Africa 56 (2), 1986

BASSAR: A QUANTIFIED, CHRONOLOGICALLY CONTROLLED, REGIONAL APPROACH TO A TRADITIONAL IRON PRODUCTION CENTRE IN WEST AFRICA

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Until quite recently little was known about the output of traditional ironworking centres in sub-Saharan Africa. Although some estimates were made for a few centres by colonial administrators and agents, the reliability of many of these figures is doubtful (see Pole, 1983; de Barros, 1985: 270–71) and some of the more interesting data still lie buried in colonial archives. The first serious scholarly attempt at quantification of precolonial African iron production was made by Warnier and Fowler (1979) who investigated iron production in the Iron Belt of the Cameroon grasslands, particularly that associated with the nineteenth-century Babungo chiefdom. Since then Goucher (1981, 1984) and Pole (1983), and to a lesser extent Haaland (1980), have provided some important quantitative data regarding both large and small ironworking centres in West Africa.

In all cases, however, production estimates have been limited either to the total iron (or slag) production for all time periods or to the annual output of a single time period or at contact. To my knowledge, recently completed research in the Bassar region of northern Togo represents the first chronologically controlled study of changing levels of iron production for a major African ironworking centre. It not only provides important data on the development and scale of iron production in Bassar and in West Africa during the later Iron Age, it also makes it possible to study the interrelationships between changes in the level of iron output, external historical forces and important developments within the ironworking society, in this case that of the Bassar.

The present article focuses primarily on the evolution and scale of the Bassar iron industry in terms of both production and exchange and how it compares with other major ironworking centres in Africa. A brief comparison is also made with some Roman period sites in Western Europe. Along the way it discusses some of the factors which helped make Bassar a major iron-producing centre.

THE BASSAR REGION

The Bassar region is located in northern Togo about 360 km from the West African coast. Only 9 degrees north of the equator, Bassar's climate is tropical and is characterised by a rainy season (April-October) followed by a dry season. Annual rainfall is variable but averages 1300–1400 mm (50–55 inches). The vegetation was originally savanna-woodland, but most of the tree cover has been removed by centuries of farm clearance and charcoal-making for the iron industry.

Lying just on the periphery of the Togo Hills (Atakora Mountains), the physical landscape of the Bassar region is characterised primarily by two discontinuous mountain chains oriented north–south and separated by a peneplain about 25–30 km wide which is dissected by the Katcha River (see Figs. 1 and 2). The region is inhabited by the Bassar, a name derived from a deity associated with Mount Bassar which rises over 450 m above the Katcha Valley. The Bassar call themselves the *Bi-tchambe*, i.e. those who speak *Tcham*, a language belonging to the Para-gurma or Voltaic group (see Cornevin, 1962: 11; Greenberg, 1970). Most Bassar live in the four population centres of Bassar (18,000 inhabitants), Kabu, Bandjeli and Bitchabe (see Fig. 2).

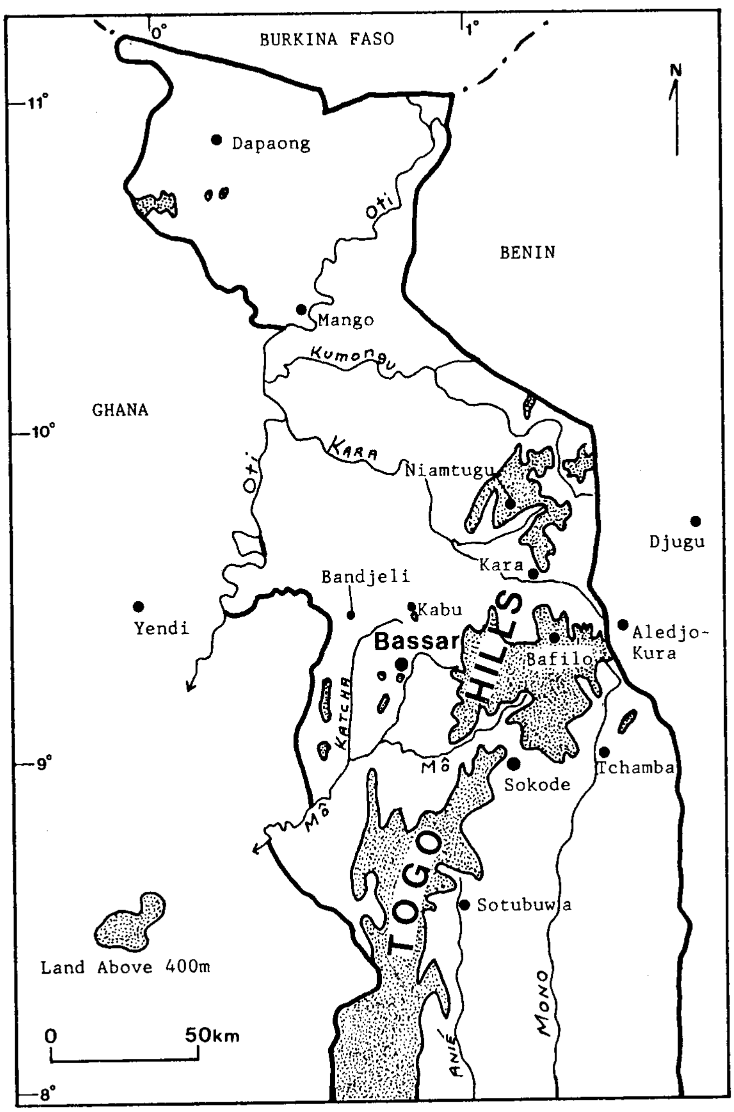

FIG. 1 *The Bassar region in its geographical context*

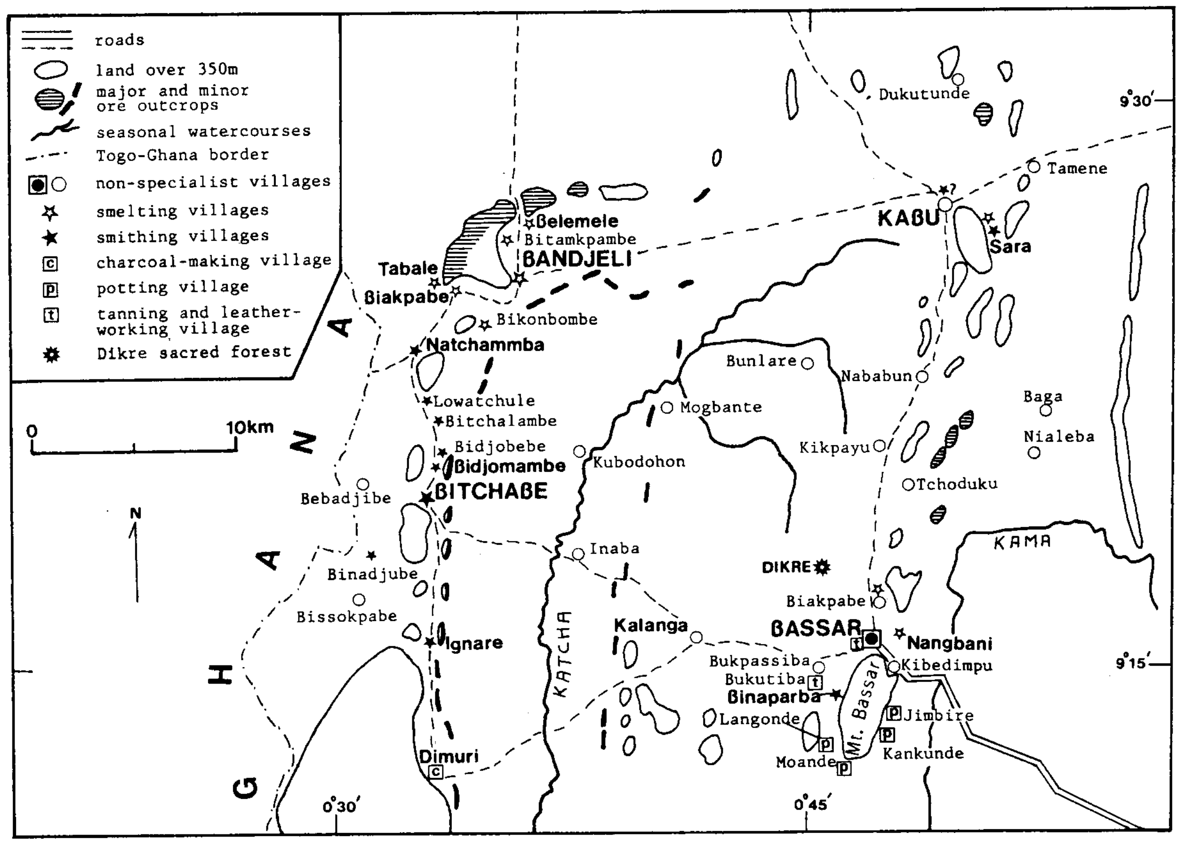

FIG. 2 *The heart of the Bassar iron industrial region showing specialist villages as they existed at contact. All nonspecialist villages except Bebadjibe, Bissokpabe, Kabu and those near Mt Bassar were not present at contact*

Bassar region iron ore deposits are estimated to be well over 500 million tons (Lawson, 1972) and generally outcrop as large hills or mountains located within or adjacent to the major mountain chains running along the north–south axes of Bandjeli–Bitchabe–Dimuri to the west and Kabu–Bassar to the east. The richest ore deposit is located near Bandjeli and contains up to 60+ per cent iron (Koert, 1906). The latter deposit is also relatively free of silica and phosphorous, impurities which tend to have a negative impact on smelting operations and iron quality (see Tylecote, 1962: 182; Eckel, 1914: 155 as cited in Kense, 1983: 34). Other major deposits are found north of Kabu and between Kabu and Bassar (see Fig. 2), but these eastern ores, as well as the hematite outcrops in the Bitchabe area, are less rich in iron (35–45 per cent) and contain substantial amounts of silica (Simpara, 1978; Lawson, 1972).

BASSAR SMELTING AND SMITHING

Thanks to early German accounts (Hupfeld, 1899; Fisch, 1911), the presence of relatively intact furnaces at numerous sites, and information provided by aged smelters and smiths (who ceased their activities in the 1950s), much is known about Bassar mining, furnaces, and smelting and smithing techniques (see also Goucher, 1984; Martinelli, 1982). Only the briefest summary will be presented here.

Mining

Hematite ore was obtained from surface trenches and pits a few metres deep. The abundance of surface outcrops rendered the creation of subterranean galleries unnecessary. In the Bandjeli area the mining was done by the women (Gehrts, 1915: 227–48) who used wooden-handled iron picks (*kutchoko*) as their major digging tool. Once mined, the ore was crushed into small nut-sized bits and most impurities were removed.

Bassar furnaces and smelting techniques

Furnaces were of the induced draught type and ranged from 2m to 4m in height. Seven to eleven draught holes were spaced evenly near the base. The amount of induced draught was controlled by the opening and closing of cylindrical clay tuyeres or tewels (*umpolo*) during the smelting process. On one side of the furnace was a large curved opening which was closed during the smelt but was opened up to extract the iron bloom once the smelt was completed (see Fig. 3 and Photo 1). Bassar furnaces were made of a relatively fine-grained, refractive, tan to orange-brown to orange-red clay (*tipatin* or *tepete*) which is found in many parts of the region.

Currently available archaeological data suggest the existence of three furnace varieties or size modes: (1) the relatively straight-sided 'Bandjeli' furnace which is 2–2·5 m in height, 1+ m in diameter (approximately 70 cm interior diameter) and has walls about 20 cm thick (see Fig. 3a); (2) the slightly bulbous 'Kabu-Sara' type located in the eastern region (from north of Kabu to just north of Bassar), which is usually 2·5–3·0 m tall, 1·5+ m in diameter (with a maximum interior diameter typically 80–90+ cm) with walls averaging about 40 cm thick; and (3) the conical shaped 'Nangbani' furnace which attains 3·5 m or more in height, 2 m or more in diameter (about 85 cm maximum interior diameter) and which has walls up to 75–80 cm thick near the base (see Fig. 3b and Photo 2).

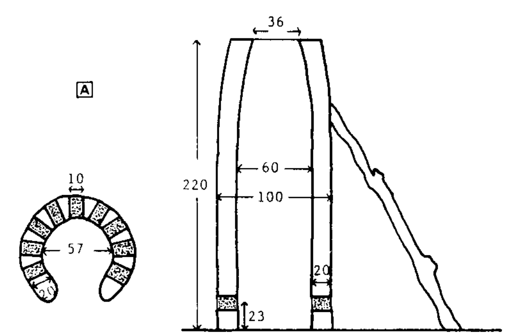

FIG. 3a *Bandjeli furnace (after Hupfeld, 1899). Measurements are in centimetres and are Hupfeld's (except for furnace height). The wooden ladder was used for loading and repair operations. Tuyeres not shown*

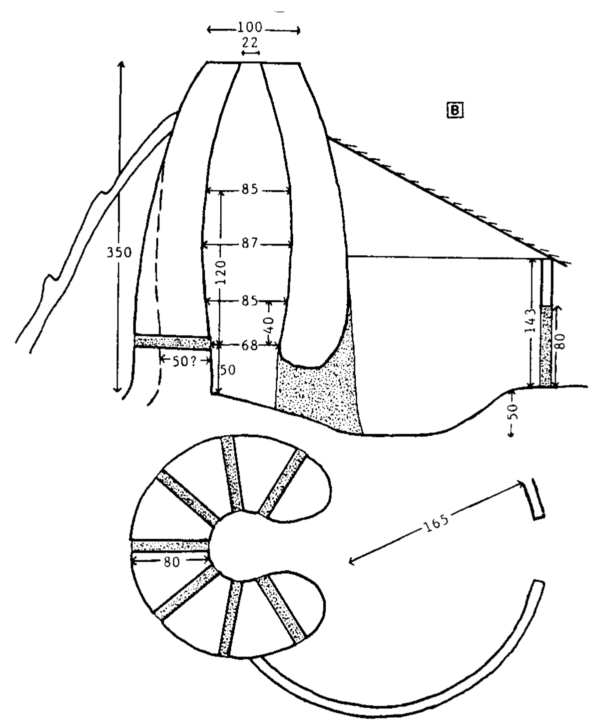

FIG. 3b *Nangbani furnace, after Hupfeld's (1899) rendition of a furnace near Bassar town. The dashed line represents the probable profile of Kabu-Sara furnace, which had thinner walls at the base. Measurements are in centimetres and are Hupfeld's (except Kabu-Sara wall thickness). The circular shelter with thatched roof was typical of eastern furnaces. Tuyeres not shown*

Informants told Hupfeld (1899) that the larger furnaces of the eastern region were necessary to obtain the standard-sized iron bloom using the inferior-grade iron ores of this zone (see also Goucher, 1984: 109).

Bassar furnaces were loaded with alternating layers of iron ore and wood charcoal fuel. Between 80 and 110 kg of ore was used per smelt in Bandjeli and somewhere between 90 and 160 kg in the east (see de Barros, 1985: chapter 10). A typical smelt lasted about two days in Bandjeli and anywhere from two to five days in the east, in each case producing an iron bloom weighing around 30 kg. It has been estimated that a given iron bloom was about 50–60 per cent pure iron (see de Barros, 1985: 280–84).

PHOTO 1 *Bandjeli furnace (scale: 2-m rod)*

Smithing

Bassar smiths obtained iron bloom from their smelting counterparts which was then broken up and crushed in iron crushing and grinding mortars made of stone (see Photo 3). Large and small cobbles and even small spherical boulders were prepared and used as pounders and crushers. Once the bits and pellets of iron were separated from the slag, they were mixed with clay and vegetable fibre to form a ball (*letankulne*). These tasks were generally performed by the women whose husbands did the actual smithing. The *letankulne* was then worked in the forge to improve the purity and working characteristics of the iron.[1] Then and only then was the iron made into hoes, axes, arrowheads, knives, spears, ceremonial bells and smelting and smithing tools. Although many forging tools

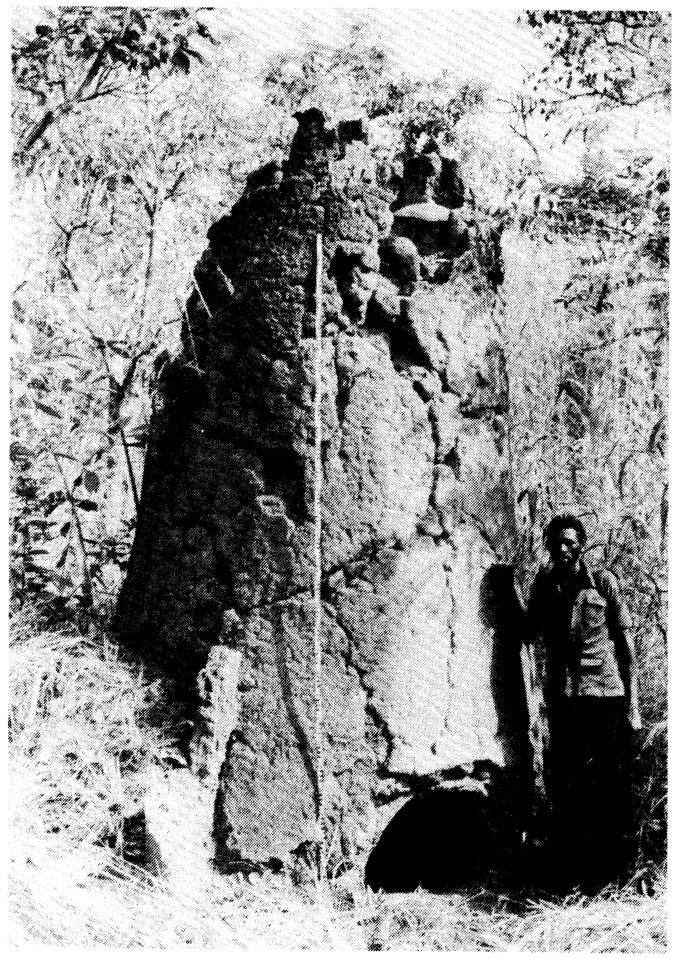

PHOTO 2 *Nangbani furnace (scale: 3-m rod)*

were made of iron, anvils and the large hammers used for the rough-out work were made of heavy quartzite stone. Bellows made of animal skins fitted to a wooden frame were used to force air into the forge pit using a funnel-shaped tuyere made of clay and straw or kapok.[2]

Village specialisation within the iron industry

Intra-industry specialisation was characteristic of Bassar metallurgy when the German colonialists first made contact in the 1890s. This internal division was most highly developed in the western part of Bassar: smelting was done by the villages around the rich iron deposits at Bandjeli; villages specialised in smithing from Natchammba to Bitchabe and Ignare to the south where quartzite stone for anvils and hammers is abundant; the charcoal making was the speciality of Dimuri which was located near forested areas not yet exhausted by the industry (see Fig. 2).

PHOTO 3 *Stone iron-crushing mortar (scale: 50-cm rule)*

In addition, within most villages there was a sexual division of labour. For example, in the Bandjeli area the women generally did the mining and transporting of the ore, while the smelting was limited to the men. A similar division of labour among smiths and their wives is described above.

To the east smelting and smithing villages (or residence groups) were closely associated with the rise of the nineteenth-century chiefdoms of Bassar (Nangbani, Binaparba) and Kabu (Sara) (see Fig. 2).

THE MAJOR IRON PRODUCTION CENTRES OF THE BASSAR REGION

In 1981 an extensive survey was undertaken to determine the spatial extent of the industry and to locate the major production centres. The Bassar region is much too large to accomplish this using formal sampling techniques within a few short months. Instead, it was assumed that most iron smelting probably took place within a few kilometres of the major ore deposits. Therefore farmers from most of the villages and residence groups located near the two main ore axes – Bandjeli–Bitchabe and Kabu–Bassar – were asked about the location of slag in their fields. (An earlier experience had shown that farmers are very much aware of even small quantities of slag on their land.) In addition a sample of villages and hamlets from the Bassar peneplain was also visited to verify whether any important smelting sites were present. Such a procedure did not, of course, produce a fully representative or complete inventory of smelting sites, but subsequent work has shown that it did provide a good picture of the spatial distribution of smelting sites of various sizes, including the location of the major production centres. With the additional information gathered during a 1982 intensive survey (see below), a total of 151 smelting sites was recorded.

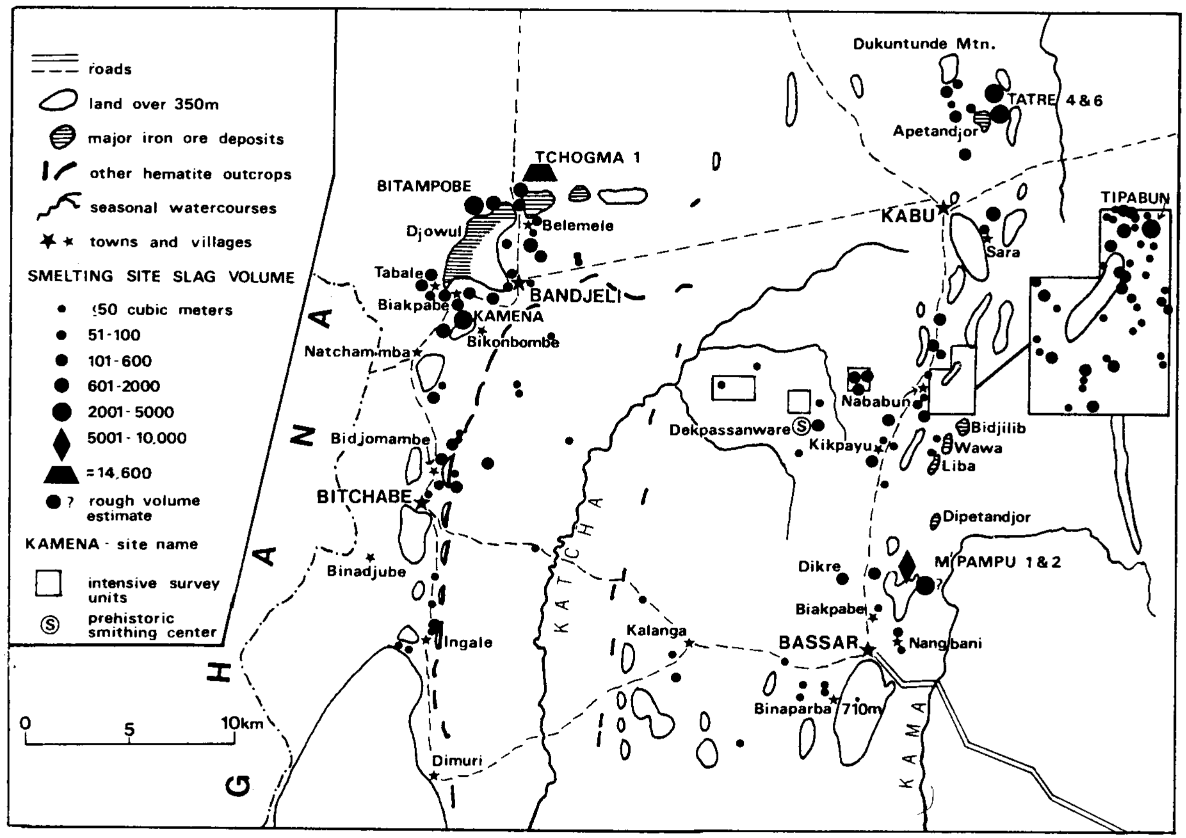

FIG. 4 *Estimated slag volume of Bassar region smelting sites located on survey. Mound dimensions were directly measured using metric tape and line level for the intensive survey sites, Tchogma 1–4 and Tatre 4–6; for all other sites, mound lengths and widths were paced and heights were visually estimated, often with aid of metric tape. The names of the major ore deposits and the Dekpassanware smithing site are also shown*

Fig. 4 presents the location and relative size (in terms of slag volume) of each site. The Bandjeli zone around the rich Djowul ore source was clearly the most important production centre. It is here that one finds the most spectacular site of the Bassar region, Tchogma 1. This site contains 184 slag mounds, a good number of which are over 4 m in height and 20–30 m in length. Other important centres were located near the Apetandjor ore mountain north of Kabu, in the vicinity of the Bidjilib–Wawa–Liba hill deposits near Nababun, and just south of the Dipetandjor ore source near Bassar. Smelting clearly took place in the Bitchabe zone, but it apparently never became a major iron producer. Well before the arrival of the Germans this zone abandoned smelting in favour of smithing. In fact villages from this zone have no recollection or tradition of ever having smelted there.

Smelting sites and ore deposits

Fig. 4 also shows quite clearly the close spatial association between smelting sites and ore deposits. Statistically the data can be summarised as follows:

Distance to nearest ore deposit (km)	*Percentage of sites*	*Percentage of slag volume*
0–1	30	49
0–2	57	77
0–4	85	97

While nearly all slag is found within a 4-km radius of the nearest ore deposit, what is more striking is that more than 75 per cent is found within 2 km. In fact, if the smelting sites of the Nababun–Kikpayu zone are excluded, over 90 per cent of the slag is within a 2-km radius. In the Nababun zone, however, most of the slag is located *more* than 2 km from the nearest ore. This can be best explained by the presence of a permanent spring at Tipabun about 3 km north of the Bidjilib ore deposit. Local informants stress the importance of access to water for furnace construction and repair. In addition there was a definite tendency to avoid large-scale smelting in areas of good farmland, such as the land just north of the Bidjilib ore deposit (see de Barros, 1985: 196).

TEMPORAL DEPTH AND MAJOR PRODUCTION PERIODS

It is often difficult to determine when smelting activity began in a given zone because early smelting operations were probably conducted on a small scale resulting in relatively small slag mounds or surface scatters. Many or most of these deposits have subsequently been buried by later sediments or destroyed by the farmer's hoe. One of the simplest and most effective methods of dating smelting sites is through radiocarbon dating of the remains of wood charcoal fuel found in the slag mounds. However, with small slag mounds and scatters there is a danger of contamination due to the burrowing of rodents and the cultivation of cereals on the mound surface. To avoid such problems in the Bassar region, mounds less than 50–60 cm in height were not dated. In view of this the earliest ^{14}C dates presented below probably point to a time when the Bassar industry was already well developed rather than to its period of origin.

The radiocarbon dates obtained from thirteen sites shown in Table 1 strongly suggest that the Bassar smelting industry was firmly established by the fourteenth century AD (see also Fig. 5). Six calibrated dates fall within this time period with the earliest reliable dates falling in the late thirteenth century AD.[3] These early dates are also well distributed throughout most of the region, with three near Nababun and one each in the Bitchabe, Bassar and Kabu zones. The dates (along with oral traditions) also clearly show that smelting activity continued uninterrupted well into the twentieth century.

TABLE I *Radiocarbon dates from Bassar smelting sites*

No.	*Lab no.*	*Site no.*	*Site name*	*Regional location*	*No. of mds*	*Radiocarbon date (BP)*	*Tree-ring calibrated date after Clark (1975)*
1	Beta-4400	4	No. Tchogma 1	Bandjeli	184	260 ± 50	AD 1530–1655
2	Beta-8801	4	So. Tchogma 1	Bandjeli	184	270 ± 50	AD 1510–1650
3a	Beta-3043	34	Tchatchafaroko 1	Bandjeli	22	<300	<300 years*
3b	UCLA-2355A	34	Tchatchafaroko 1	Bandjeli	22	<300	<300 years*
4	Beta-3042	9	Kounkoule	Bitchabe	8	580 ± 50	AD 1350–1415
5	Beta-4401	17	Tatre 2	Kabu	10	610 ± 50	AD 1330–1405
6	Beta-5353	5	No. Tipabun	Nababun	103	220 ± 50	AD 1590–1685
7a	Beta-6340	5	So. Tipabun	Nababun	103	<300	<300 years*
7b	*UCLA-2516*†	5	So. Tipabun	Nababun	103	800 ± 200	AD 985–1375
8a	Beta-6339	213	—	Nababun	26	350 ± 50	AD 1460–1600
8b	UCLA-2515†	213	—	Nababun	26	835 ± 200	AD 960–1360
9	Beta-3415	6	Nababun 1	Nababun	6	590 ± 50	AD 1345–1410
10	Beta-5351	228	—	Nababun	9	580 ± 50	AD 1350–1415
11	Beta-6293	269	—	Nababun	4	<300	<300 years*
12	Beta-6292	234	—	Nababun	11	<300	<300 years*
13	Beta-3416	7	Nababun 10	Nababun	13	660 ± 60	AD 1265–1385
14	Beta-5352	252	Dekpassanware	Nababun	12	330 ± 50	AD 1470–1615
15	Beta-3044	8	Dakpande	Bassar	3	510 ± 50	AD 1385–1445

* Based on Suess (1970) as Clark curve cannot be used with analytically modern dates.
† Both the UCLA and Beta dates from sites 5 (south) and 213 are based on charcoal from approximately the same depth of the same test pits. But all other chronological evidence (oral traditions, associated pottery and seriation results, furnace decay states and slag mound soil profiles) support the later, Beta dates. Perhaps the early dates represent traces of a much earlier smelting activity.

In addition to evidence for early smelting activity, a number of important prehistoric smithing sites were encountered in the Nababun zone which all belong to the same ceramic phase (see especially the 15-ha site of Dekpassanware in Fig. 4). Ceramic seriation results for the Bassar region suggest that these smithing sites date to the late first millenium AD. A thermoluminescent date for a surface sherd associated with smithing debris (tuyere fragments and smithing furnace bottoms) at Dekpassanware also falls within this period (Alpha 567: 1180 BP ± 20 per cent or AD 770 ± 236 years). Additional excavated TL samples have recently been obtained which, it is hoped, will confirm and render more precise the time period suggested above.

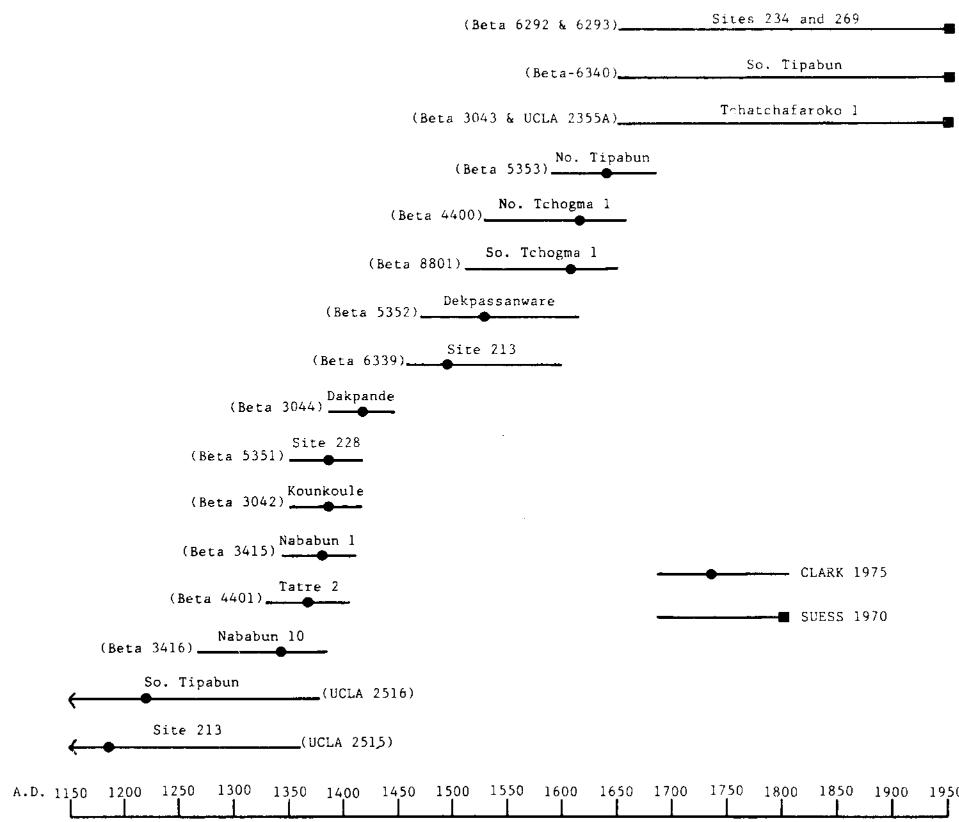

FIG. 5 *Calibrated radiocarbon dates from Bassar smelting sites. Suess (1970) was used to correct analytical modern dates since Clark (1975) is not easily interpreted for such dates. (See note to Table 1 regarding the two early UCLA dates)*

If the calibrated radiocarbon and thermoluminescent dates are examined in conjunction with oral traditions, written documents, surface and excavated ceramics, furnace decay states, slag mound soil profiles and smelting site slag volume (see below),[4] it is possible to divide the history of the Bassar iron industry into four time periods which primarily reflect major changes in the level of iron production but which also relate to important political, military, economic and demographic developments in the region. The four periods are as follows:

Period 1: Small-scale production for basically local needs:
Late-first millennium AD?–AD 1300/1350.

Period 2: Significant regional iron production:
AD 1300/1350–1550/1600.

Period 3: Large-scale production for supra-regional export:
AD 1550/1600–*ca.* 1800.

Period 4: Expanding production, disruption and eventual decline:
ca. AD 1800–1905 (Kabu–Bassar axis)
1925 (Bandjeli)

THE EVOLUTION OF BASSAR IRON PRODUCTION

Through the judicious use of smelting site survey data, oral traditions, ethnohistorical accounts and German colonial archives, it has been possible to estimate roughly the changing levels of iron output from period to period for the Bassar region as a whole and for each production zone within the region. This was accomplished in both a relative sense using differences in the volume of slag produced per period, and in an absolute sense by converting slag volume into estimates of actual iron output. With such chronologically controlled, quantified data it then becomes possible to examine the interrelationships between changing rates of iron production and important external and internal developments affecting the Bassar region.

It is important to note, however, that the procedures used to estimate changing rates of iron production were based on two important assumptions:

1. that any technological changes which occurred over time did not significantly alter the ratio of slag to usable iron produced per smelt within a given production zone;[5]
2. that changes in the rate of production of iron at one of the major production centres (Nababun–Kikpayu) could be roughly and cautiously extrapolated to other major production zones (e.g. Bandjeli and Kabu).

To the extent that these assumptions are incorrect, the estimates presented below will be in error. These assumptions were necessary, however, due to insufficient data on earlier technological procedures and the impossibility of doing an in-depth investigation of all major production zones within the financial and time constraints of the project. In spite of the potential for error, however, it is felt that the estimates are of the right order of magnitude and are thus an important contribution to our knowledge about West African iron production.

Changing production levels as measured by slag volume

Methods. Volume formulas were detemined for typical slag mound shapes based on the simple dimensions of mound length, width and height. Most mounds were viewed as three-dimensional paraboloid segments with elliptical (occasionally bent elliptical) bases. Crescent-shaped (and near circular) forms were treated somewhat differently.

The actual assignment of a given smelting site to the proper time period(s) was a multi-step task. Slag volume associated with Period 1 sites (pre-AD 1300) was assumed to be negligible in the context of the present analysis and was therefore ignored. Period 4 (nineteenth- and early twentieth-centuries) sites were identified on the basis of oral traditions, furnace decay state (including the presence of standing furnaces) and on the presence of surface fragments of large water jars of a particular type (see de Barros, 1985: Appendix 3).

Identifying Period 2 and 3 sites was a more difficult task, particularly since Period 2 sites often could only be identified using radiocarbon dating, a relatively expensive procedure. Therefore it was decided to sample smelting sites from one of the major Bassar region production zones and to date sites carefully in order to estimate the difference in the rates of production between the two periods. The results were then cautiously extrapolated to the other major production zones.

In 1982 an east–west band running from the oreless eastern part of the Katcha River valley to the Bidjilib ore deposit near Nababun was cluster-sampled. Over 9 square kilometres were surveyed (see Fig. 4). Located smelting sites were subsequently assigned to one (or more) time periods on the basis of radiocarbon dates, associated surface and excavated ceramics, oral traditions, furnace decay states and the degree of development of slag mound soil profiles. A 10 per cent correction factor was used to account for the loss of slag mound volume due to the effects of sedimentation at older sites.

Depending upon the actual lengths of Periods 2 and 3 (see above), the final tabulation of slag mound volumes indicated a 400–600 per cent increase in the rate of production during Period 3 in the Nababun–Kikpayu zone. To what extent could this increase be applied to the Bassar region as a whole? Such an increase was clearly only applicable to those zones which became important production centres during Period 3. The available archaeological and ethnohistorical evidence, including the radiocarbon dates presented in Table 1, indicated that only the Bandjeli, Kabu and Nababun zones fell into this category.[6] Oral traditions, furnace decay states and surface ceramics, as well as the similar level of ore quality, suggested that the Kabu zone's production history was similar to that of the Nababun–Kikpayu zone. However, the two radiocarbon dates from the large site of Tchogma 1 north of Bandjeli suggest the possibility that large-scale iron production in the Bandjeli zone may have begun as much as a half a century earlier, i.e. AD 1500/1550 (see Beta 4400 and Beta 8801 in Table 1). If true, it would not be surprising in view of the high quality of Bandjeli iron ores. None the less, the spread of the Tchogma calibrated radiocarbon dates only suggests this possibility; it does not clearly demonstrate it. Therefore, until more precise chronological data are obtained, it was cautiously assumed that the Nababun figures roughly apply to the Bandjeli zone as well.

As for the Bassar and Bitchabe zones, the available data suggest that the total amount of slag produced during Period 3 probably did not surpass that produced during Period 2, indicating only a 0–50 per cent increase in the rate of iron production. This was, of course, only an educated guess, but it is probably of the right order of magnitude.

Finally, in determining the slag volume for each production period a conservative estimate of the minimum amount of unrecorded slag in each production zone was incorporated into the final totals.

Results. The slag volume estimates per time period for each production zone and for the Bassar region as a whole are shown in Table 2. Estimates of the relative changes in iron production levels, which vary according to the actual lengths of Periods 2 and 3, are presented in Table 3 and are illustrated graphically in Fig. 6.[7] From these data several points emerge.

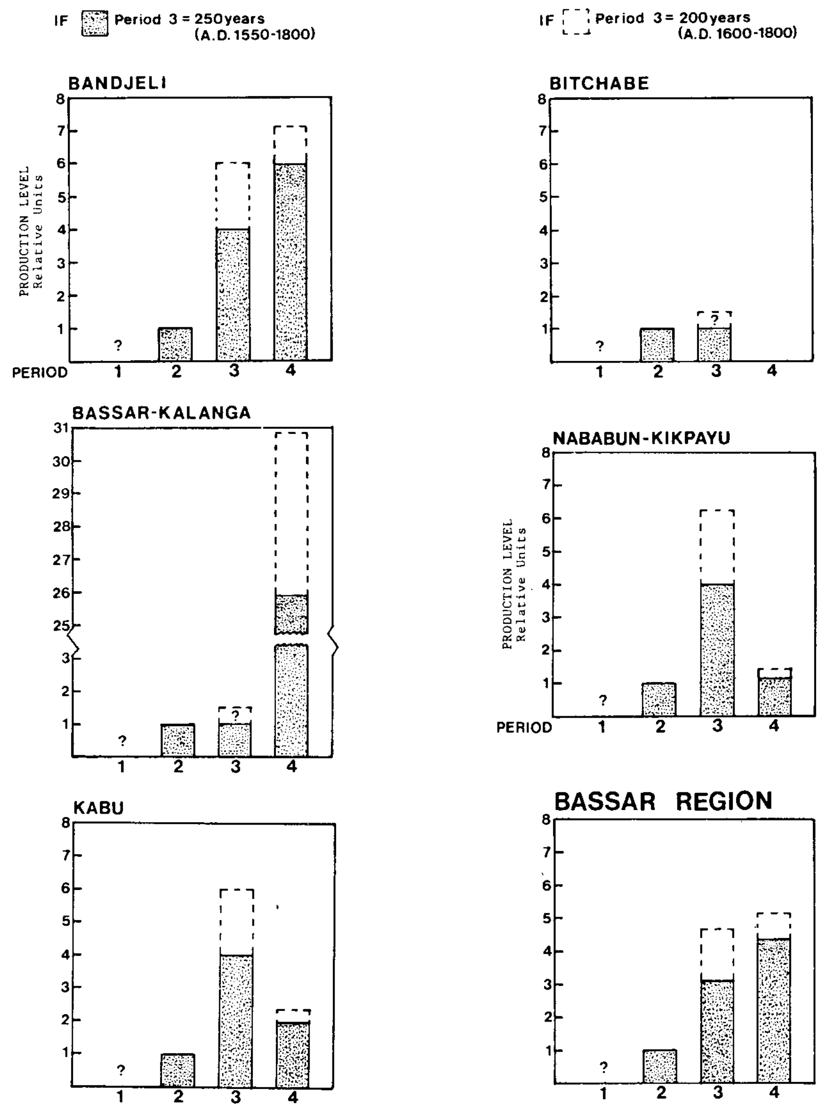

FIG. 6 *Changing levels in the rate of iron production over time in the Bassar region as measured through slag volume. Estimated changes in production levels are illustrated for each of the five production zones and for the Bassar region as a whole*

TABLE 2 *Estimated slag volumes per time period for Bassar region production zones*

Zone	Slag volume (m^3) Period 2	Period 3	Period 4	All periods
Bandjeli	3,935	15,740	11,665	31,340
Bitchabe	2,853	2,853	0	5,706
Bassar–Kalanga	1,195.5	1,195.5	12,950	15,341
Nababun–Kikpayu	2,900.2	11,600.8	1,510	16,011
Kabu	2,375.8	9,503.2	2,047	13,926
Eastern section (three zones)	6,471.5	22,299.5	16,507	45,278
Bassar region (five zones)	13,259.5	40,892.5	28,172	82,324

Note: In each zone the totals include a conservative estimate of the minimum amount of slag that was not recorded due to incomplete survey. The zonal breakdown was as follows (in cubic metres of slag): Bandjeli – 1000; Bassar/Kalanga – 1500; Kabu, Nababun/Kikpayu and Bitchabe – 4000.

TABLE 3 *Changes in the rate of iron production in the Bassar region measured in terms of slag volume*

Zone	Estimated increase or decrease in production rate (%) Period 1 to Period 2	Period 2 to Period 3	Period 3 to Period 4
Bandjeli	?	400–600 increase	19–48* increase
Bitchabe	?	0–50? increase	100 decrease
Bassar–Kalanga	?	0–50? increase	2058–2578 increase
Nababun–Kikpayu	?	400–600 increase	69–75 decrease
Kabu	?	400–600 increase	49–59 decrease
Eastern section (3 zones)	?	345–517 increase	41–76 increase
Bassar Region (5 zones)	?	308–463 increase	10–38 increase

Note: Production rate changes are expressed as a range of values due to the imprecise length of time periods.

Period 1: late-first millennium AD–AD 1300/1350
Period 2: AD 1300/1350–1550/1600
Period 3: AD 1550/1600–*ca.* 1800
Period 4: *ca.* AD1800–1905 † (eastern section)
ca. AD 1800–1925 † (Bandjeli)
ca. AD 1800–1925 (Bassar region)

* If large-scale production began as early as AD 1500 in the Bandjeli zone, then the Period 3 to Period 4 increase would be as high as 78 per cent.

† Iron production basically ceased in the eastern section *ca.* 1905/1910 and was negligible in the Bandjeli zone after 1925.

First, the Bassar region contains at least 82,000 m^3 of slag, a figure which proves to be of continental importance and places Bassar among the most important iron producers in African history (see below). Second, with 38 per cent of the total regional slag, the dominance of the Bandjeli production zone is clearly confirmed. Moreover, while the Bassar–Kalanga zone appears to have outproduced the Bandjeli area during Period 4, it will be shown later that this dominance in slag production does not in fact translate into superior levels of *iron* production because eastern Bassar furnaces probably produced close to twice as much slag per kilogramme of usable iron (see de Barros, 1985: 289–93).

Third, in spite of the approximately 300–450 per cent increase in iron production during Period 3 (see Table 3), Bassar iron production continued to expand during Period 4, perhaps by as much as 40 per cent. In view of the rapid growth of the trade of European iron to West Africa during the nineteenth century (see Goucher, 1981: 188), this is a rather unexpected result. It does not appear to be an isolated case, however, since Warnier and Fowler's (1979) data for the Babungo chiefdom (Cameroon) also show that peak production levels occurred during the nineteenth century. This suggests that indigenous African iron production was more able to compete with imported European iron than was once thought (see Pole, 1982; see also Goucher, 1984).

While iron production increased throughout Periods 2, 3 and 4 for the Bandjeli zone and for the Bassar region as a whole, it dropped precipitously during Period 4 in the Nababun and Kabu zones and disappeared altogether in the Bitchabe area. These declines, however, were more than offset by the spectacular expansion of production near the town of Bassar (a 2000+ per cent increase; see Fig. 6).

Historical explanation of changing iron production levels

While it is not clear why Bassar iron production begins to take on some importance as early as the fourteenth century, the great leap in production during Period 3 (late sixteenth–eighteenth centuries) is probably due to the emergence of the neighbouring states of Dagomba, Mamprusi and Gonja during the fifteenth and sixteenth centuries (see Fage, 1978: 97–8) which would have increased the demand for iron in the form of weapons and which helped stimulate long-distance trade into the Middle Volta Basin, as did the rise of Bono-Mansu and its Asante successor state (Levtzion, 1968: 5–6; see Fig. 7). A probable general increase in the population of West Africa due to the introduction of American food plants (cassava, groundnuts and corn) may also have been a factor (see Vansina, 1960: 226–7; Hopkins, 1973: 30–31).

The vicissitudes in zonal production during Period 4 can best be understood in the light of important political, military and economic developments which began to take shape during the late eighteenth century. During the 1770s tribute relations between the state of Dagomba and their Asante masters were regularised (Wilks, 1975: 21–3). To obtain the 2000 slaves, 800 cattle and 1600 sheep required each year (*ibid.*: 432) it is highly probable that the traditional raiding of the Bassar region by the Dagomba increased dramatically in frequency. During the early 1790s (Norris, 1984; personal communication), the Tyokossi kingdom centred on Mango to the north began to expand southwards and aggressively raided the Bassar region. Both Dagomba and Tyokossi raids are confirmed by vivid Bassar oral traditions. The combined pressure of these attacks from both

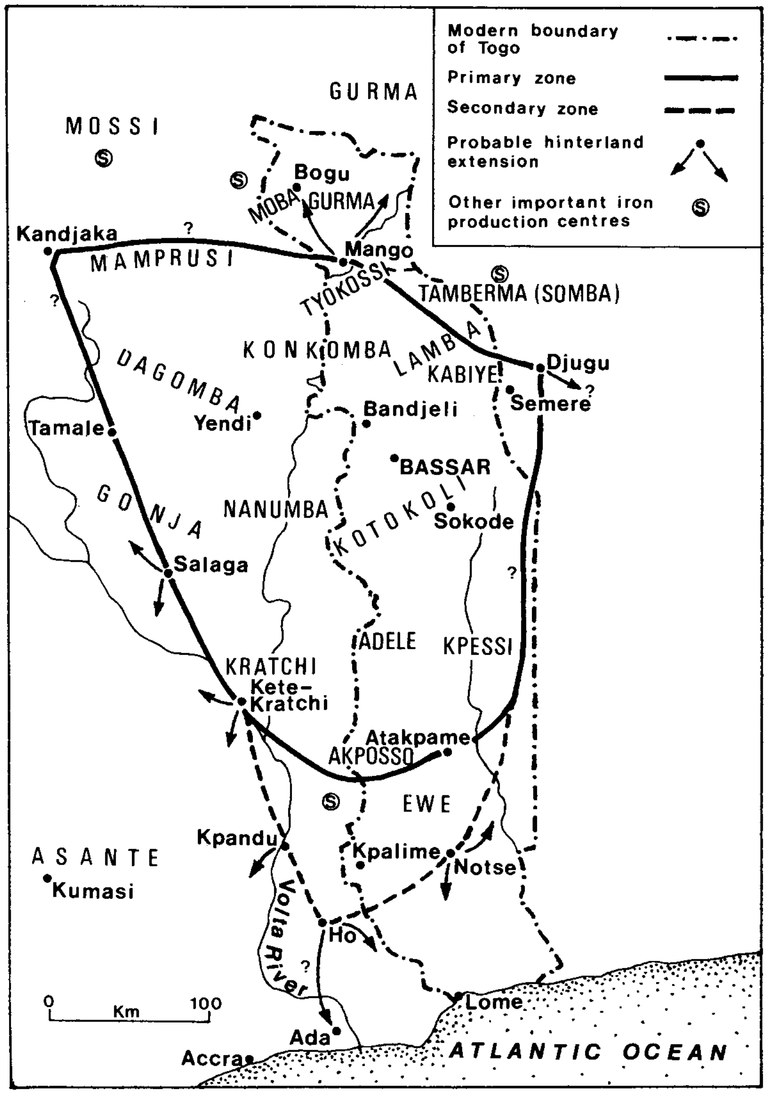

FIG. 7 *States and peoples of the Ghana–Togo hinterland, with approximate boundaries of the Bassar iron trade zone. Both primary and secondary zones of distribution are shown*

west and north quickly led to the abandonment of the Bassar peneplain and the more exposed areas of the Kabu–Bassar and Bandjeli–Bitchabe axes around AD 1800 (see de Barros, 1985: 653–65). In general the population took refuge in the vicinity of the major mountains of the regions situated near the present-day agglomerations of Bassar, Bitchabe, Bandjeli and later Kabu. The result of these population shifts led to the disappearance of the production centres north of Kabu and near Nababun. In their place rose the the M'pampu smelting sites near Bassar –Nangbani (see Fig.4). Somewhat later the site of Sara developed in association

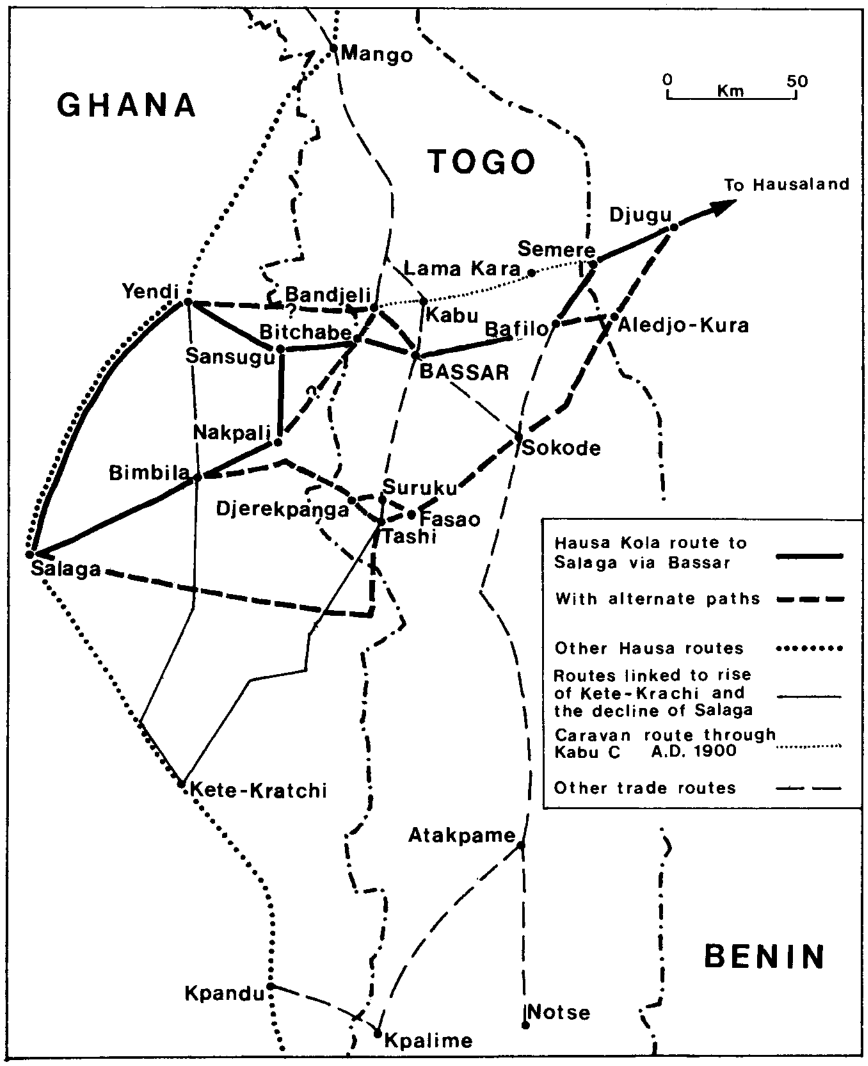

FIG. 8 *The Hausa kola route through Bassar and other important trade routes of northern Togo. (Details on Aledjo Kura–Sokode–Fasao–Salaga route provided by Barbier, 1984: personal communication)*

with the founding of the small Kabu chiefdom *ca.* 1860 (see Gnon, 1967).

The spectacular rise of the Bassar zone as a major iron production centre cannot, however, be explained simply in terms of population movements. Two other factors were also critical. First, the later part of the eighteenth century saw the rise of a major Hausa kola route which passed directly through the Bassar region via Djugu, Bafilo, Bassar, Bitchabe and on to the major kola market of Salaga via Yendi or Bimbila (see Norris, 1984; see Fig. 8).[8] Second, somewhere between 1780 and 1820 saw the development of the Bassar chiefdom which may have had its origins as a defensive mechanism against the predatory Tyokossi and Dagomba, but was also very likely a response to the potential economic benefits (tolls and taxes) to be reaped from the passage of the Hausa kola route caravan traffic. In any event, it is certain that the twin developments of the kola route and the Bassar chiefdom greatly stimulated iron production near the town of Bassar and probably that of the region as a whole.[9]

Two other factors may have played a role in the rise of Bassar as a major iron producer. The first was the exhaustion of local wood fuel supplies by other iron industries situated farther north, particularly in Togo. Goucher (1981, 1984) and Haaland (1980) have shown that it takes a great deal of raw wood to produce the charcoal needed for iron smelting and smithing and that wood supplies are inevitably exhausted at some point. Both archaeological and oral evidence indicate that iron smelting took place east and southwest of Dapaong and in the Kabiye region of northern Togo, but such smelting apparently ceased quite some time ago (see Posnansky and de Barros, 1980: 8a, 18–19; Cornevin, 1962: 90–91). These regions are now relatively devoid of trees and this deforestation may have led to the abandoning of smelting. Perhaps during the eighteenth and nineteenth centuries, Bassar, with its plentiful wood supplies and rich iron ores, may have taken up the resulting slack in the supra-regional iron supply. In addition, the distribution of Bassar's iron products far to the south by the Kotokoli, Hausa and Yarse (see de Barros, 1985: 349–54) may have helped to extinguish other iron smelting industries in southern Togo, industries which were generally based on iron ores of inferior quality and which did not have as good an access to long-distance trade networks.

Finally, the disappearance of smelting in the Bitchabe zone can best be explained by the development of intra-industry specialisation (smelting *vs.* smithing) which was probably stimulated by the zone's lack of high-quality ores, its abundant quartzite stone for anvils and hammers, and the increased efficiency required for large-scale production.

TABLE 4 *Estimated iron production per time period for Bassar region production zones*

	Iron production (tonnes)			
Zone	*Period 2*	*Period 3*	*Period 4*	*All periods*
Bandjeli	1,000–2,347	3,999–9,386	2,964–6,956	7,963–18,689
Bitchabe	333–773	333–773	0–0	667–1,545
Bassar–Kalanga	140–324	140–324	1,514–3,507	1,793–4,155
Nababun–Kikpayu	339–785	1,356–3,142	177–409	1,871–4,336
Kabu	278–643	1,111–2,574	239–554	1,628–3,772
Eastern section (three zones)	757–1,753	2,607–6,040	1,929–4,471	5,292–12,263
Bassar region (five zones)	2,090–4,872	6,939–16,199	4,894–11,426	13,922–32,497

Note: The iron production figures presented for each period per zone represent the minimum and maximum values obtained when solving the slag-to-iron conversion equation.[10]

Estimates of actual iron output

Slag volume was converted to actual iron output using a combination of Hupfeld's (1899) data on the weights of iron ore, iron bloom and iron per smelt in Bandjeli, on oral traditions and extant artefacts (blooms, hoes and hoe preforms) from both Bandjeli and the eastern part of Bassar, field estimates of the average weight of a cubic metre of slag, and upon the basic principles of iron ore reduction (see de Barros, 1985: 284–7; Fluzin, 1983; Tylecote, 1983).[10] The results of this conversion for each time period in each production zone are shown in Table 4.

When the figures in Table 4 are converted to the average annual output per period for the Bassar region as a whole, the following progression is obtained: Period 2, 7–20 tonnes; Period 3, 28–81 tonnes; Period 4, 42–98 tonnes. However, Period 4 figures are in fact too conservative for at least three reasons: (1) many of the Bandjeli Period 4 sites may not have begun production until as late as 1825; (2) the Dagomba siege of the town of Bassar during 1873–76 initiated a period of semi-anarchy in the region, reducing caravan traffic and presumably iron production as well, a situation which lasted until the Germans restored peace in 1895 (see also Martinelli, 1982);[11] and (3) many of the slag mounds at the M'pampu sites are more ellipsoid in shape than paraboloidal, which means their volumes have probably been underestimated.[12] If a revised estimate is made taking into account these factors, Period 4's average annual output was more like 60–135 tonnes (de Barros, 1985: 304–6).

Finally, data on iron bloom production recorded by the Germans in 1900 and from 1904 to 1911 (see especially Togo National Archives, 1911: p. 87) indicates an average annual output of between 150 and 200 tonnes (see de Barros, 1985: Table 26). This suggests that iron production grew throughout much of the nineteenth century and that peak production was reached during the late nineteenth and early twentieth centuries under German colonial rule.

The Bassar iron industry eventually succumbed to the competition of cheap imported European iron. This occurred as early as 1905 along the Kabu–Bassar axis, primarily because of its inferior quality ores (see Hupfeld, 1899: 179, 191). The Bandjeli zone maintained iron production at significant levels until the end of the First World War, but eventually succumbed to the abundance of scrap iron derived from vehicle and railroad operations (see also Goucher, 1984: 136–7). Low-level smelting continued in the Bandjeli region until the early 1950s, when it was forbidden by the French as a deforestation control measure.

As shown in Table 4, the total output of the Bassar iron industry for all time periods lies somewhere between 14,000 and 32,500 metric tonnes. This represents the equivalent of about 16 to 36 million large Bassar hoes (see de Barros, 1985: 296).

BASSAR AND OTHER MAJOR AFRICAN IRONWORKING CENTRES

Although data on the slag and iron output of major African ironworking centres are relatively scarce, it is possible to make some limited but useful comparisons. Table 5 compares total slag volume and average annual slag output for the four centres of Bassar, Mema, Meroe and Babungo. In terms of total slag volume, Bassar's 82,000 m^3 easily surpasses the estimated 45,000 m^3 associated with the 'B' and 'E' sites in the Mema region of Mali, once part of the ancient kingdom of Ghana (AD 800–1150; see Haaland, 1980).

Data on slag volume at Meroe are meagre. However, using a scaled map by Shinnie in Tylecote (1970) which shows sixteen of the eighteen mounds at the site (one an incredible 170 x 55 m) and using Wainwright's (1945: 23) average height estimate of about 12 ft (4 m), it was possible to make a rough estimate of between 60,000 and 80,000 m^3. (The larger figure assumes that most of Meroe's mounds are entirely composed of slag as opposed to being slag-covered hills.) These figures indicate that in terms of total slag volume Bassar ranks even with and perhaps surpasses Meroe. This is no small achievement.

TABLE 5 *Bassar iron production compared to three major African centres in terms of slag volume*

Production centre	*Total slag volume (m^3)*	*Production time period (years)*	*Average annual slag output (m^3)*
Bassar (Togo)	82,300	575–625	132–143
Mema Site B (Mali)	30,000	150–450	67–200
Mema Sites B + E	45,000?	150–550?	82–300?
Meroe (Sudan)	60,000–80,000	400 (Tylecote, 1970)	150–200
		600–700 (Kense, 1983: 64, 70–71)	86–133
Babungo (Cameroon)	163,000	?	?
	133,000 (19th century)	100	1330

Note: Slag volume and production time period figures for Mema are derived from Haaland (1980); those for Babungo from Warnier and Fowler (1979). See also de Barros (1985).

When Bassar's average annual slag output is set against that of Mema and Meroe, it again compares favourably, particularly if one accepts the more recent chronological interpretation of Meroe iron production presented by Kense (1983: 64, 70–71) and in view of the rather incomplete dating evidence for the Mema sites.

Then there is the case of the Babungo chiefdom in western Cameroon. Both in terms of total slag volume and average slag output, Babungo seems to be in a class by itself. However, it should be stressed that there are as yet no radiocarbon dates to confirm the nineteenth-century period assignment of 133,000 m^3 of slag which is based on oral traditions and differences in furnace morphology (see Warnier and Fowler, 1979).

Interestingly enough, when one turns to figures on actual iron output, the only data available besides those for Bassar are Warnier and Fowlers' (1979) for Babungo during the nineteenth century: 80–120 tonnes per year. Note, however, that Bassar's Period 4 annual output has been estimated at between 60 and 135 tonnes per year with peak production reaching 150–200 tonnes. In short, despite Babungo's huge annual slag output, its annual iron output was at best equal to that of Bassar. This somewhat unexpected result is probably best explained by the poor-quality lateritic gravels used as ore in Babungo (Warnier and Fowler, 1979) as compared to the very rich hematite ore used at Bandjeli. In any event, this example shows that one must be careful when making iron output comparisons based on slag output.

Finally, when it comes to the total iron production of Bassar versus that of

Babungo, Bassar clearly comes out on top. Warnier and Fowler's (1979) data suggest that Babungo's total iron production was between about 10,000 and 15,000 tonnes, whereas Bassar's was somewhere between 14,000 and 32,500 tonnes. In short, all things considered, the Bassar iron industry was clearly one of the most important in the history of the African continent.

BASSAR AND BABUNGO *VS.* SOME ROMAN SITES IN FRANCE

Table 6 compares the slag production levels of Bassar and Babungo with three Roman sites in France which were selected somewhat by chance from the literature.[13] They may or may not be representative of the full range of iron production levels during the Roman period in Europe. Nevertheless, the data from the French sites do suggest that, while Bassar and Babungo compare favourably with many small and middle-sized iron production centres of the Roman period, they are no match for the large production centres – particularly when one realises that sites like Forges and La Fontaine des Trois Ferriers represent just one production area or site in a larger production region. In short, the data in Table 6 do not suggest that African iron smelting reached the scale attained during the Roman period. However, since many large African ironworking centres, such as the Futa Jallon in Guinea and Yatenga in Burkina Faso, have not yet been studied, it is possible that future research may alter this conclusion.

TABLE 6 *Bassar and Babungo iron production compared to some Roman sites in France*

Production centre/ Site	*Total slag volume (m^3)*	*Production time period (years)*	*Average annual slag output (m^3)*
Bassar (Togo)	82,300	600	137
Babungo (Cameroon)	163,000	?	1330? (19th century)
La Montagne Noir–Forges (France)	about 1,250,000*	250	5000
Le Berry–La Fontaine des Trois Ferriers (France)	about 60,000†	500–600?	100–120
L'Yvonne–Forêt d'Aillant (France)	about 250,000*	500–600?	417–500

Note: The French smelting site data were derived from Sablayrolles (1980), Kerleroux (1956) and Monot (1964) respectively.
* These two figures are given in tonnes (1,500,000 and 300,000 tonnes) in their respective articles. Using the Bassar approximation of 1200 kg of slag/m^3, these figures were converted into cubic metres of slag.
† The slag is all in one mound measuring 100 m long, 60 m wide and 13 m high. It was assumed to have the shape of a prism when calculating its volume.

An analysis of annual precolonial per capita iron consumption (1·144 kg per adult couple), of traditional iron tool uselife (a traditional Bassar hoe lasted about two years), German colonial census data (the Bassar region's population in 1912 was about 18,000) and Period 2's annual iron output (7–20 tonnes) suggests that Bassar iron was being traded to neighbouring populations as early as the fourteenth century AD. In fact Bassar may have been supplying enough iron at that time to fulfil the needs of more than 50,000 people.

By the end of the nineteenth century oral traditions and ethnohistorical accounts indicate that Bassar iron and iron products were being traded throughout all of Togo, much of eastern Ghana and probably part of western Benin (see Fig. 7). The area involved may have been as large as 100,000 km^2 (38,500 square miles),[14] which would appear to be substantially larger than the trade zone of Babungo iron which was probably no greater than 40–50,000 km^2 (see Warnier and Fowler, 1979: Fig. 1). In terms of people being served, the Bassar trade zone may represent the servicing of a population of well over 600,000.

CONCLUSION

It is hoped that the results of this research will encourage others to undertake quantified, chronologically controlled, regional studies of major African ironworking centres so that a relatively complete picture can be obtained of the extent and importance of iron production throughout the various parts of the African continent during the last 2000–3000 years. Such data are particularly important for a fuller understanding of the economic history of Africa. It should be stressed, however, that time is of the essence if we are to capture the remaining invaluable ethnographic knowledge still available from those who actually participated in the indigenous African Iron Age.

ACKNOWLEDGEMENTS

I wish to thank my PhD committee chairman, Professor Merrick Posnansky, for his continued encouragement and countless constructive suggestions during the course of the research that made this article possible. Thanks also go to Professors Timothy Earle and James N. Hill.

NOTES

[1] See Goucher (1984: 122–31), who calls this the 'crucible step'.

[2] The smithing technology (iron bloom crushing; lithic and metal tools) of the Bassar was basically identical to that of the Kabiye to the northeast. There is also a striking resemblance between the iron bloom crushing procedures used by the Bassar and those used in the Iron Belt of the Cameroon grasslands (see Warnier and Fowler, 1979: 344).

[3] See note to Table 1.

[4] A furnace decay state typology was developed, particularly for furnaces of the eastern region, which permitted a rough dating of many smelting sites. It was also discovered that slag mounds which have a relatively thin humus layer (10–12 cm) almost invariably date to the last 200–300 years (see de Barros, 1985: 100, 527–9).

[5] An analysis of written and oral sources made it possible to establish that the ratio in Bandjeli was different from that along the Kabu-Bassar axis and this information was taken into account when making conversions from slag volume to actual iron output (de Barros, 1985: chapter 10).

[6] See de Barros (1985: Appendices 3 and 2E) for details.

[7] For calculation details, see de Barros (1985: Appendix 4).

[8] Dramani-Issifou (1981) argues that the Hausa route passing through Djugu dates back to the fourteenth century. This may be true but there is still little or no evidence to indicate that the route became important prior to the mid-eighteenth century.

[9] The Babungo chiefdom of the Cameroon grasslands was also in a favourable position with respect to long-distance trade routes (see Nkwi and Warnier, 1982: Map V). This suggests that *geographical position* with respect to major states and long-distance trade networks may have been a key factor leading to the rise of major iron production centres.

[10] The actual formula used was: $O = W_{sl}V_{m}w_{i}/w_{sl}Y$, where
W_{sl} = *weight of slag/m³ of slag mound or 1100–1300 kg;*
V_{m} = *volume of slag mounds for a given period or zone (see Table 2);*
w_{i} = *weight of metallic iron per smelt or 17–20 kg;*
w_{sl} = *weight of slag per smelt or 43·6–73·6 kg (Bandjeli) and 96–160 kg (other zones);*
Y = *Length of time period in question:*
Period 2: minimum 250 years; maximum 300 years;
Period 3: minimum 200 years; maximum 250 years;
Period 4: 105 years (eastern zones);
125 years (Bandjeli).

[11] During this unstable period it is likely that the alternative routes through Sokode and the Fasao were frequently used (see Fig. 8; see also Martinelli, 1982: 78–80).

[12] A demi-ellipsoid contains 33 per cent more volume than a paraboloidal segment with the same elliptical base. Thanks go to Alan Hatcher and Nathaniel Grossman of the UCLA Mathematics Department for help with the proper volume formulae.

[13] Thanks go to R. F. Tylecote for suggesting these sites.

[14] If Goucher's (1984: Fig. 2.4) information is correct that Bassar iron reached as far as Kumasi, then the total trade area may be even larger.

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Résumé

Bassari: une étude régionale quantifiée et contrôlée chronologiquement d'un centre traditionnel de production de fer en Afrique occidentale

Cet article présente les résultats d'une étude régionale quantifiée et contrôlée chronologiquement d'un centre de production de fer dans la région de Bassari au Togo septentrional. Grâce à une variété d'outils déterminés chronologiquement, l'auteur décrit l'évolution de la production de fer bassari à la fois à un niveau régional et sous-régional. Cette étude est effectuée d'une manière relative en utilisant le volume des scories comme mesure de la production de fer et d'une manière absolue en convertissant le volume des scories en évaluations du rendement effectif de fer. Quatre périodes fondamentales sont déterminées: Période 1: Moitié-deuxième moitié du premier millénaire après JC à 1300/1350 après JC, production pour les besoins fondamentaux locaux; Période 2: 1300/1350-1550/1600 après JC, production régionale de fer importante; Période 3: 1550/1600–1800, production production de fer à grande échelle pour l'exportation supra-régionale; et Période 4: 1800-1929/25, production en expansion, perturbation et déclin éventuel.

La production de fer bassari est alors comparée à celle des autres grands centres africains: Mema (Mali), Meroe (Soudan) et Babungo (Cameroun). L'industrie du fer bassari avec sa production totale de fer entre 14 000 et 32 500 tonnes (laissant au moins 82 000 m^3 de scories) et son rendement annuel de fer de 150–200 tonnes à la vente representait peut-être la production la plus élevée de l'histoire de l'Afrique sub-saharienne. Cependant, le rendement de la région de Bassari ne réussit pas à égaler les niveaux atteints par les grandes industries de fonderie de la période romaine en France.

Le fer de la région de Bassari a commencé à faire l'objet d'échanges commerciaux avec les régions voisines dès le XIVème siècle. A la fin du XIXème siècle, son commerce s'était répandu dans tout le Togo, vers la plus grande partie du Ghana oriental et probablement vers une partie du Benin occidental, soit une superficie totale d'environ 100 000 km^2. Bassari a dû satisfaire les besoins en charbon de 600 000 à 700 000 personnes.

Les raisons qui expliquent l'essor de l'industrie du fer bassari sont supposées comprendre: (1) la haute qualité et la facilité d'accès de ses minerals de fer; (2) la montée des états voisins de Dagomba, Mamprusi et Gonja dans le Bassin de la Moyenne Volta (ainsi que le Bono-Mansu et son état successeur achanti au sud) qui a accru la demande en armes de fer et stimulé le développement du commerce de longue distance, qui, à son tour, a élargi la distribution des produits de fer bassari; (3) la situation favorable de la région de Bassari sur la route la plus courte entre Hausaland et le Bassin de la Moyenne Volta qui a entraîné le passage d'une importante route Hausa kola traversant directement la région de Bassari; (4) l'introduction des récoltes alimentaires américaines qui a résulté en une hausse générale des densités démographiques, ce qui aurait accru le demande en binettes de fer pour la production alimentaire; et (5) l'épuisement des ressources de bois comme combustible dans les régions situées les plus au nord.