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Body-size changes of latest Permian brachiopods in varied palaeogeographic settings in South China and implications for controls on animal miniaturization in a highly stressed marine ecosystem

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ABSTRACT

Research on the dynamics of body-size changes in varied water depths can provide important insights into the evolution of palaeoenvironments through time. This paper attempts to investigate how the body sizes of two most commonly found chonetid brachiopod species in the uppermost Permian in South China varied with palaeo-bathymetry. The result shows that there is a broadly negative correlation between the latest Permian brachiopod body size and water depth. There is no simple singular variable that could explain this correlation because bathymetry is correlated, either linearly or nonlinearly, to food availability, redox condition and habitat temperature, as well as substrate conditions. Overall, we found that both oxygen and food availability played a more important role in controlling the differences of body sizes, and specifically several depressed factors (low food availability, anoxia, or abnormal temperature) have compounded and caused small body sizes in deeper waters during the latest Permian. We propose that the brachiopod miniaturization during the Permian-Triassic crisis in South China was collectively driven by anoxia, food restriction and high temperature.

1. Introduction

Body size is a key, intrinsic character of any organism and profoundly affects its biology and ecology (Calder, 1984; Jablonski, 1996). The study of body-size changes in space and time is important for understanding macro-evolution of organisms and ecosystems; it also provides important insights into the evolution history and dynamics of past environments. The commonly proposed controls on body-size changes include oxygen fluctuations (Savrda and Bottjer, 1986; Payne et al., 2008, 2013), food availability (Hallam, 1965; Rheault and Rice, 1996; Twitchett, 2007; He et al., 2010) and temperature changes (Hunt et al., 2010; Sheridan and Bickford, 2011; Edeline et al., 2013), as well as substrate conditions. As many of these factors vary with water depth, the relationship between body size and bathymetry is a critical aspect of studies on body-size changes (Anderson, 1971; Thiel, 1975; Peck and Harper, 2010; Shi et al., 2016). Numerous researches have been undertaken on the Permian-Triassic body-size changes of conodonts, brachiopods, siliceous sponges, ostracods or foraminifers in South China (He et al., 2007a, 2010, 2015a, 2016; Peng et al., 2007; Luo et al., 2008; Song et al., 2011; Liu et al., 2013; Chu et al., 2016; Zhang et al., 2016). Most of these studies have focused on the patterns of body-size changes of individual taxa across time and their possible underlying control mechanisms, and a few (e.g., He et al., 2010; Liu et al., 2013) have addressed the relationship between size changes in relation to primary productivity and redox palaeoproxies in the context of palaeobathymetry. Most recently, based on a global dataset of Changhsingian brachiopod orders, Shi et al. (2016) examined the relationship of Changhsingian brachiopod body-size changes in relation to the onshore-offshore-basin gradient.

The present paper aims to investigate body-size changes of latest Permian brachiopods across different bathymetrically controlled palaeoenvironmental settings within the South China basin. For this purpose, we chose two most commonly found Changhsingian chonetid brachiopod species, *Tethyochonetes pigmaea* and *Tethyochonetes quadrata*, from six different sections, which together constituted an approximately-defined basinwide bathymetric gradient spanning the

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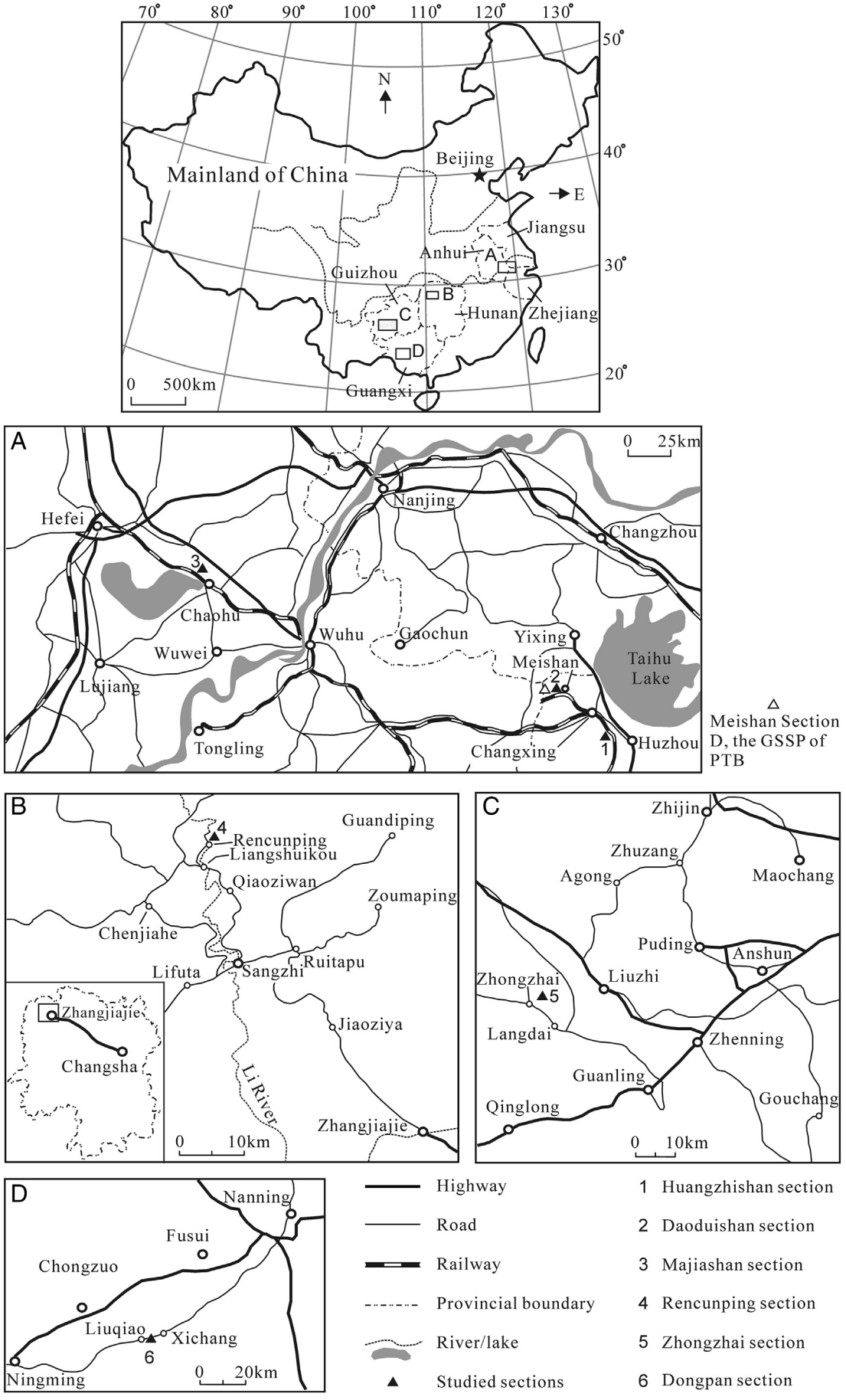

Fig. 1. Locality map of the studied sections.

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