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Relationship between $\delta^{13}C$ of shell aragonite in terrestrial snails and local climate of the East-Asian summer monsoon region

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Terrestrial snail distributes globally in various climate zones and is potential to record the information of local vegetation, and climate information (e.g. temperature and precipitation) in their structural tissues, i.e. carbonate shell and thus can play an active role in paleo-climatic and paleo-environmental reconstruction. The $\delta^{13}C$ of the snail shells is directly controlled by snails' diets and hence is indicative of the local vegetation composition, i.e. C_3 to C_4 ratio and in turn the aridity level of the ecosystem. East-Asian monsoon is a part of the Asian monsoon system and is believed to be the controlling force for paleo-environment changes in East Asia over Quaternary. East-Asian monsoon dominates the climate over much of China and the surrounding regions and is characterized by prominent seasonal changes in wind direction, precipitation and air temperature between winter (cold and dry) and summer (warm and humid). Despite the extensive studies in the last two decades, direct relations between $\delta^{13}C$ of snail shell and information of the Asian monsoon (e.g. temperature and precipitation) has not been well-established in the corridor from southeast to northeast area in China where the East-Asian monsoon plays a critical role in controlling local climate.

We measured $\delta^{13}C$ values of land snail shells from 37 sampling sites crossing the entire latitudes of China to explore the relationship between shell $\delta^{13}C$ composition and regional climate, and to further implicate the effect of East-Asian monsoon. The results show that $\delta^{13}C_{shell}$ varies from –17.75‰ to –6.65‰ in these samples, deviating negatively from the range worldwide (–15.7‰ to +1.7‰). The data also revealed negative correlations between the measured $\delta^{13}C_{shell}$ values and the mean monthly temperature (R^2=0.4376; n=37; p<<0.001) and mean monthly precipitation (R^2=0.6536; n=37; p<<0.001), as well as positive correlation with the altitude (R^2=0.3074; n=37; p<0.001) and the latitude (R^2=0.5127; n=37; p<<0.001). These relationships indicate that the $\delta^{13}C_{shell}$ record the modern climatic information and thus have the potential to be a tool in paleo-environmental reconstruction if the past $\delta^{13}C_{shell}$ is known which can be obtained through the fossil shells. We hypothesize that the environmental affect snail shell $\delta^{13}C$ by regulating and altering the local vegetation types or carbon isotopic compositions in an ecosystem, because the precipitation and temperature during snail growing season may alter the distribution pattern of vegetation. An empirical relation between the measured $\delta^{13}C_{shell}$ and the MMP and MMT is obtained as follows:

$$\delta^{13}C_{shell} = -1.215 - 0.631 \log T - 5.262 \log P \ (R=0.807;\ n=37;\ p<<0.001)$$