeletal actin was performed and confirmed validity of the method in terms of the key properties of actin: polymerization, activation of Mg-ATPase activity of myosin, and the electron-microscopic structure of actin polymers [10]. These studies are now in progress to better understand the mechanisms that regulate the catch-muscles of bivalve molluscs.

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