Tracing nutrient sources to lipid production in insects using stable isotope ($\delta^{13}C$, $\delta^{2}H$) tracers: Implications for nutritional physiology of migratory species.

Using stable isotope measurements of insect tissues to determine origin and migratory patterns is well established. However, isotopically determining nutritional origins of lipids, the primary fuel of migration, has not been as thoroughly researched. We explored isotopic links between diet and stored lipids in laboratory raised True armyworm moths *(Mythimna unipuncta)* using $\delta^{13}C$ and $\delta^{2}H$ measurements. Pupae were randomly separated into four groups (n=20) and fed isotopically distinct nectar, each consisting of a combination of high $\delta^{13}C$ (C4 sugar), or low $\delta^{13}C$ (C3 sugar) carbohydrate, with high $\delta^{2}H$ (deuterium spiked), or low $\delta^{2}H$ (tap) water. After 6 days of feeding, lipids were extracted for isotopic analysis using CF-IRMS. The carbohydrate contributed to approximately 80% of the $\delta^{13}C$ and water contributed to approximately 13% of the $\delta^{2}H$ in lipids. Lipids from C4 fed moths had higher $\delta^{13}C$ values compared to C3 fed moths (-29.1 vs -16.6 ‰, $P<0.01$). Lipids from moths fed spiked water had higher $\delta^{2}H$ values compared to moths given tap water (-187.3 vs -254.6 ‰, $P<0.01$). This direct isotopic tracing of water and carbohydrates to synthesized lipids indicates that lipids isotopically reflect dietary sources in a consistent manner. We derived isotopic discrimination factors linking environmental isotopic sources with body lipid for $\delta^{13}C$ which can be used to provide continental isoscapes for tracking sources of stored lipids.