Swimming of dolphins (experiments and modelling). [CA4]

E.V. Romanenko, Severtsov Institute of Animal Evolutionary Morphology and Ecology, RAS, Moscow.

Serious investigations of dolphins' hydrodynamics were initiated with Gray's paradox. Several hypotheses are explaining the decreasing drag of actively swimming dolphins. Besides opinions favouring such mechanisms, there is one rejecting them (Fish and Hui, 1991; Fish, 1993). However, our thorough analysis of some papers supporting the second point of view (Webb, 1975; Yates, 1983; Fish, 1993), demonstrated them to have a number of uncertainties precluding any possible conclusions as based on them: when the feathering parameter is calculated, the angle of attack is wrongly used instead of the inclination angle tangent of the flukes to the horizontal axis (Webb, Fish); the neglection of the flukes flexibility and of the effect of insufficient submergence; the thrust is assessed by using Parry's (1949) formula, which by several times overestimate the actual values (Webb, 1975) etc. Our research followed two directions: the experimentally testing Gray's hypothesis and its mathematical modelling. We measured the off-flowing velocities at three points of the dolphin's body during its active swimming and found the negative pressure gradient. Our examination of the pressure pulsations and the tangential strains in the dolphin's boundary layer enabled us to see that their values do depend on the movement regime. The critical Reynolds number grows in case of dolphins' accelerated movement, while the phase velocity of the locomotor wave grows within the animal's body. The dynamic pressure distribution and its gradient was mathematically simulated.