Review of Palaeobotany and Palynology 250 (2018) 53–59

Contents lists available at ScienceDirect

Review of Palaeobotany and Palynology

journal homepage: www.elsevier.com/locate/revpalbo

Palynological evidence for abrupt climatic cooling in equatorial Africa at about 43,000–40,000 cal BP

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ARTICLE INFO

Article history:
Received 9 September 2017
Received in revised form 20 November 2017
Accepted 23 December 2017
Available online 09 January 2018

Keywords:
Climatic cooling
Quaternary
Pollen analysis
Albertine rift
Tectonic activity

ABSTRACT

The same basal sequence of two pollen zones is found in three previously published pollen diagrams for widely separated sites situated along highlands adjacent to the Albertine Rift in equatorial Africa. Here evidence is presented that is supportive of the hypothesis that the transition between the zones was contemporaneous at all sites and dates to about 43,000–40,000 cal BP. Environmental interpretation of the sequence indicates that there was a major fall in temperature, depressed temperature thereafter persisting until the transition to the postglacial at 14,000–11,500 cal BP. The climate also became drier. Well-dated sediments of this age are rare in equatorial Africa, so comparisons are scarce. However, there is some evidence from the Eastern Arc Mountains, Tanzania, of a similar climatic event at about the same time. Farther afield, there is good evidence for abrupt climatic deterioration at ~40,000 cal BP in western Eurasia, where there was accompanying cultural change. Sedimentary basins along the Albertine Rift-margin highlands are especially well suited for palynologically-based investigations of past temperatures. Their relatively well-defined catchment areas result in reduced inputs of pollen derived from vegetation growing under different climatic conditions.

1. Introduction

Attention is directed at a major change in vegetation from moist lower montane forest or *Syzygium* swamp forest (Forest Zone 1) to vegetation with abundant *Cliffortia nitidula* (*Cliffortia* Zone) apparent in previously published pollen diagrams from three widely separated sites in Uganda, Rwanda and Burundi (Hamilton, 1982; Bonnefille and Riollet, 1988; Taylor, 1990). *Cliffortia nitidula* R.E. and T.C.E. Fries, the only East African species of the genus, is a shrub typical of the Ericaceous Belt. A major change in climate has previously been inferred for each site separately, but what has not been recognised earlier is that the dating evidence is consistent with the hypothesis that the climatic events recognised for each site were contemporaneous (dating to sometime between ca. 43,000 and 40,000 cal BP). A major climatic event is indicated, possibly having major environmental impacts over an extensive area.

Very few sediment sequences containing well preserved pollen of this age are known from eastern Africa, hence the ability to identify contemporaneous climatic changes in neighbouring sites is rare. The topographic contexts of the sites are particularly appropriate for identifying temperature changes from pollen diagrams, because all are in valleys situated within a belt of highlands stretching along the eastern margin of the Albertine Rift, the total altitudinal ranges of their catchments or immediate neighbourhoods being relatively limited. This contrasts with some lowland lakes or sites of sediment accumulation on taller mountains, into which considerable quantities of pollen can be transported from vegetation growing under environments markedly different from those that prevail near the sample sites. This complicates assessments of past temperatures.

The three sites, all peat-forming systems associated with the Albertine Rift in central Africa, are Muchoya Swamp (2260 m), Kamiranzovu Swamp (1950 m) and Kashiru Swamp (2014 m) in Uganda, Rwanda and Burundi respectively and separated from one another by distances of 120–240 km (Fig. 1). Swamp vegetation at Muchoya is dominated by the sedge *Pycreus nigricans* (Steud.) C.B. Clarke with scattered bushes of *Erica kingaensis* Engl. (Morrison, 1968; Taylor, 1990), Kamiranzovu is extensively covered by *Cyperus latifolius* Poir., with a central zone of *Syzygium cordatum* Krauss bordered by *Erica kingaensis* (Deuse, 1966; Bouxin, 1974), and Kashiru supported a *Xyris*/*Sphagnum* community prior to its destruction by peat mining in 1986 (Bonnefille and Riollet, 1988). All sites lie within the lower part of the Montane Forest Belt (Hamilton, 1982). Forest still persists around Muchoya and Kamiranzovu (Echuya and Nyungwe Forests), but has been removed at Kashiru to make way for agriculture.

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http://dx.doi.org/10.1016/j.revpalbo.2017.12.005
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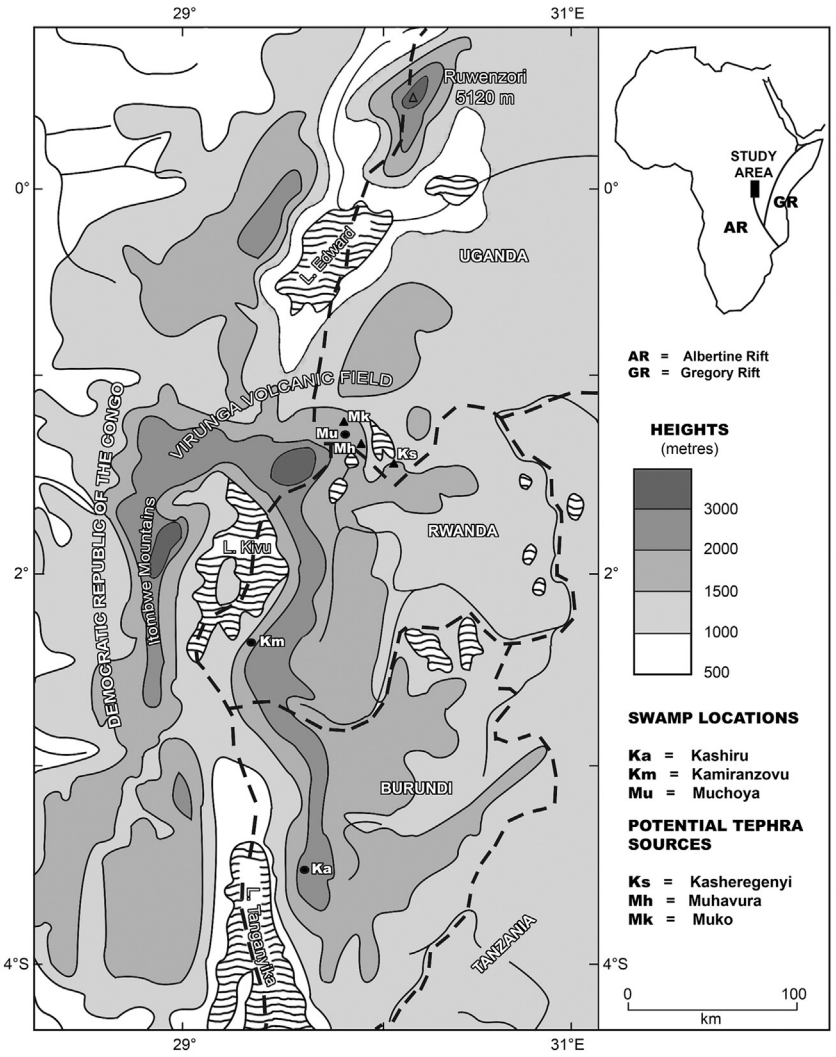

Fig. 1. Locality map. The altitudes and co-ordinates of the three sedimentary sites discussed are: Muchoya Swamp (2260 m; 1°17′S, 29°48′E); Kamiranzovu Swamp (1950 m; 2°40′S, 29°05′E) and Kashiru Swamp (2014 m; 3°28′S, 29°34′E).

2. Sediment sampling and profiles

Sediments were examined at four places at Muchoya Swamp (cores MC1–4) and one each at Kamiranzovu and Kashiru. Sediment sampling was by a Hiller borer at Kamiranzovu and Muchoya and a Russian borer at Kashiru, except at depth at Muchoya where a 20 cm auger was substituted. Sediment sampling and subsequent pollen analysis at Kashiru were by Bonnefille and Riollet (1988) and at the other two sites by one or both of ourselves. In principle, a Russian borer should allow the extraction of sediments less likely to be contaminated with foreign carbon than with the other devices, but it cannot penetrate stiff sediments, for which a Hiller borer is more suitable, or, if very stiff, an auger. Core MC2 at Muchoya, which, at 20.54 m, is one of the longest hand-drilled through Quaternary sediments in Africa, contains very stiff sediment at depth. Great care was taken at Muchoya and Kamiranzovu to avoid contamination of the samples collected for pollen analysis or radiocarbon dating, an ambition generally achieved judging by the conformability of nearly all the radiocarbon dates despite the great ages of some.

The stratigraphy of the sediments in the lower parts of cores MC2 and MC4 at Muchoya and at Kamiranzovu and Kashiru is shown on Fig. 2, together with pollen zones and calibrated radiocarbon dates (given as 95.4% probability ranges; see caption to Table 2 for details of calibration). Identification of the sediment types is as described in the field, augmented by the results of palynological and other laboratory investigations.

Kamiranzovu differs from the other sites in that there is a layer of grey sticky clay (marked L^3 on Fig. 2) above a stratum of organic clay dating to the *Cliffortia* Zone. Its appearance is similar to that of a clay layer below the *Cliffortia* Zone (L^2) and to another (L^1) below the mud that is suspected to be a fossil soil. The pollen spectra of L^3, L^2 and the uppermost part of L^1 are similar, indicating the presence of *Syzygium* swamp forest. It is postulated that the anomalous presence of a second forest zone (Forest Zone 2) contained within L^3, is due to re-deposition of material at the locality of the coring site eroded out of exposures of L^1 and/or L^2 exposed elsewhere on the mire. L^2 might also be redeposited material.

3. Dating

Twenty radiocarbon dates older than 29,000 cal BP are available for the four cores. They are arranged on Table 2 to allow visual estimates of the ages of the transitions between Forest Zone 1 and the *Cliffortia* Zone, being placed in order of depth within each core and grouped according to pollen zone. This is one approach to modelling the radiocarbon data to reveal the possible ages of boundaries between the pollen zones. We are cautious about applying modelling using interpolation to determine the ages of zonal boundaries especially in the lower parts of these