Palynological investigation of a Holocene profile section from the Palaeo-Gaxun-Nur-Basin

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Abstract Palynological investigations on lacustrine sediment samples revealed a general dominance of open Artemisia-Chenopodiaceae vegetation in the Palaeo-Gaxun-Nur-Basin (Inner Mongolia) between 5250 and 3500 cal. aBP. Riverside woods (Hippophaë, Populus) developed between 3500–3250 cal. aBP and reflect moister growing conditions. During the following moist-dry transition pronounced cooling occurred around 3000 cal. aBP, in upper elevations favouring the spread of montane woods (Picea, Betula). Aridity strongly increased from 2900 to 2700 cal. aBP. The recorded vegetational and environmental changes after 3500 cal. aBP can be correlated with glacier advances in the mountains and with a humid phase in the Tengger Shamo followed by desertification.

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In the Late-Glacial and early to middle Holocene the Palaeo-Gaxun-Nur-Basin of northern China (Badain Jaran Shamo, Inner Mongolia, NW-China) was filled with a lake of considerable extent. During the last glacial the surface area of the lake, including swamps, reached more than 32000 km², in striking contrast to the limited present-day water-bodies of Gaxun-Nur and Sogo-Nur. In 1998 material from the Eastern Juyanze basin, southeast of the large Gaxun-Nur-Basin, was collected for investigations on the development of the palaeolake and its environment (Fig. 1).

Sedimentological data and records of limnic organisms allow reconstruction of changes in past climate conditions and their impact on the catchment area and the basin ecosystem. In addition, the analysis of pollen and spores derived from terrestrial vegetation renders valuable clues for evaluation of regional plant growth conditions and palaeoclimate variations. The palynological studies, including the analysis of further microfossils such as plant tissue fragments, algae, invertebrate remains and fungal spores, aimed at reconstruction of the vegetation development and evaluation of climate changes from 5200 to 2700 cal. aBP. During this important time interval, covering the transition from the Megathermal period to late Holocene, the environment was repeatedly affected by shallowing and desiccation of lakes.

Fig. 1. Map of the Gaxun Nur area and the adjacent desert and mountain regions. The location of the investigated profile is indicated with a cross (X). Contour lines are drawn along altitudes of 1000 and 2000 m above the sea level.

1 Material and methods

The Eastern Juyanze profile (section A) comprises three different lake phases, which are represented by lacustrine deposits (lake marl) at 2.92–4.95, 10.59–10.89 and 12.33–12.73 m above base level (Fig. 2). The lower lake sediments were deposited onto river sands and fluvial sands and silts. The first lake sediment layer is covered by fluvial shallow-water deposits and aeolian sands. From ca. 8 m upwards aeolian sand layers are intercalated between the limnic deposits of two following lake phases. Based on four radiocarbon dates an age model was established applying interpolation and estimation of accumulation rates. Freshwater and oligohaline sediments were deposited during three limnic phases at 5200–3200 cal. aBP, ca. 3050–2980 and 2900–2700 cal. aBP.

The described profile was sampled in the sections 2.92–5.84, 10.59–10.89 and 12.33–12.67 m above base level. After the addition of Lycopodium clavatum marker spores volumetric subsamples (22 cm³) were prepared applying 30% HCl, 40% HF (cooled for 5 days and heated for 40 min), acetolysis and ultrasonic micro-sieving with 7 μm meshes. Most subsamples above 10.8 m could not be effectively treated with hydrofluoric acid: they were therefore prepared using sample volumes of up to 85 cm³ and zinc-chloride heavy-liquid-separation. If necessary, a final 40% HF treatment was applied. All samples were stored and mounted in glycerine.

Pollen grains were well preserved. However, in some cases the microscopic analysis was hampered by remains...
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Fig. 2. Simplified pollen diagram of the Eastern Juyanze profile including the main arboreal and non-arboreal pollen types. Total land pollen concentrations are rather low in the upper lacustrine deposits. The four 14C dates, three from the investigated profile (section A) and the lowermost one from a nearby lithostratigraphically-correlated profile (section E), are used in the age model[2,3].

Table 1 Description of the pollen assemblage zones of the Eastern Juyanze profile (section A)

<table>
<thead>
<tr>
<th>Pollen zone</th>
<th>Pollen assemblage</th>
<th>Land pollen concentrations</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAZ 1 (2.90—3.05 m)</td>
<td>Dominating Chenopodiaceae pollen, low percentages of Artemisia and Gramineae. High percentages of Picea, Betula, Ephedra, Nitraria and Hippophaë.</td>
<td>low</td>
</tr>
<tr>
<td>PAZ 2 (3.05—4.31 m)</td>
<td>Dominating Artemisia pollen, very high percentages of Chenopodiaceae. Frequent pollen of Gramineae, Ephedra and Nitraria. Low frequencies of Picea and Betula.</td>
<td>high (with absolute maxima)</td>
</tr>
<tr>
<td>PAZ 3 (4.31—4.79 m)</td>
<td>Similar pollen spectra as in zone 2, but increased percentages of Hippophaë, Populus, Rhamnaceae and Picea.</td>
<td>high</td>
</tr>
<tr>
<td>PAZ 4 (4.79—5.90 m)</td>
<td>Artemisia and Chenopodiaceae still dominating. Strongly increased percentages of Gramineae. Maxima of Picea and Pinus pollen.</td>
<td>decreasing</td>
</tr>
<tr>
<td>PAZ 5 (10.59—10.89 m)</td>
<td>Dominating Picea, Pinus, Chenopodiaceae and Artemisia pollen. Reduction in Gramineae. Strong maxima in Betula, Ephedra and Compositae subfam. Cichorioideae.</td>
<td>extremely low</td>
</tr>
<tr>
<td>PAZ 6 (12.33—12.67 m)</td>
<td>Dominating Chenopodiaceae pollen. High percentages of Ephedra, Nitraria and Artemisia. Picea and Pinus pollen relatively frequent, Betula and Gramineae strongly reduced.</td>
<td>low</td>
</tr>
</tbody>
</table>

of insoluble mineral and organic particles. Most samples in the lower part of the profile section (2.92—5.84 m) had pollen frequencies exceeding 5000 n/ccm (up to ca. 14000 n/ccm), while samples from the upper parts generally contained distinctly less than 2000 n/ccm (Fig. 2). Generally, a pollen basic sum of at least 500 grains could be counted, less in transitional limnic phases, especially in the upper part of the profile. Counts of local taxa (limno- and telmatophytes, Cyperaceae) and of some broad-leaved taxa obviously derived from far transportation were excluded from the basic sum.

2 Regional vegetation and palaeoclimate

The visual subdivision of the palynological diagram into six pollen assemblage zones (Tables 1 and 2, Fig. 2) follows the development of main arboreal taxa (coniferous trees, montane and riverside woods), shrubs and herbs of dry vegetation and grasses. Low values of index A/C, i.e. the ratio Artemisia to Chenopodiaceae pollen[, reveal relatively dry climatic conditions. The records of algae