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Long-term storage lipids and developmental evolution in echinoderms

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ABSTRACT

Question: How is maternal investment of energy storage lipids linked to the evolution of development for echinoderms with larval phases?

Hypotheses: Egg nutrients sustain development to the exotrophic larval stage in echinoderms with feeding (planktotrophic) larvae and to the exotrophic juvenile stage in species with non-feeding (lecithotrophic) larvae. Whereas planktotrophic echinoderm development requires egg lipid reserves that are readily metabolized, lipids suitable for long-term energy storage might be more appropriate fuels for lecithotrophic development.

Organisms: We considered closely related asteroid and ophiuroid species that possess a range of egg sizes and represent three modes of larval development (planktotrophy, planktonic lecithotrophy, benthic lecithotrophy).

Methods: We used Iatroscan TLC-FID to quantify maternal investment of lipids on a per egg basis for each species and focused on egg content of the two dominant classes of energy storage lipid, triacylglycerol (TAG) and diacylglycerol ether (DAGE).

Results: Energetic lipids in the small eggs of echinoderms with feeding larvae are primarily TAG, a class of short-term storage lipids. DAGE, which is metabolized more slowly than TAG, dominates the large eggs of echinoderms with non-feeding larvae. Increased deposition of DAGE lipids in the eggs of planktotrophic species may facilitate the transition to lecithotrophy.

Keywords: developmental mode, diacylglycerol ether, echinoderm, evolution, Iatroscan, lipid, triacylglycerol.

INTRODUCTION

Most echinoderms have a dichotomous life history and initially develop through a larval stage before metamorphosing into a juvenile that must grow and develop further before reaching reproductive maturity (McEdward and Miner, 2001; Raff and Byrne, 2006). Echinoderm larvae may possess feeding structures and a digestive system (planktotrophy) or lack the ability to feed, being sustained by the endogenous reserves supplied in the form of egg yolk (lecithotrophy). Planktotrophic larvae exist and feed in the plankton, whereas lecithotrophic larvae

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