The Younger Dryas in Equatorial and Southern Africa and in the Southeast Atlantic Ocean

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INTRODUCTION

At low latitudes, the atmospheric circulation and the connected precipitation patterns are closely related to the position of the Intertropical Convergence Zone (ITCZ). Over Africa, the average position of the ITCZ does not coincide with the equator, but is attracted by the Sahara desert. Through the seasons, it migrates from 20–24°N during July/August to 5–10°N in the west and 10–15°S in the east during January/February (ASECNA, 1973; Mpounza and Samba-Kimbata, 1990).

It is thought that during the last glacial maximum the ITCZ was located some 5–10 degrees more to the south during the boreal summer. During the boreal winter, it migrated to the equator in the west (the SE Atlantic and coastal zone) and to 10–20°S over central Africa (Van Zinderen Bakker, 1976; Thomas and Shaw, 1991). This caused a southward shift of the vegetation belts south of the Sahara over 5–10 degrees (Dupont and Agwu, 1992) and to stronger seasonal contrasts and a retreat of the tropical rainforest to the east in central Africa. In southern Africa, the climatic zones had moved to the north. The general result was that Africa became more arid between the Sahara and the Kalahari, and more humid south of the Kalahari.

During glacials, the oceanic surface circulation was intensified. In the SE Atlantic, this resulted in a stronger Benguela Current which probably shifted a few degrees to the north and wad accompanied with increased upwelling and productivity. The surface waters were 4°C colder than in interglacial maxima. (Jansen et al., 1984; Schneider et al., 1994; Schneider, personal communication).

Basically, the Younger Dryas event is defined as a sudden climatic deterioration observed in the pollen records of NW Europe which occurred around 10.500 ^{14}C yr BP. In other parts of the world, there might have been phenomena which are related to the Younger Dryas, but were not necessarily synchronous with this event. Several African records show abrupt climatic changes around 10–11 ka BP. Some of them are well dated, others not very well. I will give an overview of the paleoclimatic data from equatorial and southern Africa during this period. All ages are given in ^{14}C years BP.

In a paleolake in the central Sahel (**Bougdouma**, Niger) arid conditions were interrupted three times, before 12 ka, around 12 ka and at 10.7 ka PB, as is shown by the oxygen isotope record of authigenic carbonate (fig. 1). The latter influx was followed by evaporative concentration with a maximum indicating a short but marked arid phase between c. 10.3 and 10.0 ka BP (Gasse et al., 1990; Gasse and Fontes, 1992).

Lake Bosumtwi is a lake in a 1 million years old meteorite impact crater in Ghana. The carbon isotope ratio in the organic matter of the lake is a measure of the contribution of C_3 plants (trees, shrubs, high altitude grasses) against C_4 plants (mainly lowland grasses adapted to hot, seasonally dry conditions). This record shows a generally dry climate with humid excursions at ca. 18–15.5 and

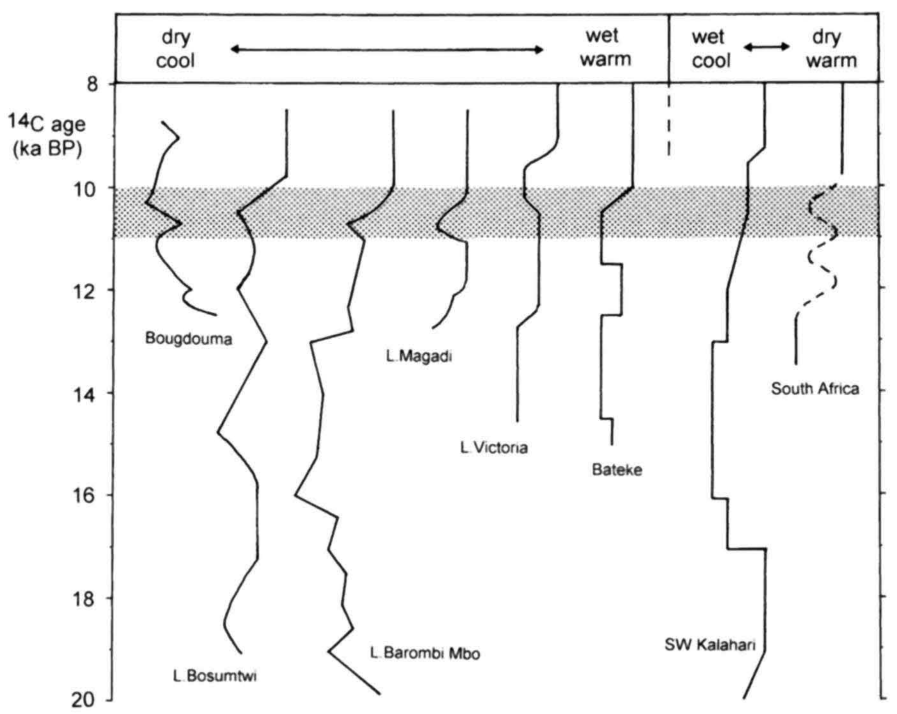

Fig. 1. Late glacial climate records from equatorial and southern Africa. For locations see fig. 2.

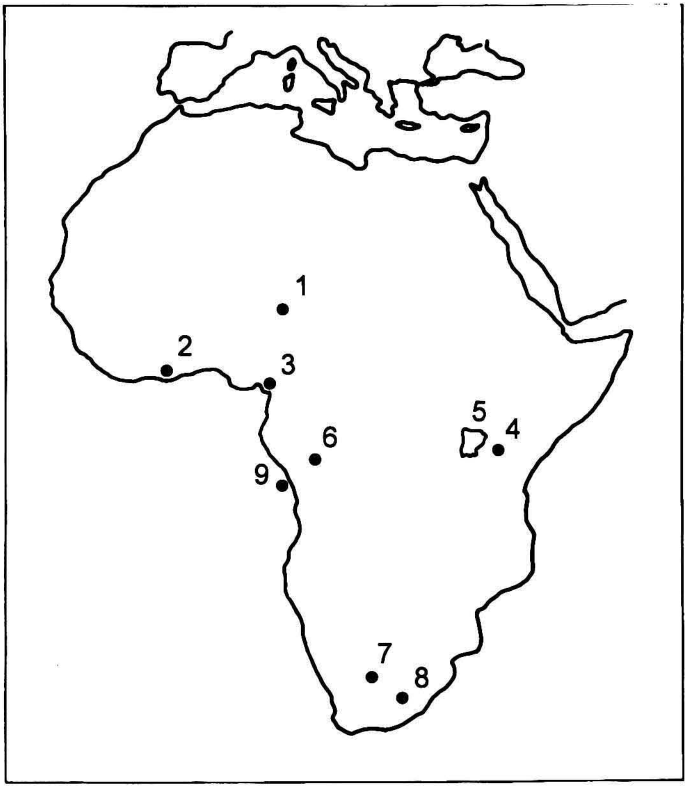

Fig. 2. Locations of the sites in the figs 1 and 3. 1. Bougdouma; 2. Lake Bosumtwi; 3. Lake Barombi Mbo; 4. Lake Magadi; 5. Lake Victoria; 6. Bateke; 7. SW Kalahari; 8. South Africa; 9. Atlantic Ocean core T89–16.

14–12 ka BP, the latter being possibly related to the Younger Dryas (Talbot and Johannesen, 1992).

Lake Barombi Mbo is a maar crater of the west Cameroon volcanic chain. Pollen data from the lake sediments show a degradation of the humid forest after 20 ka which culminated 16 ka BP and was followed by a progressive return of the tropical forest till 10 ka BP (Servant et al., 1993). A drop in the arboreal pollen record around 10.7 ka BP suggests that the return of the forest was shortly interrupted at that time.

A multi-proxy study of **Lake Magadi** in the East African Rift near the Kenya-Tanzania border describes the lake level history throughout the last deglaciation. The lake is hypersaline today and the water level was very low before 12.7 ka BP. Then the level started to rise, it was high ca. 12–11.1 ka, and fell again toward a minimum 10.8 ka BP. From 10.7 ka an intermediate level was established, and a second transgressive phase caused a new high level from ca. 10.2 ka BP on (Roberts et al., 1993).

From two other regions north of the Kalahari, climatic changes were reported of about the age of the Younger Dryas. In a multi-proxy study in the

Lake Victoria Basin, including pollen and green algae, Kendall (1969) inferred that Lake Victoria was without an outlet and the climate was dry > 14.5–12.5 ka BP. From 12.0 to 10.0 ka the lake probably had an outlet due to moderately wet conditions 12.5–10.5 ka BP. A desiccation at 10.5 ka has led to moderately dry conditions 10.5–9.5 ka, and was followed by wet conditions 9.5–6.5 ka BP.

In the region **Bateke**, north of Brazzaville (PR Congo), a series of pedological, geological, biological and archaeological features are observed which comprise morphological features like dry valleys, colluvial deposits, residual pavements of prehistoric artifacts. The features are attributed to soil reworking during the most humid periods (Schwartz and Lanfranchi, 1990). Their occurrence and absence are in accordance with the known postglacial climatic history, and show new details. In fig. 1, the concentrations in time of the features are summarized in a curve which can be read as a humidity curve. It describes a general humidification after 15 ka BP, with two arid interruptions at about 14.5–12.5 and 11.5–10.5 ka BP.

Studies of lake sediments, caves, micromammals, pollen, morphology in the **Kalahari** reveal that cold and dry conditions prevailed from about 20 to 19–17 ka BP. This period was followed by a phase of greater moisture 17–12 ka with a maximum 16–13 ka ago. After 12 ka BP aridity set in, but around 10 ka BP there was a short period of stagnation when ground water levels were still higher than today. Conditions similar to the present ones were settled by the early Holocene (Lancaster, 1989; Thomas and Shaw, 1991).

Pollen data show that **South Africa** was relatively moist and cold from the glacial maximum until 12.6 ka BP. Between 12.6 and ca. 10.0 ka BP, the vegetation was replaced twice by a warm, dry vegetation, and at ca. 9.6 ka BP the climate again had become warm and dry, and it remained so during the early Holocene (Van Zinderen Bakker and Coetzee, 1988).

The data from Bougdouma, Lake Bosumtwi, Lake Barombi Mbo and Lake Magadi, all from equatorial Africa, display an increase in temperature and humidity during the last deglaciation, with a dry, cool interruption dated between 10.8 and 10.3 ka BP. The accuracy of the ^{14}C ages do not preclude that the interruption in the four records display one single climatic event together with the interruptions in Lake Victoria and Bateke at 10.5–9.5 and 11.5–10.5 ka BP respectively. If so, the event may be related to the Younger Dryas *sensu stricto*. In southern Africa, on the contrary, there was a general postglacial decrease in humidity. The transition to Holocene aridity was interrupted twice in South Africa and, possibly, the second interruption coincides with the stagnation ca. 10 ka BP in the Kalahari. This suggests that the Younger Dryas event was indeed reflected in the African climate, as arid and humid excursions in equatorial and southern Africa respectively.

SOUTHEASTERN ATLANTIC OCEAN

In a high-resolution record from the Atlantic Ocean off the Congo/Zaïre River mouth (1.4 mm/y), the major deglaciation features showed up around 15 ka BP.

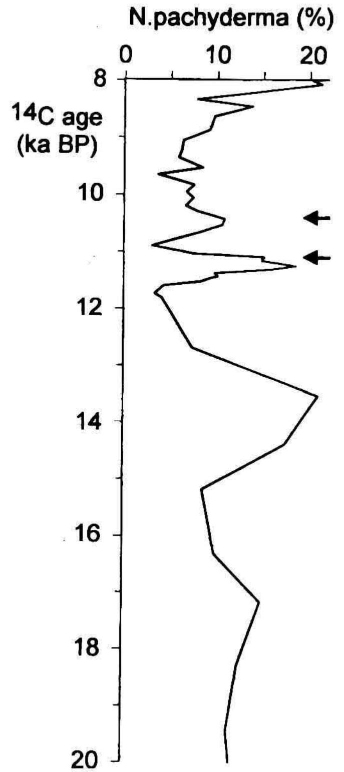

Fig. 3. Contribution of *Neogloboquadrina pachyderma* (right coiling) to the planktic foraminifera in core T89–16 from the SE Atlantic off the Congo/Zaïre River mouth, water depth 826 m (unpublished data from E. Ufkes). Age in ^{14}C years BP, corrected with 400 years for the apparent age of sea-surface water. For location see fig. 2.z

Then the foraminifers *Globigerina bulloides* and *Globorotalia inflata,* indicating coastal upwelling, retreated in favour of the right-coiled *Neogloboquadrina pachyderma,* in the first place an indicator of cold conditions (fig. 3). In this region, *N. pachyderma* is thought to represent low temperatures in the subsurface waters (E. Ufkes, unpublished results). The record displays a postglacial warming after 14 ka, followed by two cold events at 11.4 and 10.5 ka BP. The latter event probably coincides with the Younger Dryas. The core contains also continental diatoms and opal phytoliths. Opal phytoliths are siliceous clasts from leaves of vascular plants, mainly grasses. They grow on land, in contrast to diatoms which grow in rivers, lakes and swamps, and therefore they are more susceptible to eolian action. In regions where both modes of transport of terrigenous material occur, the combination of phytoliths and continental diatoms will be a signal of wind transport and aridity (Jansen and Van Iperen, 1994). Preliminary results by L. Ben Khelifa from the same core indicate two postglacial aridity events on the adjacent continent, at ca. 11.1 and 10.4 ka BP. It needs further investigation of the core material to decide whether the aridity events preceded or followed the oceanic cooling events.

DISCUSSION

In the light of the question whether the oceanic or the atmospheric system caused the Younger Dryas and its related events (E. Jansen, this volume) it would be interesting to see which event came first, the continental aridity or the oceanic cooling and upwelling. If the continental features indeed represent one single event, the ^{14}C dating system is unsuited to produce sufficiently accurate absolute ages which allow to correlate oceanic and continental sediments with a 100-year resolution (E. Bard, this volume). Marine records containing terrigenous signals may provide such a tool.

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