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## **Records of activity: radiocarbon and the structure of Iron Age settlement in Central Africa<sup>1</sup>**

It is just under 30 years now that Manfred Eggert has been roaming the equatorial rainforests of Central Africa<sup>2</sup>, in pursuit of traces of early settlement which may throw light on the poorly known later prehistoric periods at, or close to, the ›Heart of Darkness‹. Three decades of devoted fieldwork under truly demanding conditions, along with outstandingly critical and reflected theoretical reasoning on issues no smaller than the problems of Stone Age rainforest hunter-gatherer ecology, Bantu expansion, ›neolithization‹, or Iron Age beginnings, to name but a few – time to lean back and take stock in between. However, watching Manfred carrying out as vigorously as ever his four-month field seasons in equatorial Africa (they even used to last six months in the early days), it would obviously be premature to try and strike a general balance of his admirable achievements in this field. And clearly, just a few pages would never be enough space to do justice to them. Instead, I will here take a fresh look at one specific element of his still growing Central African legacy: the radiocarbon dates. It is the aim of this study to find out what they may tell us when calibrated and analysed in sets rather than individually, and how they fit in with the wider Central African and, indeed, pan-African radiocarbon evidence for the same time periods.

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1 I am most grateful to Birgitt Wiesmüller as well as Peter Breunig and collaborators (Frankfurt am Main), Alexandre Livingstone Smith (Tervuren, Belgium), and Ralf Vogelsang (Köln) for generously providing radiocarbon data bases for comparison with, and partial inclusion in, mine. Conny Meister (Tübingen) made available details relating to radiocarbon dates from Manfred Eggert's rainforest project; Eggert's kind permission is gratefully acknowledged. Christina Kohnen (Köln) unfailingly procured pertinent literature, no matter how obscure its place of publication. Thanks are also due to David Phillipson (Cambridge) for kindly recommending references on the later prehistory of Ethiopia and Eritrea, and to Renate Heckendorf (Rabat) who helped trace literature on the Maghreb. Lee Clare (Köln) kindly brushed up my English. – The research reported in the present paper is part of an ongoing project under the umbrella of Cologne University Sonderforschungsbereich 389 ACACIA, generously funded by Deutsche Forschungsgemeinschaft (DFG). I take the opportunity to thank DFG and their expert reviewers, including Manfred Eggert, who have favourably evaluated the ACACIA projects for almost twelve years now, sacrificing considerable amounts of their time for providing excellent conditions at Cologne University for interdisciplinary Africanist research.

2 His River Reconnaissance Project was launched in 1981, after an initial 1977–78 field season in the Equator Province of former Zaïre; see e.g. Eggert (1980; 1993).

## Introduction

Few aspects of an archaeologist's professional record are as enduring and resistant to the ravages of time as are the radiocarbon dates produced on his account. To be sure, they are not fundamentally different from other archaeological data in that they, too, require theory-based and context-sensitive interpretation in order to serve the goals of historical reconstruction and explanation. On the other hand, radiocarbon dates count among those archaeological data the least removed from what may be perceived as empirical reality: along with their sample contexts they are ›facts‹ just as hard as finds of stone implements or pots with their respective geographical coordinates and other related circumstantial information, such as the qualification as objects from the surface or from excavation, find depth, layer matrix, association with features or other objects, etc. Radiocarbon dates on properly recorded samples even have the additional advantage of being fixed not only in space but also in time, and this by virtue of their very content, i.e., without involving more or less complex comparative analysis. Most radiocarbon age determinations are considered to be of relevance to the research problems to which they were intended to provide answers, others are rejected as inacceptably old or too recent for various possible reasons. However, as long as one is dealing with ›archaeological‹ samples which may be assumed to relate to whatever kind of human agency, as is true of the vast majority of samples from archaeological contexts<sup>3</sup>, such samples may be treated as being indicative of human settlement activity in the widest possible sense of the term.

Thus, regardless of how unsatisfactory a given age reading may be for the researcher who submitted the sample to help answer a certain question, it may still constitute a valid proxy for human settlement in that sample's find area at a specific time. It follows that each and every radiocarbon date for which there is no good reason to view it as a statistical outlier has, by its very existence and irrespective of its relevance to specific research topics, a historical value no smaller than any archaeological artefact found in a given area. Consequently, just as no archaeologist would ignore or even throw away finds from excavation or surface survey simply because they do not relate to his specific interests, radiocarbon dates must never be ›discarded‹ in the sense of being left unpublished. One reason is that statistical outliers may be the more convincingly identified the more complete the published record of existing dates becomes. Yet, seemingly aberrant single dates may begin to make sense once they gain support by others of the same magnitude that might in turn be considered just as improbable by the submitters of their respective samples – insights which would be lost by the suppression of ›inacceptable‹ results. By adhering to good practice in this respect, for which Eggert's publications are exemplary<sup>4</sup>, archaeologists committed to intensive research in their respective study areas will over time accumulate extremely valuable sets of radiocarbon dates, for these may be treated as basically little biased records of ancient settlement activity in those areas. In fact, as long as no all too selective approaches are followed, systematically favouring certain time periods to the detriment of others in terms of collection and submission of samples for dating, we can in the long run expect radiocarbon date sets to result from such regional studies that will, certainly when exceeding, say, 100 dates each, adequately reflect at least major trends of

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3 A different class are ›environmental‹ radiocarbon samples, relating for instance to the development of soils, the accumulation of sediments or colluvia, bush fires due to lightning, volcanic eruptions, and the like.

4 To cite but a few examples, he published dates aberrant by at least 1000 radiocarbon years on samples associated with Imbonga pottery in former Zaïre (Eggert 1984, 262 Fig. 5) and dates even earlier than 8000 bp apparently relating to Iron Age ceramics from Cameroon (Eggert 2002, 520 Tab. 1).

variability in past settlement intensity over space and time and, for that matter, in palaeodemography. The following considerations set out from exactly this premise.<sup>5</sup> The starting point will be an analysis of the overall set of radiocarbon age determinations from the rainforest project directed by Eggert. However, first a few words seem appropriate on some technical aspects of handling radiocarbon dates sampled from the literature.

## African radiocarbon dates: an elusive treasure

In 2003 I decided to make a systematic effort to collect in a special data base primary radiocarbon and other dates relevant to the African ›Metal Ages‹, i.e. periods of copper, bronze and iron production or use. At that time it came as a stroke of good fortune that my colleague Birgitt Wiesmüller kindly provided her splendid collection of some 1400 radiocarbon dates mostly relating to Early Iron Age occurrences in many parts of Africa which she had painstakingly put together from the literature and partly used for her M.A. dissertation (Wiesmüller 1996; cf. footnote 1).

Meanwhile, this data base has been amended to 4046 entries, namely 3948 radiocarbon dates, 92 luminescence dates, and half a dozen historical dates.<sup>6</sup> As the original aim had been to assemble chronological evidence for metallurgical *beginnings* this data set is somewhat biased toward Early Iron Age phenomena but it also contains dates on early copper working and from periods directly preceding the earliest appearances of metals in Africa. By contrast, dates from the Later Iron Age and still more recent phases are less well represented. One reason is that it was only in an advanced stage of the project that the research focus shifted from the *beginnings* towards a more comprehensive perspective. However, even had this approach been followed from the start, it would still have been impossible for a single researcher to master the sheer mass of available Later Iron Age radiocarbon dates. So although our data base on the African ›Metal Ages‹ is a far cry from being comprehensive, it should still give a fair idea of the chronology of the earliest uses of copper and iron in most African regions, and at the same time be representative of major trends in settlement intensities during the regional Early Iron Ages.<sup>7</sup> To be more precise, this should be particularly true of the time bracket 3000–1500 bp which will be of special interest below and for which every effort was made to come as close as possible to a comprehensive data collection in all regions that have seen relevant research.

Before we go on to explore some of the potentials of this data base, a few remarks on the labour input required for its compilation and maintenance seem apt at this point. Anyone who has ever tried to compile even a modest African radiocarbon data base from the literature, such as the one described here, will know just how tedious this task can be. Collecting dates is tantamount to running into continual trouble, to do first of all with missing, incomplete, inaccurate or distorted contextual information, e.g. lab numbers, geographical coordinates, basic site data, sample material and species,  $\delta^{13}\text{C}$  values, cultural

5 Another example is provided by the five hundred odd radiocarbon dates from the Eastern Sahara, summarily presented and interpreted by Rudolph Kuper, this volume. Cf. Gehlen et al. (2002).

6 For the most part, new entries came from the literature. Additional data sets were kindly provided by the colleagues mentioned in footnote 1. Furthermore, a sample of Egyptian radiocarbon dates was taken from a list assembled by Stan Hendricks (Hasselt, Belgium), and the set of radiocarbon dates produced by the Cologne University Radiocarbon Laboratory was also screened for relevant data. Both the Egyptian dates mentioned and the Cologne Lab dates are included in the Cologne radiocarbon calibration package CalPal (see below).

7 The most notable exceptions are the Maghreb on the one hand and, surprisingly, Egypt on the other, areas for which it proved especially difficult to find published data.

affiliations, and references, to name but the most important. Other common nuisances include duplicate or confounded lab numbers or misquoted standard deviations. All in all, considerable time is wasted trying to track down or cross-check information which every researcher would have submitted along with their samples anyway. Yet even so, the proportion of insoluble problems of this kind remains unsatisfactorily high when relying upon published sources: for instance, of the 4046 radiocarbon dates currently in my data base 222 have no geographical coordinates, 123 lack a lab number altogether, while 144 have duplicate or equivocal lab numbers, and in 186 cases more than one radiocarbon age value and/or standard deviation are offered by different authors or in various places in the literature or on the web. Considering on the one hand the costs for obtaining, selecting and preparing relevant samples, plus those for the dating procedure itself, and on the other hand the importance of absolute dates and their associated information in archaeological and palaeo-ecological research<sup>8</sup> such a level of ›noise‹ hampering proper analysis by the scientific community are clearly excessive, and means ought to be devised to reduce it to a more tolerable level. I will return to this aspect in the concluding section.

### Sampling the rainforests: peaks by proxies

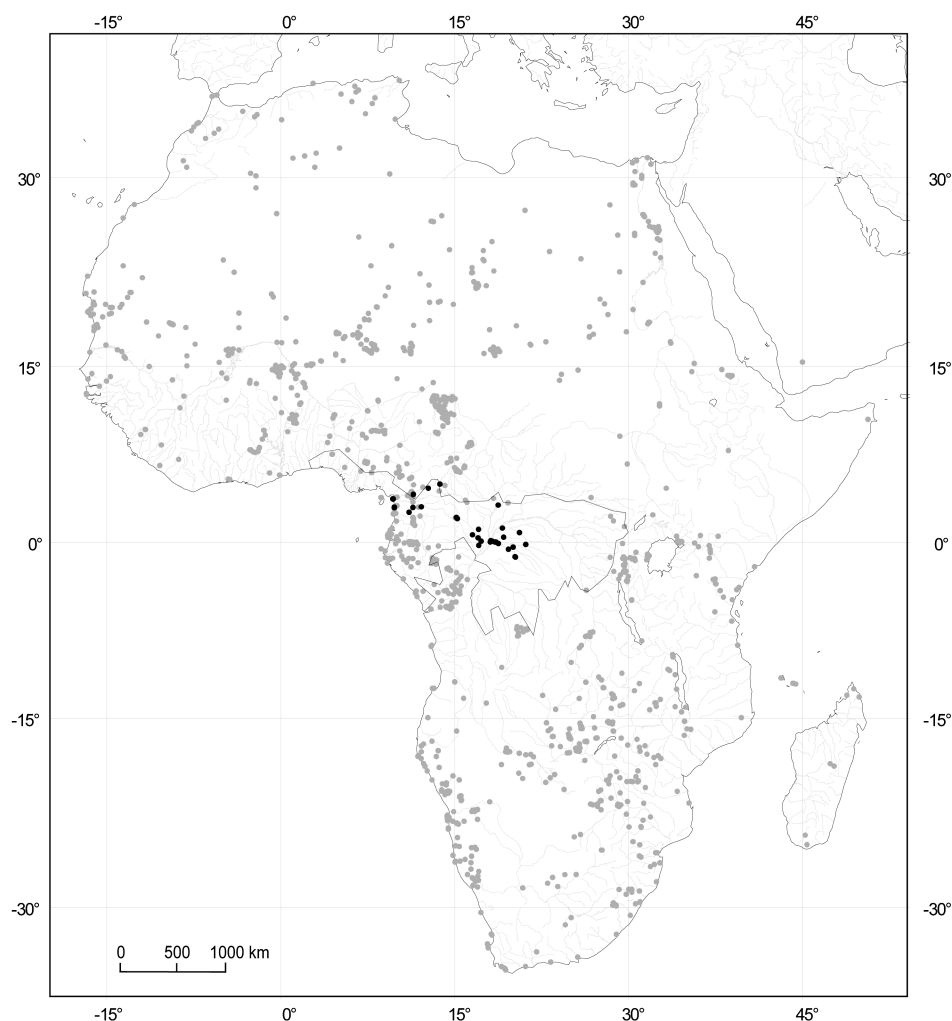
To my knowledge Manfred Eggert's Central African radiocarbon record at present comprises 135 dates. Of these, 66 relate to the Democratic Republic of Congo (DRC), or Congo-Kinshasa, the former Zaïre; 57 dates are from the Republic of the Congo (RC), or Congo-Brazzaville; and 12 dates resulted from research in Cameroon. The samples stem from a total of 35 sites. Up to now these dates have been discussed in the literature individually or, by subsets, in various combinations in specific chronological contexts, but they have never been jointly plotted on a map (Fig. 1) nor calibrated as a group (Fig. 2,1). However, both ways of treating them as a set yield instructive insights.

The map of all entries currently contained in the African ›Metal Ages‹ data base (Fig. 1)<sup>9</sup> could hardly be more illustrative of how Eggert's dates fit in with the pan-African radiocarbon evidence from the relevant time periods: most of them, namely the dates from the two Congos, fall into one of the continent's largest empty quarters, namely the interior of Central Africa and adjoining areas both to the north and south. Few other regions of Africa would appear to be in similarly urgent need of enhanced chronological control, except for parts of the Maghreb, the Mediterranean zone and the Horn of Africa. One does not even need to recall the familiar maps drawn to illustrate Bantu origins and alleged expansion routes, in which the equatorial rainforest plays such an important role<sup>10</sup>, to grasp just how pathetically flimsy the chronological basis still is in this part of the continent for the reconstruction of historical processes of whatever nature. At the same time it is encouraging to see of what a single, dedicated scholar is capable when attempting to fill a knowledge void of this magnitude in the course of seven field seasons within a comparatively modest field project.

8 See for instance Runge (2002a,b) and Clist (2006) for examples of the use of  $\delta^{13}\text{C}$  values for reconstructions of vegetational history.

9 Plotted by means of PanMap, Version 0.9.6. PanMap is a simple freeware GIS program, ideally suited for easy and fast visualization of georeferenced point or vector data. The software is part of the information system PANGAEA, operated by the Alfred Wegener Institute for Polar and Marine Research (Bremerhaven) and the Center for Marine Environmental Sciences (University of Bremen). Download, along with a variety of ready-made vector layer files including, amongst other things, coastlines, rivers and lakes, national borderlines, and elevations, from <[www.pangaea.de/](http://www.pangaea.de/) Software/ PanMap>. The availability of this extremely useful tool is gratefully acknowledged.

10 Examples: Heine et al. (1977); Phillipson (1977); Vansina (1995).



**Fig. 1:** Distribution of all radiocarbon dates currently included in the African 'Metal Ages' database for which geographical coordinates are available ( $n=3824$ ). Black dots denote dates from fieldwork directed by Manfred Eggert, 1977–1999 ( $n=135$ ). Note that sites appear only once, regardless of the number of dated samples taken from them. Present limits of the equatorial rainforest are indicated in simplified outline.

By virtue of this body of dating evidence, accumulated over the last three decades in one of Africa's least researched areas, the archaeological community meanwhile disposes of dated sites and features where there had been next to nothing before Eggert's project began. Turning from space to time, we may now examine the significance of these dates in terms of chronology and early settlement processes. Figure 2.1 shows the dendro-chronologically calibrated, overall probability distribution of all radiocarbon dates resulting from Eggert's rainforest project, plotted along the x-axis in the time window 3000 BC to AD 1950. The curve is a cumulative histogram of probabilities derived by fitting the Gauss curves corresponding to individual uncalibrated radiocarbon dates on the y-axis to

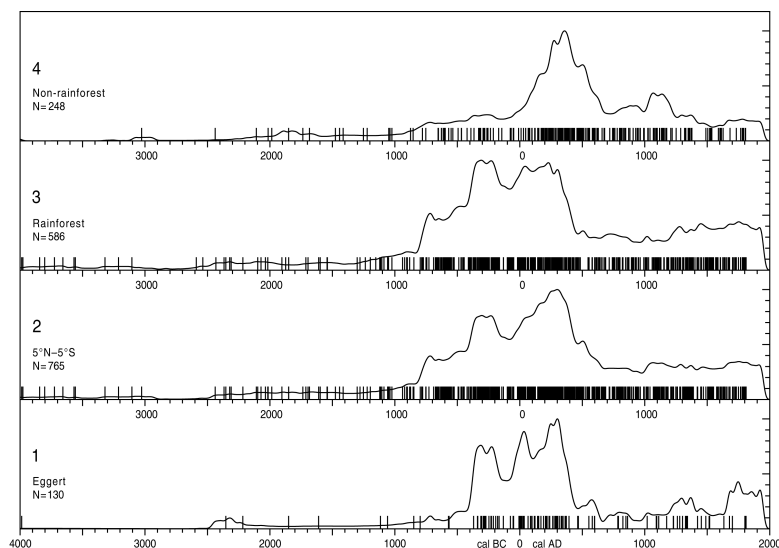
the radiocarbon calibration curve.<sup>11</sup> Ticks on the horizontal axis denote arithmetic means of individual calibrated dates, the latter treated as if they were normally distributed too; these strokes fuse to solid black bars in areas of high date density. This type of calibration procedure known as 'group dispersion calibration' is well described in Weninger (1986). Like all other conversions of radiocarbon ages into calendar dates and their corresponding plots it was performed in this paper by means of the CalPal calibration package, using the current IntCal04 calibration curve.<sup>12</sup>

The peaks and valleys of the calibrated dispersion curve in Fig. 2,1 indicate calendar time intervals represented by larger or smaller numbers of radiocarbon dates from the calibrated set. Therefore, without running the risk of getting carried away by the details of individual dates, their accuracies, or archaeological significances, we can take a structural look, as it were, at the joint distribution of this specific date sample over calendar time. So what is the information inherent in this curve? First and foremost, one expects it to reflect a peculiar selection of samples from archaeological contexts relevant to the specific research topics chosen by the submitter. Knowing that from the outset one focus of Eggert's rainforest project has been early settlement by ceramic-bearing populations, it is hardly surprising to find he obviously made special efforts to come by absolute dates for the earliest pottery groups found in his study areas; this is well documented by a major peak in his radiocarbon record between c. 400 BC and AD 300. While there is nothing much before that time bracket, a considerable number of dates from more recent periods up to the present bear witness to the fact that besides coming to grips with early settlement Eggert's rainforest research has always aimed at establishing a complete archaeological sequence of the ensuing periods, too. Although the dates covering these phases are overall more evenly distributed, at least small local maxima again reveal special research interests. The AD 1200–1400 peak is a case in point: it relates to a number of dates obtained in order to establish the chronological position of Bondongo pottery, of which early finds in the Equator Province of former Zaïre in the 1950s had helped catalyze Eggert's later commitment in that part of Africa (Eggert 1980). In broad outline, then, the major features of the radiocarbon date dispersion curve relating to this particular project may be described as comprising an early, 700 calendar year-long maximum with two notable depressions, around 100 BC and AD 100/150 respectively, and a long 'tail' showing comparatively little significant variation, with the

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11 Of the total of 135 samples three contained insufficient radiocarbon to be dated, and two yielded 'modern' results (younger than AD 1950), leaving 130 radiocarbon dates suitable for calibration. These give a continuous probability curve from the late 3<sup>rd</sup> millennium BC to the present, with four exceptions: two dates (KIA-12946 and KIA-12947) from the 9<sup>th</sup> millennium bp on samples taken at Mouanko-Lobethal in Cameroon (Eggert 2002, 520 Tab. 1), one further 9<sup>th</sup> millennium bp result (Hv-12204) relating to the site of Iyonda in DRC (Wotzka 1995, 302 f.; 412 no. 1), and a 6<sup>th</sup> millennium bp date (Hv-12616) for Bamanya in DRC, associated with an extraordinarily large standard deviation of  $\pm 695$  radiocarbon years (Wotzka 1995: 310; 412 no. 2). These extremely early dates, which are isolated from all the rest and must without exception be discounted as irrelevant to the research that gave rise to their production, were excluded from Fig. 2,1 and from all similar graphs in this paper where they would have had the sole effect of compressing the time scales so as to leave unduly little space for the main field of dates. These outliers will likewise be disregarded below.

12 Cologne Radiocarbon Calibration and Palaeoclimate Research Package (September 2005 version) by Bernhard Weninger, Olaf Jöris and Uwe Danzeglocke. Amongst other highly useful features, like for instance glacial calibration and exploratory climate history research, this splendid software permits simultaneous calibration of up to 2000 radiocarbon dates and, for comparative purposes, the display in one and the same graph of up to ten cumulative curves, summarizing a maximum of 1000 calibrated dates each, i.e. joint visualization of up to 10,000 radiocarbon dates. Free download from <www.calpal.de>. – For the IntCal04 calibration curve see the latest Calibration Issue of Radiocarbon (vol. 46/3, 2004). Southern hemisphere correction was not applied to calibrations used in the present paper.



**Fig. 2:** Group dispersion calibration of late Holocene radiocarbon dates from equatorial Africa in the time window 4000 BC – AD 1950. 1 From fieldwork directed by Manfred Eggert; 2 all dates from locations between 5° northern and 5° southern latitude; 3 all dates from locations within the equatorial rainforest; 4 all dates from non-rainforest locations between 5° northern and 5° southern latitude.

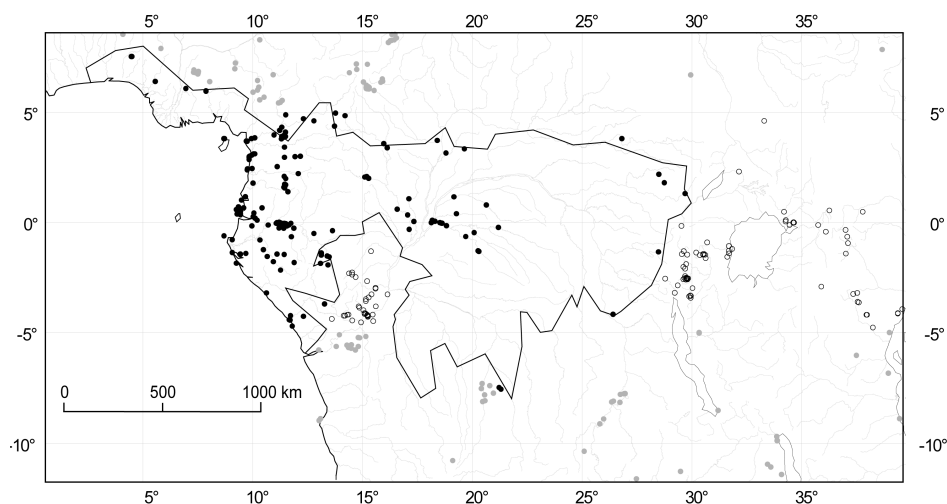
exception of a slight overall increase after c. AD 1200. All in all, one might be inclined to read this as the record of a strongly biased selection taken from the theoretical universe of all possible samples relating to the last 2500 years of Central African settlement history.

Yet, there is more to Eggert's radiocarbon curve. It does in fact echo in some important respects the corresponding curve for all of Central Africa (Fig. 2,2).<sup>13</sup> Although the congruence is not perfect there is an obvious structural resemblance in that both curves share the early long-term maximum with its clear internal subdivision, followed by a marked decline after c. AD 300, a global minimum just before AD 1000, and a subsequent increase to modest levels throughout the second millennium AD. The fact that this general structure of Eggert's project curve is repeated in the much more comprehensive sample of 788 dates from all of equatorial Africa makes it highly unlikely that the project curve should be just one idiosyncratic outcome of the chance history of research.<sup>14</sup> Rather, it lends strong support to the hypothesis that both curves essentially model the same past reality, if with somewhat different degrees of reliability. Apparently, despite all potentially distorting factors like personal bias, differential geographical distribution, (chance) discovery and selection of relevant sites and features, Eggert seems, in the long run, to have acquired an overall sample astonishingly representative of equatorial African settlement history over the last two and half millennia. Is it possible that something coming close to a random sample should have emerged from research following anything but a sophisticated sampling strategy in obtaining datable materials?<sup>15</sup> In the specific case at hand one conceivable objection

13 Here defined as the zone between 5° north and 5° south of the equator. However, the patterns described also hold for wider definitions of up to 8° north and south.

14 The similarity is not due to a potential domination of the Eggert dates within the Central African sample. Rather, the latter remains almost exactly the same after removal of Eggert's dates.

15 John Bower (1986, 35) had attested Eggert a »more or less intuitive sampling ›design‹«, a comment affirmatively acknowledged by the latter (Eggert 1993, 296).



**Fig. 3:** Distribution of late Holocene radiocarbon dates from the equatorial rainforest (black dots;  $n=566$ ), non-rainforest sites located between 5° northern and 5° southern latitude (circles;  $n=256$ ), and from remaining regions within the map window (gray dots;  $n=400$ ). Note that sites appear only once, regardless of the number of dated samples taken from them. Present limits of the equatorial rainforest are indicated in simplified outline.

could be that the whole community of researchers doing fieldwork in Central Africa might have pursued their endeavours sharing the same bipolar bias for early settlement by pottery-producing populations on the one hand, and Late Iron Age communities on the other, while basically ignoring any cultural activity that went on in between.<sup>16</sup> However, even if this improbable scenario were true, how should we explain the correspondence in specific shape of the two curves within the obviously well-sampled time interval of the early maximum, especially the marked decline in the late first millennium BC?

A closer look at this first, long-term peak in the comprehensive Central African curve reveals that substantial settlement started somewhat earlier in some regions outside of Eggert's study areas.<sup>17</sup> More importantly, this first Central African settlement climax of the late Holocene turns out to be of a distinctly two-peak structure, after an initial plateau. It follows that the first local decline around 100 BC needs to be taken seriously or, in other words, as being indicative of a historical recession in settlement intensity. By contrast, the second local fall-off in Eggert's curve, the one around AD 100, would appear to be in need of further analysis since it does not show up in the complete Central African curve. For the moment, two explanations are equally possible: we might either be dealing with a regional phenomenon that made itself felt only where the bulk of Eggert's dates come from, namely towards the interior of the Central African rainforests; or his radiocarbon dates have disproportionately less well sampled the history of settlement in this particular time window, producing a spurious third peak within the 'big climax'.

16 On the regional level, for instance, Clist (1995, 174 f.) has argued along these lines with regard to Woleu-Ntem Province of Gabon.

17 These precocious regions are known to belong to western Central Africa (see below).

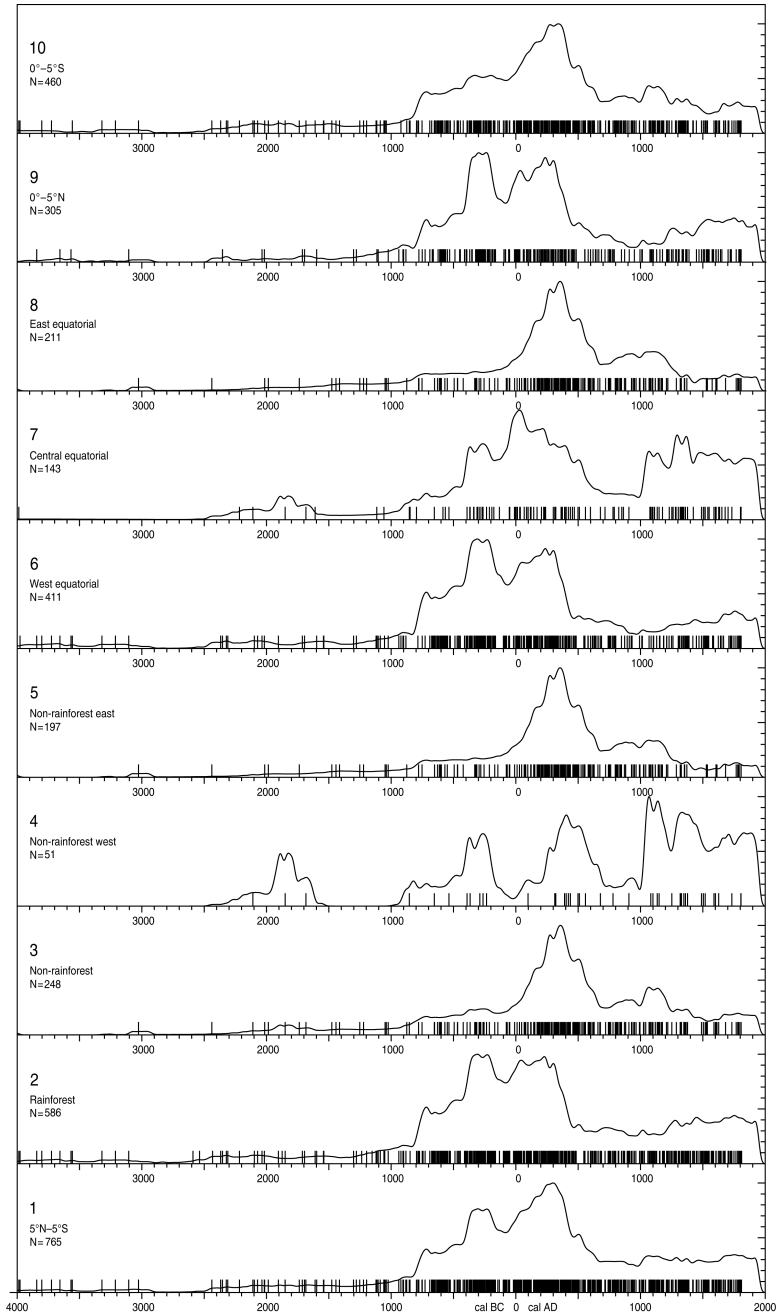


It has become evident that Eggert's project sample fits in quite neatly with the overall archaeological radiocarbon record of Central Africa from the last 3000 years. At this point the question arises as to whether we are here dealing with a peculiar Central African radiocarbon, or for that matter, settlement fingerprint or not. However, since in the relevant time window Central Africa was characterized by a major dichotomy between rainforest and non-rainforest types of habitat, offering very different conditions for human settlement, it might make more sense to check first whether our observations really relate to a rainforest, rather than a Central African, fingerprint.

That the latter is indeed the case follows from a comparison of the curve for all dates from sites within the Central African rainforests with that for the totality of Central African dates from outside the rainforests. While the basically two-peak shape of the rainforest curve (Fig. 2,3) resembles that of Eggert's project curve (Fig. 2,1) and, even more closely, that of the total Central African curve (Fig. 2,2), the non-rainforest curve (Fig. 2,4) is of a different, essentially unimodal type: a dominant peak between c. 100 BC and AD 700, is followed by a much humbler local maximum in the period c. AD 1000–1200, within a generally declining trend towards more recent times. The first and major settlement climax in equatorial Africa outside the rainforests (c. 100 BC – AD 700) was thus coeval with the more recent of the two rainforest settlement peaks. Taken at face value, these data imply that, by and large, substantial human settlement in late Holocene Central Africa would have begun earlier in areas today covered by rainforests than elsewhere. However, a glance at the joint distribution map of these two sets of data (Fig. 3) reminds us to be careful in interpreting the observed pattern in relative chronology: all non-rainforest sample find spots are located east of 13,5° eastern longitude while the majority of rainforest dates come from more westerly sites. This gives rise to some doubt as to whether the rainforest vs. non-rainforest dichotomy is really crucial for understanding the relative sequence of major settlement episodes in equatorial Africa around the turn of the Christian era. Judging from the map we may as well be dealing with a spatial trend in that west Central Africa might have taken chronological priority in terms of its first settlement culmination over areas located further east, regardless of their specific vegetational milieus.

Such a chronological west–east gradient of settlement maxima is in fact clearly borne out by a comparative graph showing the respective curves for west, central, and east equatorial Africa, where these zones are exclusively defined on the basis of geographical longitude (Fig. 4,6–8). However, this triple subdivision is not meant to be an adequate representation of the physical geographical situation. Instead, it departs from the spatial distribution of radiocarbon dates (Fig. 3) described above, using 13,5° and 22° East as dividing lines.<sup>18</sup> The observation that the western equatorial curve (Fig. 4,6) shows nearly perfect correspondence with the equatorial rainforest curve (Fig. 4,2) on the one hand, and very high similarity to the Central African curve (Fig. 4,1) on the other, is indicative of a strong determination of the two latter curves by the west Central African dates. By implication, the two-peak curve structure with the conspicuous minimum around 100 BC must neither be interpreted as a Central African nor an equatorial rainforest fingerprint, but rather as a specific west Central African pattern (relating, however, to an area mostly covered by rainforests). In this part of the continent the two major early settlement peaks would seem to have been of nearly equal intensity, but possibly with a slight predominance in this respect of the first one (Fig. 4,6). The postulate of a chronological west-east gradient mainly rests on three observations: (1) In the west of Central Africa (Fig. 4,6) the first (and, possibly, absolute) settlement maximum was reached around 300 BC. (2) In the central

18 In view of the actual locations of extant dates the second line, without affecting the curves, could have been drawn at 26° East.



**Fig. 4:** Group dispersion calibration of late Holocene radiocarbon dates from equatorial Africa in the time window 4000 BC – AD 1950. 1 From locations between 5° northern and 5° southern latitude; 2 from locations within the equatorial rainforest; 3 from non-rainforest locations, between 5° northern and 5° southern latitude; 4 from non-rainforest locations, 13,5–16,5° E; 5 from non-rainforest locations beyond 28° E; 6 from locations west of 13,5° E; 7 from locations 13,5°–22° E; 8 from locations beyond 22° E; 9 from locations 0°–5° N; 10 from locations 0°–5° S.

equatorial region (Fig. 4,7) this only occurred around the turn of the Christian era, at a time when settlement activity in west Central Africa was already on the rise towards its second climax. (3) The eastern equatorial areas (Fig. 4,8) saw their one and only culmination around AD 300, a period corresponding to the second western apex (Fig. 4,6), yet one of settlement decline in the central forests.

The little exercise in pattern recognition carried out above has thus highlighted two aspects of the Central African radiocarbon record which I propose to read as proxy data for structural features of regional settlement history around the turn of the Christian era: (a) a basic chronological west to east succession of settlement intensity peaks, and (b) a west-east gradient from a two-peak towards a one-peak structure of early settlement. In addition, an analogous north-south trend becomes apparent from a comparison of Figs. 4,9 and 4,10: taking the equator as an arbitrary divide, the northern part of Central Africa (Fig. 4,9) may be seen as having gone through the two-peak type of settlement process whereas the south (Fig. 4,10) seems to have seen only one global maximum, coeval with that of the equatorial east (Fig. 4,8) and, for that matter, with the more recent western peak (Fig. 4,6). In other words, the marked 2<sup>nd</sup> century BC decline which affected the northern latitudes (and west Central Africa at large) did not generally make itself felt (as strongly) in the sub-equatorial parts of Central Africa (Fig. 4,10) where the 1<sup>st</sup> millennium BC saw but a modest intensification of settlement in the form of two succeeding plateaus rather than a clear-cut peak. Without having space here to elaborate upon this, it may be noted that the observation of a general chronological north-south gradient of early settlement activity in Central Africa is in accordance, at least as for its western parts, with views held by specialists in the regional archaeology (e.g. Oslisly 2001, 263; Oslisly & Peyrot 1992).<sup>19</sup>

In comparison, practically all Central African curves shown in Fig. 4 are variations on a few basic themes: substantial settlement, coterminous with a first period of demographic growth – be it due to immigration or increased natality – began in some regions around 800 BC; a first climax was reached c. 400–300 BC, followed by a depression, c. 200–100 BC, and a second climax, culminating c. AD 300–400; a second depression, c. AD 400–700, preceded an intermediate period, c. AD 700–1000, and a phase of recovery, after c. AD 1000.<sup>20</sup> This is the general rhythm underlying the 2000-year-long early peopling and exploitation of Central Africa by settled populations. Since this rhythm appears to have structured the pertinent settlement processes across the continent, from the Atlantic to the Indian Ocean, the conclusion suggests itself that these processes were in some way(s) interrelated.

Possible mechanisms articulating supra-regional settlement processes include migratory waves of advance (population expansions), demographic fluctuations due to environmental, especially climate, changes, pandemic diseases, or combinations of these. In late Holocene Central Africa climate variation with concomitant oscillations between dense rainforest vegetation during humid periods and more open, savanna type landscapes connecting insular rainforest relics in the drier intervals is known to have occurred and is

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19 Although not directly relevant to my main argument here, the non-rainforest curves (Fig. 4,3–5) are instructive in other respects: The overall equatorial non-rainforest curve (Fig. 4,3) is clearly determined by the equatorial East African non-rainforest radiocarbon record (Fig. 4,5) which is, of course, nearly identical to the equatorial East African record at large (Fig. 4,8; cf. map, Fig. 3). By contrast, the western equatorial non-forest curve (Fig. 4,4) reveals significantly more variability over time, including early (19<sup>th</sup> century BC) and late (after AD 1000) peaks, but has only limited effects on the joint curve (Fig. 4,3) due to the small sample size involved ( $n=51$ ); in fact, samples of this size may arguably be considered as approaching the lower size limit, or even as being too small, i.e., too liable to chance effects, for the type of large-scale pattern recognition pursued in the present study.

20 The more recent periods will probably be unreliably represented by the curves due to under-sampling.

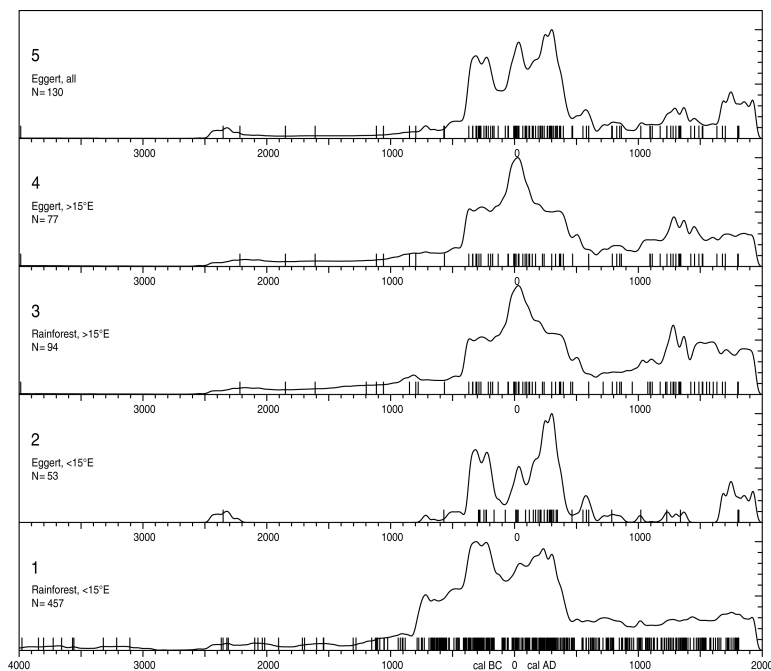
rightly held to have been a major parameter, determining the relative ease of human long-distance communication and exchange, and opening or locking ›corridors‹ feasible for migration. In this respect it is significant that what has above been christened the ›big climax‹ of late Holocene Central African settlement, namely the period c. 2500–1500 bp, equivalent to the calendar time interval c. 800 BC–AD 700 (Fig. 2,2) corresponds climatically to the Holocene dry maximum which saw the largest extent of savannas in the course of the last 12,000 years (Elenga et al. 2004, 184 Fig. 2).<sup>21</sup> In very general terms, we thus note a correlation in late Holocene Central Africa between an opening up of landscapes on the one hand and a rapid increase in settlement intensity on the other (Clist, this volume, speaks of the expansion of the ›village mode of production‹). However, even the two-peak structure of the dominant radiocarbon and settlement maximum, with its local depression late in the 1<sup>st</sup> millennium BC, might be mirrored in the twin peaks of the palaeoenvironmental record; similarly, the small increase in the radiocarbon curve after AD 1000 will perhaps be found to be related to the most recent, comparatively modest, phase of forest retreat (Fig. 1 in Clist, this volume). While presently the correspondences between these lesser amplitudes of the two curves under comparison are not perfectly synchronous and thus remain in need of detailed corroboration, it is already safe to conclude that a major intensification of human settlement took place in Central Africa at a time when savannas expanded to the detriment of rainforests at a scale that had last been reached in the late Pleistocene. Conversely, the drastic settlement decline and minimum so consistently following the ›big climax‹ in all Central African radiocarbon curves in the period c. AD 400–1000 (Fig. 4) very clearly correlates with a time of massive recovery of rainforests.<sup>22</sup> The rhythm underlying the major themes of human settlement in Central Africa during the last three millennia was thus climatic in nature.

Returning to Eggert's rainforest project, we are now in a better position to understand the specific shape of its radiocarbon curve. As can be seen from Figure 5 the west-east gradient observed in Central Africa at large also holds for the rainforests (Fig. 5,1.3), and for Eggert's project record.<sup>23</sup> The latter's three-peak structure (Fig. 5,5) now readily discloses itself as being composed of the two western peaks (Fig. 5,2; cf. Fig. 5,1) plus the single peak which lies chronologically in between and relates to the more central parts of the continent (Fig. 5,4; cf. Fig. 5,3). It follows that even the small samples resulting from subdividing

21 Reproduced (from a different source) as Fig. 1 in Clist, this volume; cf. Clist's accompanying discussion. – The period in question saw the culmination of relative dryness, causing the ›major Holocene vegetation change registered in Atlantic equatorial Africa‹ (Elenga et al. 2004, 189 f.); it occurred early within the overall relatively dry climate phase known as Kibangian B, lasting in total from c. 3500 bp to the present (Maley 1993, 44).

22 Regionally, this drastic decline in human settlement has been recognized for some time, for instance in the middle Ogoewe Valley and Ogoewe-Ivindo Province of Gabon where radiocarbon dates were lacking for a period of up to 1000 calendar years, between c. AD 400 and 1400 (Clist 1995, 172 ff., 182 f.). Oslişly (2001, 265 f. with Fig. 3) suggested wide-spread epidemic disease as a possible explanation for what he viewed as a true ›hiatus‹, whereas Clist blamed it on a lack of research devoted to the periods in question.

23 In this graph (Fig. 5), 15° eastern longitude was chosen for subdividing the equatorial rainforests into a western and an eastern section; dealing exclusively here with the rainforest zone this makes more sense than the 13,5° East divide used above for both rainforest and non-rainforest regions. Furthermore, for the rainforest proper a triple subdivision would presently be useless since our data base does not even hold 10 radiocarbon dates from east of 22° longitude (cf. map, Fig. 3). – The subdivision used in Fig. 5 discloses a further characteristic of the west-east gradient under consideration: apparently, the two-peak type of curve only applies to longitudes below 15° East – but is still evident beyond 13,5° East (Fig. 4,7) –, giving way to a one-peak structure further to the east. A more detailed impression of the time gradient may now be gained by reading our figures in the following sequence:



**Fig. 5:** Group dispersion calibration of late Holocene radiocarbon dates from equatorial Africa in the time window 4000 BC – AD 1950. 1 From rainforest locations west of 15° E; 2 from sites west of 15° E investigated by Manfred Eggert; 3 from rainforest locations east of 15° E; 4 from sites east of 15° E investigated by Manfred Eggert; 5 all dates from fieldwork directed by Manfred Eggert.

Eggert's data into a western ( $n=53$ ) and an eastern set ( $n=77$ ) may be regarded as being representative of their respective rainforest zones.<sup>24</sup> We cannot but conclude once more that what Eggert has in fact collected over the years comes fairly close to unbiased samples of radiocarbon dates from the theoretical universes of his study areas. It is by virtue of this very quality that his specific radiocarbon record, beyond dating pottery, pits, sites, or, in places, iron metallurgy, makes a major structural contribution to the settlement history of late Holocene Central Africa, the significance of which we have only just started to recognize. It is quite fascinating to see these individual dates join up with one another, and with those from other projects, like pieces in a jigsaw puzzle, allowing a first glance at what will hopefully become a more detailed picture in the future. However, disillusionment immediately looms up when considering those vast tracts of rainforest adjoining Eggert's

Fig. 4.6 – Fig. 4.7 – Fig. 5.3 – Fig. 4.8. It is tempting, but premature, to interpret this pattern in terms of successive eastbound migrations (cf. footnote 20). Such a hypothesis would presuppose convincing, chronologically ordered west-east chains of cultural links to be observable in the archaeological remains from along the hypothetical migration routes. However, at present such sequences have only been established for a few Central African sub-regions, as for instance the inner Congo Basin (Wotzka 1995), while attempts made to trace the origins of early rainforest pottery groups such as the Imbonga Group, or the Pikunda-Munda Group have so far been in vain (Eggert 2002); but see Clist (this volume) for a somewhat different view of this latter aspect.

<sup>24</sup> As for the central and eastern rainforests beyond 15° longitude this statement is quite trivial, however, since here Eggert's radiocarbon dates constitute the bulk of the available data.

study areas which will be critical for really coming to grips with equatorial Africa's later prehistory but which are today practically devoid of any archaeological radiocarbon dates, most notably the enormous stretches between roughly 20° and 30° eastern longitude (Fig. 3).

Having identified some basic features of the Central African radiocarbon record for the last 3000 years we may now return to the question whether this record, despite the necessary geographical differentiations, is specific enough to justify being labelled a Central African radiocarbon fingerprint.

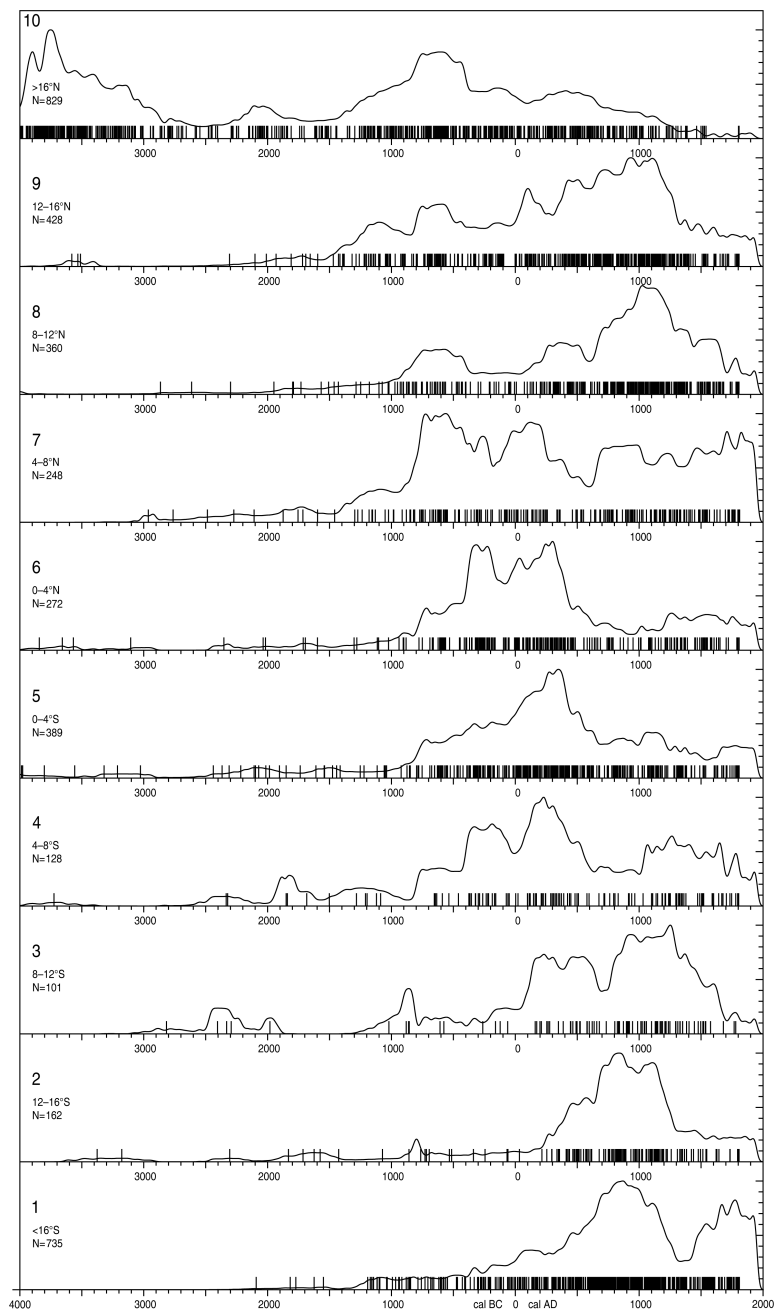
## Beyond equatorial Africa: supra-regional comparisons

For the sake of general comparison with radiocarbon date dispersion curves for regions outside of Central Africa an artificial subdivision of the continent into 10 latitudinal zones extending parallel to the equator was chosen (Fig. 6). Moving outwards both north and south from the equator in steps of four degrees, four such strips each were defined, together covering latitudes up to 16° degrees north and south; higher northern or southern latitudes were assigned to two additional zones. In very broad outline these contiguous geographical strips follow Africa's major climate and vegetation zones, from the high precipitation (rain) forest areas and equatorial East African savannas in the centre to increasingly drier regions north and south of the equator, characterized by various types of savannas, Sahelian, or desert vegetation. While unsuitable for detailed supra-regional comparisons of settlement intensities over time, the corresponding radiocarbon curves do, by way of hypothesis, allow large-scale structural analyses taking account of major correspondences in curve shapes and the location of peaks and minima.<sup>25</sup>

A Central African pattern of the type described above does indeed emerge (Fig. 6,4–7).<sup>26</sup> Without difficulty, Eggert's radiocarbon evidence (Fig. 5,5) may be recognized as uniquely matching this specific equatorial fingerprint and none of the others. As mentioned above, in Central Africa the heyday of Early Iron Age settlement ended around the mid-first millennium AD. Further south, i.e., beyond 8° southern latitude according to our subdivision (Fig. 6,1–3), the settlement maxima follow a clear chronological gradient towards more recent times. In the southern savannas (Fig. 6,3) the first Iron Age peak only began in the early Christian era, at the time of the second Central African one, yet the former lasted longer, namely until c. AD 600, a period when Central African settlement had already been swiftly declining for a couple of centuries. However, in the northernmost zone

25 Fig. 6 must not be mistaken as exactly representing regional settlement intensities on a pan-African scale during the selected time window, 4000 BC to the present. The reason lies in the bias of the underlying radiocarbon data base towards the regionally and chronologically diverse periods of metal use. For example, the radiocarbon dates on the copper-bearing predynastic cultures of Egypt and those of the Maghreb, while sampled fairly adequately, will obviously not give an adequate impression of 5<sup>th</sup> and 4<sup>th</sup> millennium settlement activity outside the Nile valley, let alone in all of our most northerly zone (>16° northern latitude). On the other hand, for instance the ›Copper Age‹ and Early Iron Age radiocarbon dates from the West African desert and savanna regions were collected with an aspiration for exhaustiveness, while dates on Late Stone Age and Neolithic cultures in the same areas were treated selectively so as to cover above all the transitional periods to the ›Metal Ages‹; they are thus underrepresented.

26 Of these four generally similar curves only the one relating to the zone immediately south of the equator has an untypical one-peak structure (Fig. 6,5). The reason is that a high proportion of radiocarbon dates falling into this zone are on samples from beyond 13,5° East, including the vast majority of the dates from equatorial Eastern Africa (cf. Fig. 3), so that the west Central African peak discussed above does not show up in this set. Calculated jointly, the curves in Figs. 6,5 and 6,6 would resemble the curve in Fig. 4,1 (even though the latter covers a zone wider by 2° latitude).



**Fig. 6:** Group dispersion calibration of late Holocene radiocarbon dates from Africa in the time window 4000 BC – AD 1950. Comparison between 10 different latitude zones. 1 South of 16° S; 2 12–16° S; 3 8–12° S; 4 4–8° S; 5 0–4° S; 6 0–4° N; 7 4–8° N; 8 8–12° N; 9 12–16° N; 10 beyond 16° N.

of the southern hemisphere savannas (Fig. 6,3), around AD 700 a comparably drastic decrease ensued, a period which appears to have seen general low-intensity settlement also in the adjoining equatorial regions up to at least 4° northern latitude (cf. Fig. 6,4–6). Around the equator, this minimum seems to have lasted for the rest of the first millennium AD. By contrast, from AD 800 onwards, settlement intensity in the southern savannas quickly rose again towards the Later Iron Age peak (Fig. 6,3). This in turn largely corresponds to the first Iron Age maximum further south (Fig. 6,2) where settlement had only begun to intensify from c. AD 300 and, more markedly, from the 7<sup>th</sup> century AD. The same peak appears in the curve for Africa south of 16° southern latitude (Fig. 6,1) where it broadly coincides with the regional Early Iron Age.<sup>27</sup>

To the north of the equatorial rainforests (Fig. 6,7–9) curves differ from the Central African ones in that they are inversely skewed, indicating a more comprehensive sampling of the Later Iron Age, especially the period c. AD 500–1500 which is markedly less well represented in the Central African samples at hand. However, in this respect the dispersion of dates from the 4–8° latitude zone (Fig. 6,7) is truly intermediate between the Central African and the more northerly curves, which admits of the possibility that the opposite patterns observed may in fact be representative of substantive historical processes rather than merely indicating sampling differences. In any case, the curves in Figs. 6,8 and 6,9 come close to what might theoretically be expected to be the radiocarbon precipitate, as it were, of consolidated Iron Age societies, basically successful and demographically expansive over at least the first millennium AD. By contrast, the radiocarbon curve for our northernmost zone (Fig. 6,10) mirrors above all the specific research interest behind the underlying data base: its 4<sup>th</sup> millennium BC peak reflects large numbers of radiocarbon dates on the copper-bearing predynastic cultures of Egypt, while the more recent, late 2<sup>nd</sup> and earlier 1<sup>st</sup> millennium BC, maximum is in good part due to dates obtained in some quantity in order to clarify the chronology of early copper and iron production in Niger (Agadez and Termit regions) and Mauritania (Akjoujt region). Thus, while this curve is definitely too biased to allow interpretation in terms of more general later Holocene settlement processes<sup>28</sup>, even here some structural features shine through which appear to be of wider significance.

One of these is the 800–400 BC peak just mentioned which has counterparts in adjoining zones as far south as 4–8° northern latitude (Fig. 6,7–10). Another, still more widespread, phenomenon following this time period is a (local) minimum (or, at least, a plateau) in the second half of the first millennium BC, in evidence at least down to the 4–8° southern latitude zone, but most pronounced in Central Africa, c. 200–0 BC (Fig. 6,4–10).<sup>29</sup> In the Christian era one of the most striking structural patterns is a marked, short local minimum around AD 600, connecting zones as far apart as the Sahel and (culminating around AD 700 in some parts) the southern savannas (Fig. 6,2–9); this may even shimmer through in the faint declines in this time interval of the two extreme, northernmost and southernmost curves (cf. Fig. 6,1.10). A fourth pattern, featuring in five of the ten curves considered here, is constituted by sharp declines after AD 1100/1250 towards minima or

27 The more recent peak in this curve is due to approximately 300 Namibian radiocarbon dates indicating a Southwest African settlement climax after AD 1400. – I owe Ralf Vogelsang a debt of gratitude for generously providing his collection of a large number of these Namibian radiocarbon dates.

28 This is all the more true considering the vast part of the continent and the diversity of geographical regions subsumed in this artificial zone. For instance, it includes parts of the Sahara climatically unsuited for human settlement, say, in the first millennium BC, besides oases and the Nile valley, offering favourable living conditions throughout.

29 As for West Africa, this is reminiscent of the notion of a »1st Millennium BC Crisis« recently proposed by Breunig & Neumann (2002); cf. Breunig et al., this volume.



plateaus (Fig. 6,1–3.8.9).<sup>30</sup> However, sampling of these very recent periods would seem to be in need of substantial revision before any conclusions should be drawn from this tentative observation on the three southernmost and two of the northernmost curves at hand.

Two major conclusions may be drawn from the foregoing comparison of radiocarbon curves relating to latitudinal zones: First, regional fingerprints are discernible, despite all research biases and chance effects determining the actual composition of sample batches submitted for dating; it is suggested that such type curves, when calculated from sufficiently large samples and relating to areas which would, on subdivision, yield generally corresponding curves, may be interpreted as proxy data for basic historical variability in regional settlement intensities and, thus, demographic fluctuations. Second, a number of structural similarities connect curves on supra-regional levels at various scales; explanations for these must be sought in high-level factors governing settlement activity, such as over-exploitation of resources, pandemic human and animal diseases, or climate change. There is clearly enormous interpretative potential in the data presented here but sound interpretations would require in-depth analyses which are beyond the scope of the present paper. However, the comparisons undertaken above highlight the extreme usefulness of complete regional radiocarbon date sets or, if dreaming of such a thing be permitted, a complete pan-African radiocarbon data base.

## Conclusions

We started this little exploration of our African ›Metal Ages‹ data base by pursuing the radiocarbon track left by Manfred Eggert on his paths in the rainforests. This turned out to be more than just the dating record of an individual scholar's personal research agenda, and more than a source of ideas on the chronological positions of specific phenomena in a given study area. Instead, by applying group calibration to this data it could be shown to be quite representative of a larger pattern, an equatorial African radiocarbon fingerprint, as it were, clearly distinguishable from its counterparts in other regions. In a way, we have retrospectively watched a researcher add newly discovered pieces to a lost mosaic much larger than the details he actually set out to reconstruct. For certain, we still have no clear idea of what the original overall picture looked like. But we are beginning to feel that it is critical to keep – and maintain accessible – every piece of the jigsaw, no matter how badly it may serve its most immediate purpose of helping to clarify a specific detail.

The above discussion of cumulative radiocarbon curves revealed some structural aspects of Central Africa's late Holocene settlement history as, for instance, major chronological north-south and west-east gradients. These are not claimed to be new insights. Instead, the approach followed here is intended as a first step towards making fuller use of the dating evidence at hand. The radiocarbon data base behind the present contribution has proved to have the potential of being an adequate tool for this task although, obviously, a lot remains to be done in order to better tap that potential. One such task would clearly be a more comprehensive scrutiny of potential biases contained in the data, of subsets favouring specific time periods to the detriment of others, etc. But already now the preliminary results considered here do seem to indicate that our empirical basis is not so bad after all. As a side effect they yield guidelines for future research, both on a regional and a supra-regional level.

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30 These curves relate to non-rainforest areas. Cf. data presented by Verschuren et al. (2000) on a dry ›Medieval Warm Period‹ (c. AD 1000–1270) in the East African tropics.

However, a more general lesson to be drawn from this study is one concerning data management. I consider radiocarbon dates, be they ›archaeological‹ or ›environmental‹, to be part of the world's historical heritage. From this perspective the manifold problems one is liable to encounter when trying to collect specific sets are unacceptable. It is a sheer waste of precious time tracing obscure literature, comparing contradictory publications, trying to find out about sample materials and  $\delta^{13}\text{C}$  values, or hunting after geographical coordinates of remote sites. It is high time that a global effort be made to ensure safe, long-term storage of all dates, existing and new ones, along with complete records of pertinent information in a centrally administered data base, accessible via internet to anybody interested in making use of them. Such a database could for instance be maintained jointly by the international community of radiocarbon laboratories in collaboration with, or at least under the auspices of, UNESCO. Laboratories should be obliged to report all new dates for publication in that open access data base within some fixed period of, say, one year after measurement, during which the submitters (and payers) may make use of a limited copyright, guaranteeing them to be the first to have the opportunity of exploiting the results. After the lapse of this period, or indeed at any earlier time copyright holders might decide to release them for publication, radiocarbon dates would become World Heritage. As such they would immediately be made accessible and protected against distortion, obscurity, oblivion, and loss. While it remains only too valid that »the future of central African archaeology«, and, one may add, of the archaeology in many other African regions too, »lies in fieldwork« (Eggert 1993, 327), it is equally true that its present state depends on keeping adequate track of what its past has produced in terms of ›imperishable data«.

## References

- Bower, John 1986: A survey of surveys: aspects of surface archaeology in sub-Saharan Africa. *The African Archaeological Review* 4, 21–40.
- Breunig, Peter & Katharina Neumann 2002: Continuity or discontinuity? The 1<sup>st</sup> millennium BC-crisis in West African prehistory. In: Lenssen-Erz, Tegtmeier, Kröpelin et al. 2002, 491–505.
- Clist, Bernard 1995: Gabon: 100 000 ans d'Histoire (Libreville/Paris: Centre Culturel Français Saint-Exupéry/Sépiea).
- 2006: Mise en évidence dans le nord-ouest du Gabon de la présence de l'Homme au sein des forêts d'âge Holocène. *Journal of African Archaeology* 4/1 (in press).
- Eggert, Manfred K. H. 1980: Der Keramikfund von Bondongo-Losombo (Région de l'Equateur, Zaïre) und die Archäologie des zentralafrikanischen Regenwaldes. *Beiträge zur Allgemeinen und Vergleichenden Archäologie* 2, 381–427.
- 1984: Imbonga und Lingonda: Zur frühesten Besiedlung des zentralafrikanischen Regenwaldes. *Beiträge zur Allgemeinen und Vergleichenden Archäologie* 6, 247–288.
- 1993: Central Africa and the archaeology of the equatorial rainforest: reflections on some major topics. In: Thurstan Shaw, Paul Sinclair, Bassey Andah & Alex Okpoko (eds.), *The Archaeology of Africa. Food, Metals and Towns. One World Archaeology* 20 (London/New York: Routledge) 289–329.
- 2002: Southern Cameroun and the settlement of the equatorial rainforest: early ceramics from fieldwork in 1997 and 1998–99. In: Lenssen-Erz, Tegtmeier, Kröpelin et al. 2002, 507–522.
- Elenga, Hilaire, Jean Maley, Annie Vincens & Isabelle Farrera 2004: Palaeoenvironments, palaeoclimates and landscape development in atlantic equatorial Africa: a review of key sites covering the last 25 kyrs. In: Richard W. Battarbee, Françoise Gasse & Catherine E. Stickley (eds.), *Past Climate Variability through Europe and Africa. Developments in Paleoenvironmental Research* 6 (Dordrecht: Springer) 181–198.
- Gehlen, Birgit, Karin Kindermann, Jörg Linstädter & Heiko Riemer 2002: The Holocene occupation of the eastern Sahara: regional chronologies and supra-regional developments in four areas of the absolute desert. In: Lenssen-Erz, Tegtmeier, Kröpelin et al. 2002, 85–116.

- Heine, Bernd, Hans Hoff & Rainer Vossen 1977: Neuere Ergebnisse zur Territorialgeschichte der Bantu. In: Wilhelm J. G. Möhlig, Franz Rottland & Bernd Heine (eds.), *Zur Sprachgeschichte und Ethnohistorie in Afrika: Neue Beiträge afrikanistischer Forschungen* (Berlin: Reimer) 57–72.
- Lenßen-Erz, Tilmann, Ursula Tegtmeier, Stefan Kröpelin et al. (eds.) 2002: *Tides of the Desert: Contributions to the Archaeology and Environmental History of Africa in Honour of Rudolph Kuper*. *Africa Praehistorica* 14 (Köln: Heinrich-Barth-Institut).
- Maley, Jean 1993: The climatic and vegetational history of the equatorial regions of Africa during the upper Quaternary. In: Thurstan Shaw, Paul Sinclair, Bassey Andah & Alex Okpoko (eds.), *The Archaeology of Africa. Food, Metals and Towns*. *One World Archaeology* 20 (London/New York: Routledge) 43–52.
- Oslisly, Richard 2001: Chronologie des âges du fer dans la moyenne vallée de l'Ogooué au Gabon. In: Jean-Paul Descœudres, Eric Huysecom, Vincent Serneels & Jean-Louis Zimmermann (eds.), *The Origins of Iron Metallurgy. Proceedings of the First International Colloquium on the Archaeology of Africa and the Mediterranean Basin held at the Museum of Natural History in Geneva, 4–7 June, 1999*. *Mediterranean Archaeology* 14 (Sydney: Meditarch) 263–268.
- Oslisly, Richard & Bernard Peyrot 1992: L'arrivée des premiers métallurgistes sur l'Ogooué, Gabon. *The African Archaeological Review* 10, 129–138.
- Phillipson, David W. 1977: The spread of the Bantu languages. *Scientific American* 236, 106–114.
- Runge, Jürgen 2002a: Holocene landscape history and palaeohydrology evidenced by stable carbon isotope ( $\delta^{13}\text{C}$ ) analysis of alluvial sediments in the Mbari valley (5°N/23°E), Central African Republic. *Catena* 48, 67–87.
- 2002b: Wie alt ist der Regenwald? Umweltgeschichtliche Forschungen im Kongobecken Zentralafrikas. *Forschung Frankfurt* 1–2/2002, 22–29.
- Vansina, Jan 1995: New linguistic evidence and the 'Bantu Expansion'. *Journal of African History* 36, 173–195.
- Verschuren, Dirk, Kathleen R. Laird & Brian F. Cumming 2000: Rainfall and drought in equatorial east Africa during the past 1,100 years. *Nature* 403, 27 January 2000, 410–414.
- Weninger, Bernhard 1986: High-precision calibration of archaeological radiocarbon dates. *Acta Interdisciplinaria Archaeologica (Nitra)* 4, 11–53.
- Wiesmüller, Birgitt 1996: Untersuchungen zur Chronologie der frühen Eisenzeit in Afrika anhand linguistischer, archäologischer und naturwissenschaftlicher Quellen. *Beiträge zur Allgemeinen und Vergleichenden Archäologie* 16, 139–214.
- Wotzka, Hans-Peter 1995: Studien zur Archäologie des zentralafrikanischen Regenwaldes: Die Keramik des inneren Zaire-Beckens und ihre Stellung im Kontext der Bantu-Expansion. *Africa Praehistorica* 6 (Köln: Heinrich-Barth-Institut).