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This Week's Citation Classic

Bone Q. On the function of the two types of myotomal muscle fibre in elasmobranch fish. *J. Mar. Biol. Ass. UK* **46**:321-49, 1966.
[Plymouth Laboratory, Marine Biological Association of the UK, Plymouth, England]

This paper showed that the two main muscle fibre types in the dogfish myotome differ in vascular supply, innervation, and mitochondrial content. The two fibre types are active during different patterns of swimming, and represent two independent motor systems. [The *SCI*® indicates that this paper has been cited over 185 times since 1966.]

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"When I joined the Plymouth Laboratory as a silver-staining histologist working on muscle innervation in fish, I was naturally influenced by the high calibre of the experimental physiologists working there, and so decided to begin an experimental approach to functional morphology. With a great deal of help from Eric Denton, Trevor Shaw, and Hans Meves (then a visitor working with Sir Alan Hodgkin), I learned enough to begin simple experiments on my own. Colin Pennycuick was working on dogfish muscle mechanics, and after a rather unpalatable supper of dogfish steaks boiled in a beaker over a Bunsen burner, he suggested that I look at the function of the two obvious muscle fibre types in the myotome. Although several histologists had looked at red and white muscles in fish myotomes, and had produced some curious speculations about their functions, a combination of electromyography and measurement of metabolite levels after exercise quickly led to the view that in fish the myotome is divided into two parts: one operating anaerobically during short bursts of high-speed swimming, the other aerobically during long periods of sustained cruise swimming.

"The similarity of the dogfish arrangement to that in other fish made the idea that in all fish the myotome consists of two separate motor systems an attractive one, and the proportions of the two systems in the myotomes of different fish correlated well with their swimming behaviour. Later work on teleosts, using a variety of approaches, showed, however, that the simple dichotomy of function found in dogfish was complicated because the white 'anaerobic' portion of the myotome was active at intermediate sustained swimming speeds, as well as during bursts of maximum speed swimming. A possible reason for this difference became clear when two colleagues and I, working at UBC, examined herring and carp in a respirometer, finding that herring behaved like dogfish, whilst carp resembled the teleosts previously examined; herring and dogfish share a particular pattern of muscle innervation not found in higher teleosts. The generalisation that the fish myotome is functionally divided into two parts has been accepted, and such a division is of course an obvious solution to the problem of the requirement for a very wide range of power output from the myotomes as the fish varies its swimming speed. It has recently been found that the mantle muscles jet propelling squid are similarly divided into two fibre types,[1] and the solution of a dual motor system thus appears to be a general one for animals operating over a wide speed range in a dense fluid.

"I look back on this paper with pleasure for two reasons. First, it has brought me in contact with many workers on fish muscle, some of whom it provoked to begin experimenting, and secondly because it was the first piece of work I did which made me realise the enjoyment one can get even from very simple experiments.

"I suppose that the reason this paper has been widely cited is that it explained in a simple way the striking fibre types of the fish myotome, and showed that fish are excellent experimental animals for problems of fibre type function. To my mind, however, the most interesting point about it was that it suggested that the fibre types of terrestrial animals should be looked at in terms of their evolution from the fish arrangement."

1. **Bone Q, Pulsford A & Chubb A D.** Squid mantle muscle. *J. Mar. Biol. Ass. UK* **61**:327-42, 1981.