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Natural and anthropogenic rapid changes in the Kara-Bogaz Gol over the last two centuries reconstructed from palynological analyses and a comparison to instrumental records

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Abstract

Palynological analyses (pollen and dinocysts) of a sediment core taken in the Kara-Bogaz Gol have been used to reconstruct rapid and catastrophic environmental changes over the last two centuries (chronology based on ^{210}Pb). A natural cyclicity (65 years) of water level changes in the Caspian Sea (CS) and in the Kara-Bogaz Gol (KBG) and anthropogenic factors (building of a dam separating the CS and the KBG waters) combine to induce rapid changes in water levels of the KBG, in the salinity of its waters and in vegetation cover of its surroundings. The impact of low water levels on the dinocysts is marked by a lower diversity and the survival of two species that are typical of the KBG, the Caspian Sea species present in the KBG having disappeared. During periods of higher water levels (AD 1871–1878), the lake is surrounded by a steppe-like vegetation dominated by *Artemisia*; whereas during periods of low water levels (AD 1878–1913 and AD 1955–1998), the emerged shore are colonised by Chenopodiaceae. The period of AD 1913–1955 corresponding to decreasing water levels has an extremely low pollen concentration and a maximum of reworking of arboreal taxa. During the last low-level period, humans responded by abandoning the shores of the bay. What happened to the KBG can be used as an example of what may happen in the future for the Aral Sea.

A problem of reworking of Tertiary dinocysts into modern deposits has been detected owing to the knowledge of the modern dinoflagellate assemblages recently made available through a water survey. A comparison to modern surface pollen samples from Central Asia (Anzali, Caspian Sea south and central basins, Aral Sea, Lake Balkhash, Lake Issyk-Kul and the Chinese Tien-Shan range) allows us to establish the potential reworking of at least five arboreal pollen taxa possibly by run-off and dust storms.

1. Introduction

The level of the Caspian Sea has fluctuated greatly in the last century with a drop of 3.25 m from AD 1900 to 1977 and a rise of >2 m from AD 1977 to 1994 (Rodionov, 1994). The causes until now are still poorly understood but seem to have a cyclicity (Kroonenberg et al., 2000; Giralt et al., 2003). The Kara-Bogaz Gol (KBG or sometimes referred to as the bay—zaliv, in Russian literature), literally the black throat lake, is connected by a narrow strait (proliv) to the east of the Caspian Sea (CS or the sea) (Fig. 1a). Its water level closely follows that of the CS; but, due to high evaporation rates, its level remains lower. In addition, the level of the KBG has artificially been changed by a dam built in 1980, which led to an unintentional catastrophic drying out. The KBG has therefore undergone several rapid level changes over the last 200 years owing to both human and natural causes (see Frolov, 1999; Giralt et al., 2003 for further details).

It is a challenge to reconstruct climatic changes as well as vegetation changes in semi-desertic and desertic areas owing to the usual lack of suitable sedimentary archives (continuous and anoxic). It is believed that the sedimentary infill of the last water body in the KBG is about 30 m thick, covering the last 10,000 years (Lepeshevkov et al., 1981). Hardly any palynological work is known from its infill, possibly none in non-Russian language literature. In

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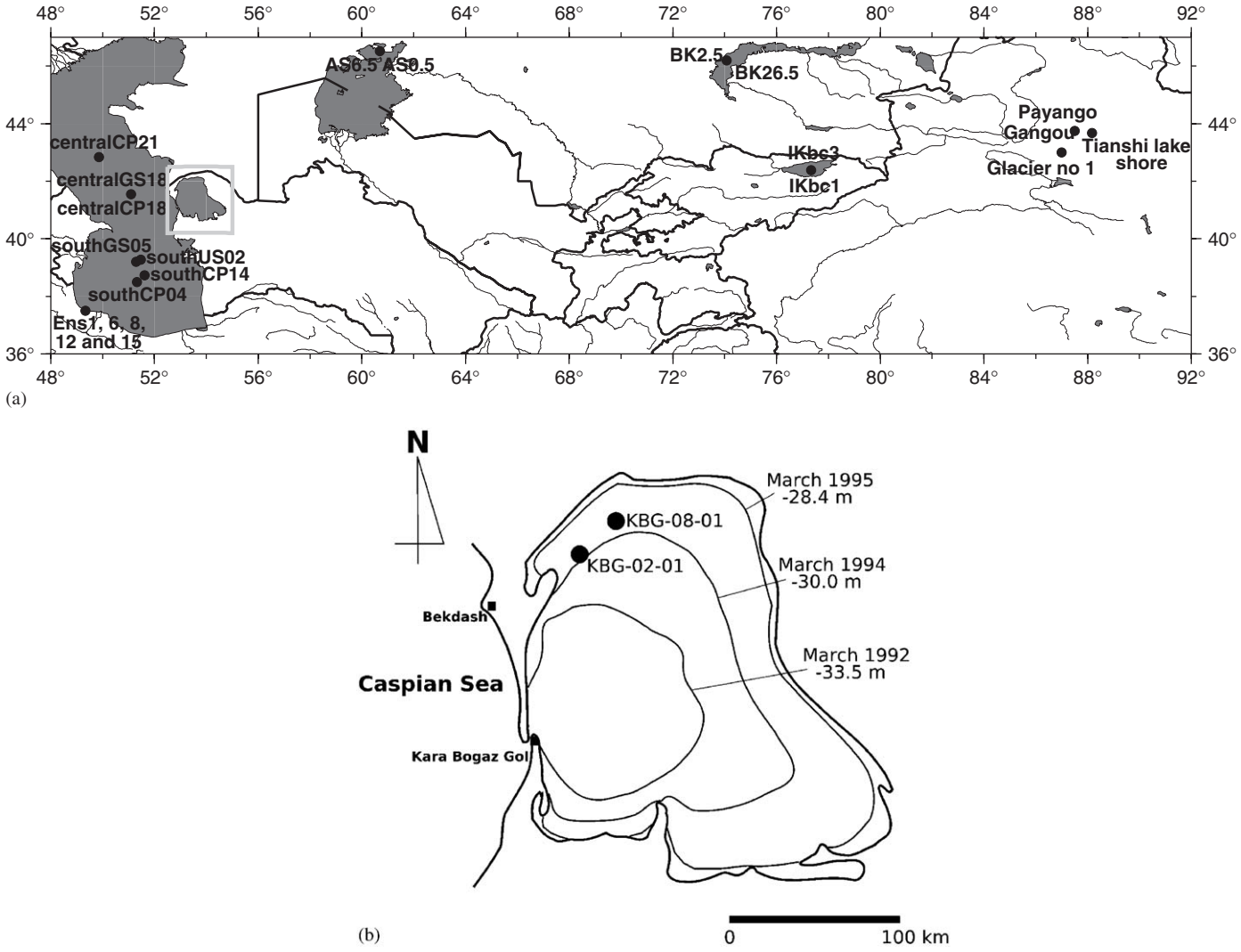

Fig. 1. (a) Location map of the pollen surface samples. Abbreviations of names according to Table 4. The frame around the KBG relates to Fig. 1b. (b) Map of the Kara-Bogaz-Gol with core location showing the dynamics of the filling of the KBG after the restoration of the outflow of seawater from Caspian Sea (adapted from Babaev, 1998).

addition, the environmental variability of the desertic and semi-desertic region around the CS still remains extremely poorly known. Holocene palynological analyses from the region around the KBG in the desertic and semi-desertic environments are very scarce. One Holocene pollen diagram by Z. Aleshinskaya in the central basin of the Aral Sea (Tarasov et al., 1996) is available in the Global Pollen database. This study is the only one east of the CS and west of the high-altitudinal lake of Issyk-Kul (Giralt et al., 2002, 2004), i.e. in a c. 2000 km W–E transect. A short report on a sediment core taken near the shore of the KBG in the late 1990s provides an idea of the hydrological changes during the Holocene reconstructed from the lithology, stable isotopes of C and O and geochemistry amongst others (Ferronskii et al., 2003). During a first phase dated from 9.2 to 8.5 ka, the KBG receives water from Rivers Karyn-Zaryk and Kaidak in the north; but the KBG did not outflow to the CS. During a second phase (8.5–2.2 ka), an intense river runoff into the KBG and a discharge in the central basin of the CS have been determined. From 2.2 ka to the present, the CS flows into the KBG.

In 1999, eight sediment cores (1 m long) were taken from the water surface in the N–W of the KBG (Giralt et al., 2003). Analysis of one the cores for its content in organic-walled palynomorphs (pollen, spores, dinoflagellate cysts and other microfossils) giving a history over the last two centuries (i.e. further back in time than the available instrumental record) is the central part of this paper. This investigation aims at providing information on changes of vegetation types, dinoflagellate cyst (or dinocyst) assemblages and in the physico-chemical conditions of the surface water mass. Instrumental data on water levels and precipitation have been compiled and compared to proxy data. Modern sample data (mosses, flood mud and core tops) from central Asia have been added in order to understand better the origin of pollen spectra of the KBG record, especially the arboreal pollen (AP). They are from