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Letter to the Editor

Early to mid-Holocene lake high-stand sediments at Lake Donggi Cona, northeastern Tibetan Plateau, China — Comment to the paper published by Dietze et al., Quaternary Research 79 (2013), 325-336

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The motivation of this letter is a better appreciation of the problematic differentiation between wetland and lake sediments fundamental in many palaeoclimate studies. Dietze et al. (2013) recently reported on the formation and age of deposits in the vicinity of Lake Donggi Cona regarded as lake high-stand sediments. They investigated sediments exposed as terraces at nine section sites near the lake. Detailed lithological descriptions in the field were combined with grain-size analysis of sediment samples and sophisticated statistical assessments of the grain-size data using end-member modelling analysis, and radiocarbon dating. Fine-grained carbonate-rich sediments of their Facies I were interpreted as lake sediments accumulated "below the wave-dominated zone". Radiocarbon age data for the sediments of the sections were used for the reconstruction of higher lake levels of Donggi Cona in the early and mid-Holocene and the inference of low levels after ~4700 cal yr BP (Dietze et al., 2013).

Analysis of ostracod (micro-crustacean) shells from one of the section sites investigated by Dietze et al. (2013) was recently performed in the frame of the master's thesis by Rong Fan (2014). A total of twelve species were identified from the sediments of section P14 (Fig. 1). Taxa which are commonly found in lakes and ponds of the region and elsewhere have generally low abundances and occur more frequently in the upper part of section P14 (Meisch, 2000; Mischke et al., 2007; Fig. 1). Species inhabiting small permanent or seasonal ponds predominate together with the typical stream-dwelling *Ilyocypris sebeiensis* which also occurs in small stagnant water bodies and larger lakes (Meisch, 2000; Mischke et al., 2010a, 2014). The very large species *Tonnacypris* cf. *lutaria* and *Trajancypris clavata* prefer small temporary ponds (Meisch, 2000; Figs. 1 and 2). The typical inhabitants of the modern shallow waters of Lake Donggi Cona *Fabaeformiscandona danielopoli*, *Eucypris afghanistanensis*, *Pseudocandona compressa*-group, *Ilyocypris echinata* and *Leucocythere dorsotuberosa* were not recorded from the

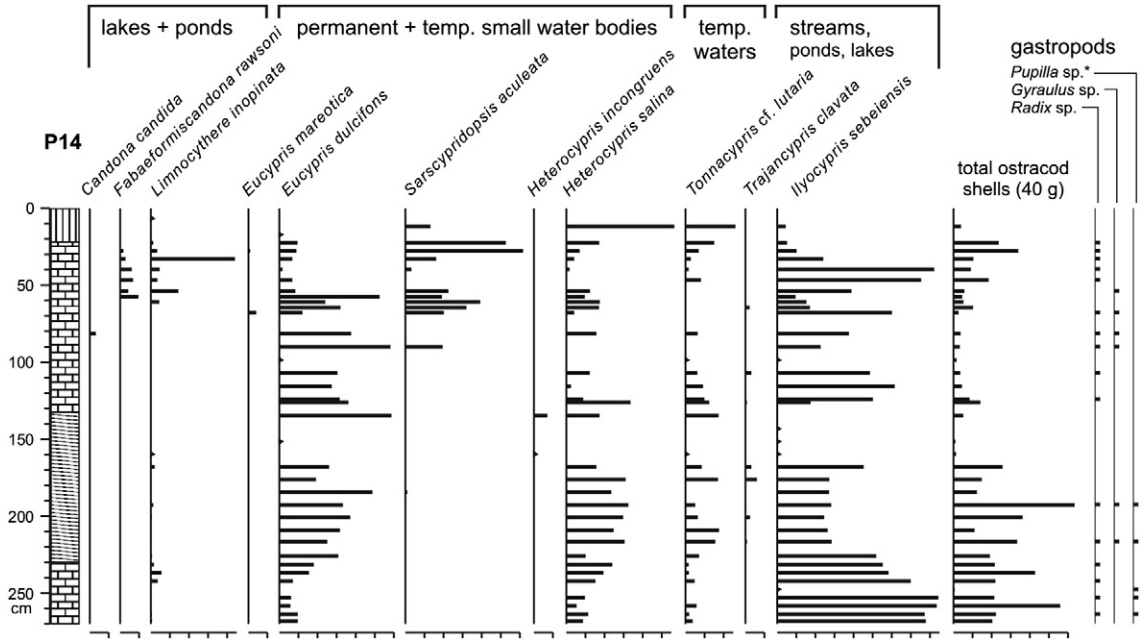

Figure 1. Relative species abundance data of ostracods and presence–absence data of aquatic and terrestrial (*) gastropods from the section P14 at Lake Donggi Cona (ticks for ostracod species data represent 10% and for total shells data 100 shells). Presence of ostracod shells is indicated by triangles instead of bars for samples containing less than 20 shells in total. A single shell of *Leucocythere dorsotuberosa* was recorded in section P14 at 28 cm (not shown). Lithology simplified following Dietze et al. (2013): fine-grained platy sediments regarded as lake sediments at the base and between 131 and 22 cm, low-energy fluvial/alluvial sediments in between, and soil on top.

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sediments of P14 apart from a single shell of *L. dorsotuberosa* (Mischke et al., 2010a). The ostracod assemblage from P14 is also not comparable with those of a sediment core from Lake Donggi Cona covering the last 19 ka due to the absence of *Leucocythere* sp. and the rarity of *Fabaeformiscandona rawsoni* and *L. dorsotuberosa* in the sediments of P14 (Mischke et al., 2010b).

Thus, the ostracods from the P14 section indicate that the sediments were accumulated in a wetland setting rather than a lake environment. Small temporary and permanent ponds, springs and streams probably existed during the formation of the P14 sediments on the alluvial plain of the tributary which runs close to P14 today. Further evidence for a mixed setting of dry and wet habitats at the P14 site instead of the expanded Lake Donggi Cona comes from shells of the land snail *Pupilla* sp. recorded in the lower part of the section (Figs. 1 and 2).

The new ostracod and gastropod data from section P14 show that lake and wetland sediments cannot be always sufficiently differentiated using detailed sedimentological field and laboratory analyses. Additional evidence is required to convincingly identify lake sediments exposed above modern lakes and use these as geological archives of past hydrological and climate conditions. Preserved organism remains provide reliable proxies of past depositional settings especially if the distribution of the species in modern water bodies of a region is relatively well known (Mischke et al., 2007, Li et al., 2010, Mischke et al., 2010a, 2014; Zhang et al., 2013). In addition, well preserved shorelines and their deposits can serve as precise lake level indicators (Madsen et al., 2014). "Paleo-shorelines and ancient onshore terraces that contain lake sediments" were mentioned by Dietze et al. (2013) but detailed evidence for preserved shorelines above the level of the P14 section has not been presented so far.

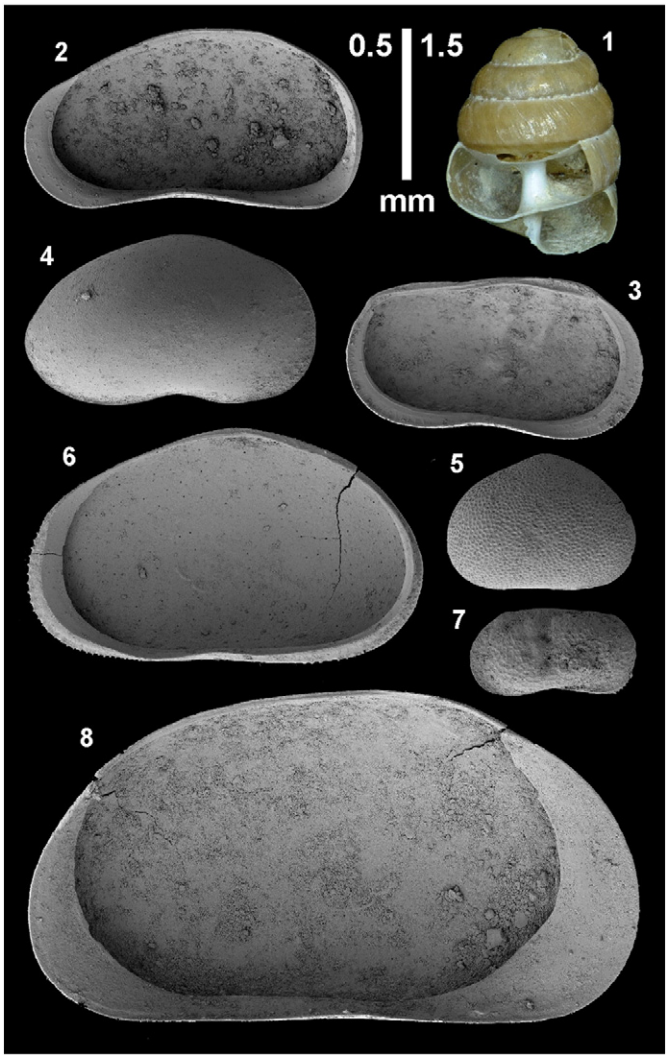

Figure 2. Ostracods and gastropods recorded at P14: 1 *Pupilla* sp. (apertural view); 2 *Fabaeformiscandona rawsoni* right shell (RS) internal view (iv); 3 *Ilyocypris sebeiensis* left shell (LS) iv; 4 *Eucypris dulcifons* RS external view (ev); 5 *Sarscypridopsis aculeata* RS ev; 6 *Heterocypris salina* RS iv; 7 *Limnocythere inopinata* LS ev; 8 *Tonnacypris* cf. *lutaria* LS iv. Scale for *Pupilla* is 1.5 mm. All specimens housed in the Institute of Geological Sciences of Freie Universität Berlin, Germany.

The new data for P14 emphasize once more that lake sediments and wetland deposits are commonly confused (Quade and Pratt, 1989, Rech et al., 2003; Quade et al., 2008; Pigati et al., 2009, 2014). Quade et al. (1998) and Pigati et al. (2014) showed that the so-called "black mats" are common components of the deposits formed in wetlands. Interestingly, a "black, organic-rich layer in P14" was recorded by Dietze et al. (2013) and ascribed to possibly "represent short-term sapropel deposition". Accordingly, we assume that these sediments represent organic matter preservation in a wetland setting and were probably formed in a pond.

The careful differentiation between wetland and lake deposits has important implications for the inferences of past depositional processes and the regional hydrological and climate conditions. Wetlands and other groundwater-fed settings require much less precipitation than lakes in arid regions and the discovery of ancient wetland deposits does not necessarily imply that climate was significantly wetter (Pigati et al., 2014).

We do not argue that wetlands in the Donggi Cona catchment are not somehow related to the contemporaneous lake level which controls backward erosion and deposition of streams as the local base level. However, spring-fed wetlands at the foot of slopes and groundwater or stream-fed wetlands on alluvial plains may be significantly higher above the lake level depending on local groundwater conditions, the down-cutting and lateral erosion of streams following drops in lake level and the related local geomorphology and geology of individual valleys. Thus, cautious interpretations of sedimentological data and the selection of appropriate lines of evidence are required to determine past depositional settings and develop sound palaeoenvironmental and palaeoclimate inferences.

The original article by Dietze et al. (2013), when combined with this letter and their response to it, hopefully shows that sedimentological analysis alone are often not sufficient to discriminate between sediments of lakes and those of small stagnant or slowly flowing water bodies. Remains of organisms are useful indicators of specific depositional settings, and sedimentological analyses supplemented by microfossil analysis have the potential to result in convincing reconstructions of sediment deposition modes. We hope that this dialogue has taken the academic community closer to that goal.

Acknowledgments

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