地理学报(英文版) 2002年第12卷第4期

The ostracod assemblages and their environmental significance in the Chen Co area, southern Tibet in recent 1400 years

作者: ZHU Liping LI Yuanfang

The CC1 core, with a length of 216 cm, was drilled in the west part of the Chen Co (Lake) in southern Tibet Plateau. The 210Pb and 137Cs measurement indicated that it was a consecutive sedimentary sequence since ca. 1400 years. The os tracoda and their assemblages under the level of 1 cm samples´ cutting interval were finished for this core to revea l the past environmental changes in the lake area. A total of 15 species of ostracods belonging to 7 genera in the co re sediments had been identified. According to the ostracod distributions, abundances and preservations in the core, seven ostracod assemblages had been distinguished. The ostracod assemblages and their ecological features, together w ith the sediments dating decision were used to infer the past ca. 1400 years environmental changes of the Chen Co env ironmental evolutions in three stages, which had responded to the Medieval Ages Warm-period (MAW), the Little Ice Ag e (LIA) and modern warm period. The results show that the changes of the Chen Co environment had been mainly influenc ed by the climatic variations. The trend of the lake level fluctuations had been accorded with that of climatic varia tion during the past 1400 years.

ZHU Liping, LI Yuanfang, LI Bingyuan (Inst. of Geographic Sciences and Natural Resources Research, CAS, Beijing 10010 1, China) 1 Introduction The global change studies move so fast that the environmental changes in recent years are ke pt being focused. It is also the same case in China while more scientists have made and are making progress on recons tructing the past environmental sequences based upon the methods such as historical documents, archaeological materia ls, tree-ring, ice cores and lacustrine deposits (Li and Zhu, 2001; Shi et al., 1999; Yao, 1997; Yao et al., 1996; Zh ang, 1995; Zhang et al., 1999; Zhu, 1973). However, ostracoda, as one of the important micro-creature phyla, is well studied on elucidating the paleo-environment of the Quaternary period. This paper deals with the assemblages of the o stracod in the CC1 core, southern Tibet and their paleo-biological information. Thus, the lake environmental evolutio n in recent ca. 1,400 years was discussed. The results showed that the ostracoda in this sedimentary core had indicat ed the environmental changes during the analyzing period, and was an effective index to determine the paleo-lake envi ronment. The lake, namely Chen Co (28o53´-58´N, 90o28´-35´E), is situated in the intermountainous basin of the Himala yas, which belongs to the precinct of the Langkazi County, the Tibet Autonomous Region. The lake level is as high as 4,438 m asl with a water area of nearly 40 km2. The lake is mainly supplied with the river, namely Kaluxiongqu, whic h is formed by the glacier melting water (Wang and Dou, 1998). The lake chemistry has a little change from the water salinity of 1.05 g/L and the pH value of 8.75 in AD 1983-1984 to those of 1.2 g/L and 9.1 in AD 1999 the year for thi s fieldwork. Physiographically, the scope of the study site belongs to the semi-arid area of the Plateau temperate mo nsoon zone. The annual mean temperature is 2.4 oC while the annual mean precipitation is 370 mm obtained at the weath er station of Langkazi County. The soil is a kind of calcium umber with much more lime contents and salts (ISST, 198 4; 1988). The research materials were taken from a lake core, namely CC1 core that was drilled out with the PISTON sa mpler in the west part of the Chen Co. The sampling site (28o56´21´´N, 90o29´12´´E) was 8 m deep and the core length was as long as 216 cm (Figure 1). The sediment core was black gray in color before it was dried. Although the fine gr ains were the main composition of this core, some difference was still easily distinguished as follows: above 54 cm, silt-clay alternated with clay with a thin layer of fine sand at 53-54 cm section; 54-77 cm, mainly silt-clay, but si lt mixed with a few plant debris appeared in the section of 63-68 cm; 77-106 cm, loose clay-silt with few coarse san d and fine gravel with a diameter of 3-7 mm in the section of 95-100 cm; 106-193 cm, still silt-clay, but also few fi ne gravel at 134-135 cm section; and below 193 cm, again clay-silt with more plant debris in the section of 208-211 cm. 2 Features of the ostracods The total 216 samples were taken out from the CC1 core at an interval of 1 cm each. The amount of 5 g in dry weight was separated from each sample for water soaking, washing and sieving. The processed samples were put under the microscope for visibly picking out ostracod shells. Some 21,100 shell valves in total were picked out. These ostracods belonged to 7 genera and 15 species, e.g. Candona candida (Muller), C. neglecta Sars., C. gyirongensis Huang, C. xizangensis Huang, Cytherissa lacustris (Sars), Ilyocypris biplicata (Koch), I. cf. dunschanensis Mandelstam, Leucocythere mirabilis Kaufmann, L. parasculpta Huang, L. tropis Huang, L. dorsotuberosa Huang, L. postilirata Pang, Limnocythere luculenta Livental, Leucocytherella sinensis Huang and Paracypricercus angulata Yang. The ostracods were relatively abundant in the CC1 core sediments, among them Leucocytherella sinensis possessed the highest abundance with a ratio of 70% in the shells´ total amount. This species topped in quantity in each layer so that its abundance determined the total ostracod abundance during different periods. This feature was well showed in the ostracod abundance curves due to the peak and valley values occurring at the same time (Figure 2). The quantities of Ilyocypris biplicata, Leucocythere tropis and Paracyprcercus angulata were also higher than the other species. The latter ones appeared the asymmetric distribution among the samples. According to the species composition and quantities of the ostracods, seven ostracod assemblages were sorted out as follows: Assemblage 1 (below the depth of 187 cm): possessed relatively abundant quantities and contained five genera and seven species, e.g. Leucocytherella sinensis, Ilyocypris biplicata, Leucocythere mirabilis, L. tropis, L. dorsotuberosa, Limnocythere luculenta and Paracypricercus angulata. Leucocytherella sinensis was dominant followed by Ilyocypris biplicata. Assemblage 2 (the section of 187-147 cm): was very simple in the composition of genera and species and few in quantity. Leucocytherella sinensis appeared frequently but few in quantity while Leucocythere mirabilis and Ilyocypris biplicata occasionally emerged out (Figure 3). The individual Paracypricercus angulata and Leucocythere tropis were found in the section 153-154 cm. Assemblage 3 (the section of 147-126 cm): possessed more genera and species as well as quantities than assemblage 1. The seven genera and nine species in this assemblage were: Leucocytherella sinensis, Ilyocypris biplicata, Leucocythere mirabilis, L. tropis, Limnocythere luculenta, Paracypricercus angulata, Candona candida, C. gyirongensis and Cytherissa lacustris. The last one occasionally possessed the high ratio in the assemblage. Assemblage 4 (the sections of 126-108 cm and 46-34 cm): was composed of only one species, i.e., Leucocytherella sinensis with fewer in quantity. The remnant shells were so thin and dilapidated that they disappeared some time. Assemblage 5 (the sections of 108-78 cm and 34-18 cm): was the one with more abundant genera and species as well as more quantities than that of the former four assemblages. For examples, the ostracod shell valves were as more as 1500/5g and nearly 2000/5g in the samples of 83-82 cm and 20-19 cm, respectively. These shells belonged to 11-12 species including Candona neglecta, C. xizangensis and Leucocythere dorsotuberosa and the other 9 species in assemblage 3. In addition, different colors such as white, light rust-yellow and black appeared on the shells. Assemblage 6 (the section of 78-46 cm): consisted of fewer species, normally no more than 5. The dominant one in quantity was still Leucocytherella sinensis. The other species were not only fewer in quantity but also in sharp fluctuations. No ostracod shell was found in the sections of 74-73 cm, 72-71 cm and 60-55 cm. Assemblage 7 (the section 18-0 cm): possessed high abundance and rich species. Except Candona neglecta, the other 14 species found from this core were observable in this assemblage. Leucocytherella sinensis, with the ratio of as high as 68-94%, consecutively appeared in all the sections together with Leucocythere tropis. Ilyocyporis biplicata, Paracypricercus angulata and Limnocythere luculenta were also frequently observable species in most samples of this section while Leucocythere mirabilis and Cytherissa lacustris could be found in the lower part of this section. 3 Ecological environmental analyses of the ostracods Almost all of the preserved ostracods in the CC1 core were present species that still lived in the water agent of the Tibetan Plateau and even the whole Northern Hemisphere. However, these ostracods were less ecologically recognized, especially in the features of their limnology compared with some other genera of the microfossils (Carbonel et al., 1988). According to the existing data, Cytherissa lacustris was most suitable to live in the fine silt sediments with poorly nutrient environment. For example, it lived in the deep or relatively deeper water zones in the Lake Mondsee of Austria. Leucocythere mirabilis was also one of the main species in the two zones of this lake, but Candona candida frequently appeared in the shallow water zone near the lakeshores (Carbonel et al., 1988; Danielopol et al., 1993). Other data showed that Candona neglecta generally lived in the shallow water of the lakes. Bhatia et al. had reported that this species appeared in the clear and cold fresh water and alkaline lakes with plenty of plants (Bhatia et al., 1985). The other species were just discovered and named from the lake sediments and some Quaternary deposits in Tibet, but their ecological knowledge was less studied (Huang, 1984; Huang et al., 1985; Peng et al., 1985). Therefore, for seeking more proofs to infer the paleo-environment of the Chen Co, we also selected 11 samples from the water-sediments boundary at different water depth s (1-20 m deep) to do the ostracod analyses. The living ostracod body analyses had been done to the samples at the water depths of 1.5 m, 4.5 m and 8.3 m. The results suggested that ostracod shells existed in each sample while the living ones were also found in the corresponded samples. However, the features of these ostracod at different depths possessed quite difference, upon which 3 ostracod fauna groups were partitioned out as the shore group, the shallow-water group and the deep-water group. The shore group appeared in the water depth ranging from 0 to 2 m with fewer genera and species and less in quantity due to the unstable sedimentary environment. The shallow water group distributed from 2 m to 8 m deep in water with developed ostracod. Leucocytherella sinensis was dominant while the sub-dominant species, such as Ilyocypris biplicata and Paracypricercus angulata, were obviously more in quantity than the other two groups. The deep-water group lived in water below 8 m deep and was still dominated by Leucocytherella sinensi. The sub-dominant species were the same as that of the shallow water group but fewer in quantity. This group was characterized by the simultaneous occurrence of Cytherissa lacustris and Leucocythere mirabilis. This result also accorded with the determination of Carbonel et al. (1988). However, Leucocytherella sinensis could be found to be distributed at all levels of the water depth so that it was a rapidly developed and mature species with highly propagating ability. Ecologically, temperature is one of the important factors to influence the ostracod distribution. Cytherissa lacustris, Candona neglecta, C. candida and Leucocythere mirabilis in the CC1 core were usually regarded as cold water species, eventually narrow temperature cold water species (Huang, 1984; Wang et al., 1990). The local species, such as Candona xizangenisis and Leucocytherella sinensis in Tibet also belonged to the cold-tolerable genera (Peng, 1997). However, these species were that kind of cold water ones with much eurytopicity and might tolerate the bigger changes of the temperature. Thus, it is difficult to use them as proof to elucidate the water temperature fluctuations during recent thousand years. But, no matter what adaptation the creatures had, they still behaved best in development and most speedy in reflection under the favorable temperature conditions (Hao, 1978). So when the climate was in the warm period, the ostracoda developed well with their individual bodies and reached higher abundance in quantity (Gasse et al., 1991). Water agent is an extremely complicated ecological system with much more interactions among the biological, physical, chemical factors etc. Any change of these factors would necessarily affect the ostracoda which lived in this ecological system and resulted in the changes of the distribution, development and shells´ preservation of the ostracoda. Thus, various kinds of information obtained from integrated analyses of the sedimentary profiles are needed to infer the paleo-environment in addition to the ostracod ecology. 4 The paleo-environmental analyses The dating of the CC1 core was determined by the sedimentary rate derived from the 210Pb measurement and the absolute time marks derived from the 137Cs measurement. An average sed-imentary rate of 0.16 cm/a was obtained by the comparison and calibration between the two methods in the top 30 cm section (Zhu et al., 2001). However, as 210Pb attenuation activity is the function of sedimentary rate and in site sediments density while the latter is dominated by particle size, therefore the sedimentary rates are correlated with their particle sizes. Here an EOF regression method was applied to calculate the relative coefficient (r=0.62) between sedimentary rates and sediments medium sizes. A depth-age model was built to infer out that this 216-cm long core was consecutively formed in recent ca. 1400 years (ca. AD 593-1998). Thus, the paleo-environmental changes in the Chen Co area were revealed in terms of the features of the ostracod genera and species, abundance, temporally evolution and shells´ preservation. 4.1 The deep-water lake period from the end of the 6th century to the 1370s The section below 126 cm formed between the end of the 6th century and the 1240s, in which the ostracod assemblages 1, 2 and 3 appeared. The eurytopicable species Leucocytherella sinensis was dominant while Leucocythere mirabilis and Cytherissa lacustris were also available. The combination of the ostracoda in this period was similar to that of the deep-water group. However, the sub-level fluctuations of environmental changes reflected by the ostracod assemblages still existed. The much more genera and species as well as the higher abundance in assemblages 1 and 3 indicated a favorable environment for ostracod development. In addition, Ilyocypris biplicata, which implied the running water environment, increased during the periods of ca. AD 708-843 and AD 1199-1213. It suggested that the imported water was increasing during those periods. The section of 126-108 cm was corresponded to the period of ca. AD 1244-1374, in which there was only the assemblage 4 with the single species such as Leucocytherella sinensis. The quantities also sharply descended. Although these facts suggested a deteriorative environment for the ostracod development, the other factor such as sedimentary structure still possessed the impacts. Carbonel (1988), according to his studies of the ostracod distribution in the Arcachon Basin of France, thought that the fine grains (<63 ?滋m) dominated the species development to the ostracoda living in the top sediments of the Eyre delta. In this study, the grain sizes of this section were much less than 63 ?滋m that implied a deep-water environment. The decreasing of oxygen in the mud layer under deep water was a potential reason for the undeveloped ostracod. 4.2 The shallow-water period from the 1370s to the 1890s 4.3 The transitional period from deep-water to shallow water during the end o

f the 19th century to present 5 Comparison between the ostracod records and other data Because the lake Chen Co was a closed one and mainly supplied with the river water, its physical situations such as water temperature and depth were directly affected by the source and fluxes of the importing rivers, of which the variations were closely related to the climatic factors. Upon the information derived form the ostracod assemblages of the CC1 core, the lake level´s fluctuation and the lake water volume´s variation frequently occurred in the recent ca. 1400 years, e.g. the lake intensively expanded during the periods of ca. AD 708-780, 1199-1213, 1731-1803 and 1929-1935 while the lake shrank during the periods of ca. AD 1454-1525, 1645-1670, 1803-1891 and since the mid-1960s. In fact, it was the change of the lake water depth that was reflected by the ostracod assemblages. These changes were actually influenced by the temperature and precipitation when the supplying source was mainly from the glacier-melting water. In the semi-arid areas of China, the correlations between temperatures and humidity indices had ever been studied. The result was that the precipitation increased during the warm period and decreased during the cold period due to the monsoons´ enhancing and weakening (Gong and Hameed, 1993). This feature was also reflected with the Guliya ice core records in the Tibetan areas (Yao et al., 1995). As the Chen Co was just situated in the temperate monsoon semi-arid zone, the lake area was possibly under the control of this kind of climatic features. Therefore the warm periods of this area were inferred to be corresponded to the deep-water (the lake´s expanding) period from the end of the 6th century to the 1370s, especially the lake´s intensively expanded periods of ca. AD 708-780 and ca. AD 1199-1213. Globally, ca. AD 600-1280 were climatically favorable period while the Little Ice Age (LIA) started from ca. AD 1300 (Xu, 1998). In China, the obtained data showed that two warm periods occurred in recent 2000 years, e.g. the Sui Dynasty-the Tang Dynasty (ca. AD 589-907) and the Five Dynasties-the early Yuan Dynasty (ca. the early 10th century-the late 13th century (Zhang, 1996). These warm events were all reflected in the ostracod records of this area. The ostracod assemblages indicated that the lake was in the shallow situation during the period of ca. AD 1370s-1890s, in which ca. AD 1454-1525, 1645-1670 and 1803-1891 were environmentally much worse for the ostracod´s living. These events were roughly simultaneous with that of cold and less precipitation recorded by the Guliya ice core (AD 1451-1500, 1601-1690 and 1791-1880) (Shi et al., 1998; Yao et al., 1995; Yao et al., 1996). However, the converse process that, the lake water increased and induced the CaCO3 dissolved in ca. AD 1731-1803, was still coincided with the ice core records. It also suggested that the temperature started to rise again at the beginning of the 18th century while the temperature and precipitation increased through the whole century. The recent warm period in the Tibetan area started from the ending of the LIA, during which the obviously warm stages were the 1940s and since the 1970s. However, the dry climate fell in this area since the early 1980s (Lin, 1993; Lin and Chen, 1993). From the Guliya ice core records, the latest warm period was AD 1880-1990 (Yao et al., 1996) during which the higher diversity and abundance of the ostracods were just the results of the warm climate. However, there were still some changes of the dominant species. For examples, the climatic change from warm/humid to warm/dry in the mid-1960s had resulted in the appearance and disappearance of the deep-water species. Therefore, the lake level fluctuations recorded by the ostracods of the CC1 core were corresponded to the alternations of warm/humid and warm/dry climate. This variation was also as same as that of the lakes in the northwest Tibet (Li et al., 2001; Zhu et al., 2001b).

关键词： the Chen Co; recent 1400 years; environmental changes; ostracoda

