ENERGY STRATEGY AND LIPID ACCUMULATION IN CALANUS EUXINUS IN DEEP AND SHALLOW ZONES OF THE BLACK AND MARMARA SEAS

L. SVETLICHNY[1], A. E. KIDEYS[2] and E. HUBAREVA[1]

[1] Institute of Biology of the Southern Seas, Sevastopol, UKRAINE
[2] Institute of Marine Sciences, Middle East Technical University, Erdemli, TURKEY

ABSTRACT

Late development stages of *Calanus euxinus* inhabiting predominantly deep-sea regions of the Black Sea have an ability to accumulate large lipid reserves under conditions of low phytoplankton concentration. During spring-autumn period the main part of *Calanus* population performs dial vertical migrations from warm oxygen-saturated surface layers to cold oxygen minimum zone (OMZ) where diapausing V copepodites aggregate. Our previous experiments (Svetlichny et *al.* 2000) indicated that during morning descending to the depth of daytime habitat *C. euxinus* could decrease energy losses nearly 10-fold. Therefore, we set up a hypothesis that due to dial migrations to OMZ the Black Sea *Calanus* could use to best advantage the energy of consumed food for growth and lipid accumulation.

To test this hypothesis, we conducted comparative examination of the dynamics of prosome lenght, oil sac volume, gonad development stage and moulting patterns in *C. euxinus* from deep regions and shallow zones with high oxygen concentration even near the bottom in the Black Sea and in the Marmara Sea to which this species is carried by the Black sea current.

Our study showed that vigorous lipid accumulation in the sac took place just after the moulting of IV copepodites (with lipid content of 0.43±0.4% of body capacity) into V copepodites (CVs) with oil sac volume of 18.7±5.7%. Preparing for diapause and diapausing postmoult CVs with small gonads before sex differentiation dominated in *C. euxinus* population in deep zones of the Black Sea during all seasons. In summer and autumn deep-water females contained 7.2±4.2% of lipids. At the same time, CVs with enlarged gonads and low lipid storage (7.7±5.1%) and females with oil sac volume of 1.4±1.0 % were present at shallow stations with the depth less than 80 m. All phases of moulting cycle were found in equal proportions in non-migrating CIIs and CIIIs, but intermoults and premoults dominated in migrating CIVs and especially CVs from the Black Sea shallow water without oxygen-deficient layer. Although phytoplankton concentration was higher, premoult CVs with oil sac volume of 0.6±0.8% and mature slim females of *C. euxinus* were found in the Marmara Sea. It can be explained by the absence of effect of hypoxia that inhibits the development of copepodites during postmoulting period and allows CVs from deep water to store up lipids actively and enter diapause. On the base of energy balance model it was shown that under low phytoplankton concentration (<50 μg C/l) CVs migrating to OMZ could accumulate lipids (up to 2% of body capacity daily), in contrast with CVs from shallow zones of the Black and Marmara Seas which rapidly developed into lipid-poor females without diapause.

Thus, after the invasion to the Black Sea *C. euxinus* could optimize their life cycle strategy using the unique temperature and oxygen gradients in narrow aerobic zone.

The most intensive lipid accumulation takes place during early developmental period in CV_s, which are ready to enter diapause. Hypoxic conditions inhibit *Calanus* development and facilitate active formation of significant lipid reserves.

Due to dial vertical migrations to cold oxygen-deficient layers, the Black Sea *C. euxinus* can decrease mean daily energy expenditure and accumulate large amount of lipids at low phytoplankton concentration.