Book Section:
Iles, L. (2020) Gender in African metallurgy. In: Aldenderfer, M., (ed.) Oxford Research Encyclopedia of Anthropology. Oxford University Press.

https://doi.org/10.1093/acrefore/9780190854584.013.65

Gender in African Metallurgy

Louise Iles

Summary

Gender is frequently invoked as a core explanatory factor for many aspects of past African metallurgy, including conceptualizations of the technological process by its practitioners, the organization of—and participation in—metallurgical production activity, and the acquisition of power and wealth that is associated with it. If a study of technology is to contribute to our understanding of the African past, an exploration of the socioeconomic framework of a production activity is as important as understanding the materiality of a technology; gender is an essential part of that framework.

Ethnographies offer an unparalleled opportunity to consider concepts such as technological style, symbolic expression, and gender in relation to technological activity and materiality—structuring principles that can be of limited visibility in the archaeological record. It is through ethnographic and historical documentation that gender has been made highly and dramatically visible in African smelting and metalworking processes. A stark focus has tended to rest on the cosmologies of fertility and human reproduction that permeate many (though certainly not all) iron smelting technologies across the continent. Metal production is positioned as a form of social reproduction, enabling the continuation of cultural activity through technological production. Metaphors of transformation are reproduced through the design and decoration of technological artifacts, through taboos and prohibitions, and through the symbolic songs, words, and actions of the metal workers, and have been closely tied with narratives of female exclusion from (and conversely male access to) metallurgical activities.

Insights from the ethnographic and historical records of sub-Saharan Africa have been used to inform archaeological interpretations, both implicitly and explicitly, within and far beyond the continent. Yet the insights they provide need to be tempered by a critical evaluation of the ways in which such analogies are selected from a vast bank of historic and ethnographic data and how they can be most appropriately utilized. Importantly, the variability that is present within the ethnographic record cautions against the construction and promulgation of overgeneralizations, and strongly suggests that gender and gendered work roles within African metallurgy, past and present, are not yet fully understood.

Keywords
Africa, metallurgy, iron, copper, gender, technology, ethnography, ethnoarchaeology, history, archaeology

Metal Technologies as Social Entanglements

Metals have long played an important role in the development, maintenance, and expression of social structures and power hierarchies across the African continent. From the earliest appearance of meteoritic iron in Egyptian tomb contexts five thousand years ago (Rehren et al. 2013; Johnson et al. 2013) to the legal and illegal mining for ores of cobalt and tantalum in modern-day Democratic Republic of the Congo (e.g., Fairhead 2005), metals have been intrinsically linked with negotiations of political and economic relationships. These negotiations center around access both to the raw materials and to the knowledge needed for successful operation of these technologies, as well as restrictions on who can participate in such production processes. The malleable yet pervasive concept of gender—a complex, culturally constructed signifier of social roles and economic participation (see examples in Kent 1998; Kelly and Arden 2016)—ties into these ideas of power, control, and wealth and is thus inexorably linked with the production and consumption of metals.

Locally produced iron and copper (and its alloys) heavily dominated sub-Saharan Africa's metallurgical landscape up to the mid-20th century (e.g., Herbert 1984, 1993), after which point imported metals began to take precedence, reflective of an increasingly globalized world and the expanded access to materials that followed. Gold, tin, and to a much lesser extent, silver were also extracted and worked in some areas, particularly in those regions associated with long-distance, extra-continental trade (Killick 2009; Chirikure, Heimann, and Killick 2010; Herbert 1973). The origins and development of sub-Saharan Africa's early and varied metallurgical traditions have been reviewed in detail elsewhere (Alpern 2005; Holl 2009; Killick 2009, 2016), so discussion of this sometimes controversial subject will not be repeated here. However, the early craft practitioners who made these metals, worked with these metals, and traded these metals were participating in technologies that produced tools, weapons, adornments, and art for populations across the continent. Metal technologies in this way ultimately served as "currency" in many socioeconomic forms. Studying the material traces of these technologies can provide insights into the preferences, needs, and norms of the society they operated in through a consideration of the social relationships and interactions that these technologies were entangled within (Joyce 2013).

To achieve these insights, it is important to recognize that the study of technology, whether in the past or the present, requires not just an investigation of the technical aspects of a process, but also an exploration of the socioeconomic context of that production activity. It is clear that production technologies require physical, material inputs (in the case of metals, this means at a minimum ore, clay, water, and fuel). Yet, significantly, production technologies also require technical-social knowledge and the appropriate application of skill. With regard to metal production, this means a working knowledge of furnace construction, raw material selection, and labor organization, for example, as well as proficiency in the smelting process itself. Such socioeconomic factors (labor, economic market, knowledge)

are just as critical for the establishment and persistence of a technology as the availability of raw materials.

Although some parameters are fixed in a production technology, most integrate an element of choice on the part of the practitioner (Dobres and Hoffman 1994; Sillar and Tite 2000), such as which ore to choose, how to temper a clay, or who should undertake the process. These choices are informed by the social framework that the technology is embedded within and are an expression of the technological style of communities of makers (Lechtman 1977; Hosler 1994; Roddick and Stahl 2016). By reconstructing such choices, it is possible to get a glimpse into how that production was organized and to consider why it was organized as it was. These glimpses of past choices and decisions can be carefully disentangled from the material traces of the archaeological record through a detailed reconstruction of production remains, evaluated in conjunction with an awareness of alternative strategies and resources that may have been available to past craftspeople.

The integration and interrogation of chemical, microstructural, and macrostructural analyses of slag blocks, for example, were able to describe variation through time in ore selection, furnace construction, and plant use in precolonial western Uganda (Iles 2018a), with implications for understanding how communities of iron smelters were connected within a social landscape (Iles 2018b).[1] In such a way, the technological choices of a past craft activity can be accessed through the archaeological record, though admittedly with less resolution than for those technologies witnessed in the present. However, interpreting the motivations behind these past choices is more challenging, not least because the meanings and values that give shape to these technologies are known to be dynamic and changeable.

Ethnographic accounts of craft technologies have been able to provide detailed insights and new perspectives on many such socioeconomic aspects of technologies around the world. Not only does witnessing the operation of technologies shed light on “invisible” elements of technical processes in the archaeological record (e.g., the multifarious uses of plants in metallurgical procedures or the process of learning a technique), the documentation of “craft in action” has illustrated the intricate web of relationships and negotiations that shape technological practice and technological choice (e.g., McNaughton 1988; Schmidt 1997; Fredriksen and Bandama 2016). In many cases, such ethnographic studies have also illustrated the need for a practitioner to harness esoteric and arcane knowledge in addition to their technical prowess. Whether that involves placing a downturned horseshoe above a British blacksmithing forge (e.g., Webber 1971, 113–114) or sacrificing a white chicken or sheep to a new anvil in Toro, western Uganda (Childs 1998), these actions and behaviors act as a reminder that it is impossible for craft activity to take place outside of a social context. Production activity is inherently embedded within the socioeconomic framework that its

practitioners inhabit and the traditions and expectations that form the basis of that technological landscape.

Recognizing the Role of Gender in African Metallurgy

If gender is a framework of culturally accepted behaviors and appropriation of space (Moore 1996) through which bodily differences between people are socially recognized and mediated, it is impossible to fully understand any production activity without a consideration of gender. Gender is widely considered to be socially constructed and unfixed to biology, a framework of identity that is flexible, dynamic, and variable through time and space (Weedman 2006; Brumfield and Robin 2008), one which is culturally produced and constructed through all practices, behaviors, and interactions (Warnier 2012; Joyce 2013; Wynne-Jones and Fleischer 2015).

Recognition of gender in the past is shaped to a certain extent by contemporary cultural experiences of gender, resulting in much scholarship having a persisting tendency to assume gender's binary nature and its role as a core structuring component of past economic activity (Brumfield and Robin 2008), reinforced through a tendency to prioritize typically male work in earlier historic and ethnographic research (Stahl 2016, 164). Yet gender identities (and gender roles) have been repeatedly shown historically, anthropologically, and ethnographically to comprise some extent of fluidity, accommodating changes through time in social norms and perspectives that govern the frameworks and rules within which work operates, including within the sphere of metallurgy (Herbert 1993; Iles 2015, 159). Exploring gendered participation in specific socioeconomic activities can therefore only provide snapshots into the role of gender at that moment in time, snapshots which in sub-Saharan Africa have invariably been witnessed either during or following the significant socioeconomic changes that occurred due to colonial European influence (Stahl 1993, 2016).

The exclusion of women from much metallurgical activity in sub-Saharan Africa has been frequently recorded ethnographically across the continent (Herbert 1993), implicitly or explicitly stated. This can include unambiguous preclusions on undertaking certain activities, but it may also take the form of expectations and obligations placed on certain groups of people that would make their participation in particular craft activities impossible. Yet, to focus on the exclusion of women as a universal feature of African metallurgy would be misleading. In one context, it has been expressed that to teach metalworking to a woman would be time wasted—the knowledge and skill would be lost once the woman was married and went to live with her new husband's family (Kusimba 1996, 398). In other contexts, women have become highly respected smiths (Mtetwa et al. 2017).

Gendered practice in itself creates and maintains "gendered ideals" (Kelly and Ardren 2016, 3), reinforcing gender roles through access to finances, knowledge, or material items needed for that work. However, women metallurgists do appear in historical and ethnographic examples, if infrequently (Baumann 1891, 233; Hatton 1967, 39; Herbert 1993, 1984; Goucher and Herbert 1996; Iles 2013, 2015; Mtetwa et al. 2017). These exceptions, alongside the historical documentation of shifts in gendered craft production norms following colonial cultural impact, illustrate the complexity of gender roles and their capacity to transform within a relatively short time frame (Stahl 1993, 2016; Brumfiel and Robin 2008). It warns against generalizations through time and across space that homogenize gendered practices and suggests that a critical evaluation of the formation of the ethnographic and historical record may be called for (see Iles, 2013, 2016).

Witnessing Gender in Metallurgical Practice

The African continent has offered an unparalleled opportunity to see non-mechanized, "pre-industrial" metallurgy in action, meaning in this instance furnaces and hearths powered by hand or natural draught. Some of the earliest descriptions of smelting and smithing activity derive from accounts written by early European explorers traveling through sub-Saharan Africa in the 19th century. These explorers were often in search of natural resources or aiming to conquer and map Africa's most dramatic landscapes, such as the River Nile or Mount Kilimanjaro, and there would often be a team of scientists within their ranks (including geologists and botanists). Eyewitness accounts of metallurgical processes, described with variable levels of accuracy and detail, appear within many of the diaries of these early explorers (e.g., Barth 1857; Baumann 1891; Livingstone 1857; Schweinfurth 1873), who were almost exclusively men.

These early accounts were later supplemented by records made by settled colonial officials and missionaries, as well as scholars commissioned by anthropological and ethnological societies in Europe, who touched upon metallurgical processes in their diaries and reports (e.g., Kellogg 1917; Macdonald 1899; Roscoe 1911; Weeks 1909; Cline 1937, see bibliography, 143–150). Later still, this included more formal anthropological and ethnoarchaeological investigations aimed specifically at documenting metallurgical technologies (e.g., Bower 1927; Crawhall 1933) until the mid-20th century (later for smithing technologies; e.g., Brown 1995), when local metal production mostly ceased and was replaced by the importation of metals via international trade routes (e.g., McNaughton 1988, 31). Later reconstructions, such as those carried out by archaeologists from the 1970s onward, have also formed an important part of this data set (e.g., Childs 1998; David et al. 1989; van der Merwe and Avery 1987; Schmidt 1997). However, it is important to consider that these later reconstructions were generally carried out outside of a normal socioeconomic framework (being commissioned by Western researchers rather than observed as part of regular daily practice) and were generally based on memories of

technological processes that had been abandoned perhaps decades earlier (David 2001; Schmidt 1997).

Indeed, as with all anthropological and ethnoarchaeological data, there are issues and considerations to bear in mind with information gained from these data sources (David and Kramer 2001; Iles and Childs 2014; Weedman 2006). The presence of outsiders, whether 19th-century explorers or 21st-century anthropologists, will potentially skew the processes that are undertaken or those that are revealed to the onlooker. The background of the researcher—the context that defines their interest in the subject—will influence the questions they ask of a craft practitioner and what information they choose to record. The agenda of the person recording the process will, subconsciously if not consciously, influence the content of the technology recorded. The development of trust and mutual respect in the relationship formed between the researcher and the informant will also play a significant role in the depth and the direction of the information gleaned from the encounter, as may the gender of the researcher (consider the different views afforded to the male researcher and the female researcher of an iron smelt reconstruction in western Uganda [Reid and MacLean 1995]). Differential access granted to observers or researchers to people, to their memories, and to their activity spaces must be considered when evaluating such accounts (consider the access granted to a missionary, John Campbell, in 1820 in Marathodi, South Africa to iron smelting furnaces [in male, open spaces] but not to copper smelting furnaces [in female, private spaces] [Hall et al. 2006]).

Nevertheless, looking at the ethnographies and archaeologies of African metallurgies as a whole, most striking is the extensive variation present across the continent (Killick 2015; Chirikure 2015). This includes variation in terms of technical approach to metal production, such as the design of smelting furnaces, how air is introduced into a furnace, or how slag is physically separated from a metal within the furnace design. Smelting furnaces present within the African continent range from large, natural draught furnaces for smelting iron in western Tanzania (Haaland 2004) to small, box-like wind-powered copper smelting furnaces at Wadi Dara, Egypt (Craddock 2000). Identity is intricately embedded within the physicality of many of these metallurgical technologies, including the molding of the physical markers of womanhood and manhood onto the materials of production themselves (the tuyères, the bellows, the furnace) (e.g., Schmidt 2009) to the experimentation with stylistic elements communicated through the design of metal objects (e.g., Larick 1985). Viewed together, it is clear that the practical and socioeconomic challenges of how to produce metal and how to work with metal have been addressed very differently across the continent, resulting in an unmatched range of variation in technological style (Cline 1937; Childs 1991; Killick 2015).

However, despite this variation, common threads have been identified as important themes running through many (though, importantly, not all) of these technologies (Herbert 1993). Most prevalent is the idea of metallurgical production as a signifier of social reproduction

through the transformation of stone into metal. This has been seen to manifest in several ways, such as the positioning of a king or ruler as a smith, harnessing the power of metal to bring material wealth and health to a population (e.g., de Maret 1985), the association of iron with bridewealth (e.g., Childs 1999), or the association of iron with childbirth (e.g., Schmidt 2009). Gender and a gendered organization of production sit at the heart of many of these conceptualizations and invocations of metallurgy witnessed in the 20th and 21st centuries. Considering that in prehistoric economic production activity, gender is for the most part invisible (Kelly and Ardren 2016, 3), such examples give an unparalleled opportunity to consider the role of gender in past metallurgical production technologies.

Some of these concepts are explored in more detail here alongside case studies that specifically address gender in African metallurgy. It is important to bear in mind that each case study is not meant to be representative of a technological "tradition" that applies across the African continent, nor even throughout a particular area, but is specific to a technological process undertaken at that time and within a particular context.

Anthropomorphic Metaphors of Iron Metallurgy

The complex pyrotechnologies of smelting metals from ores are transformative technologies: through the process of smelting and the application of heat, raw materials are transformed into something completely different. They take on new properties and a new socioeconomic value that enables social reproduction through a physical, tangible material (McNaughton 1988, 40). This process has parallels with human reproduction and female fecundity, the combining of blood and semen, and its transformation through the "heat" of intercourse and pregnancy to produce a child (Herbert 1993, 83): a different, yet perhaps equivalent act of creation and social reproduction. In many examples of iron (and copper) smelting across the continent, the reproductive powers of women are symbolically evoked through the materiality of the smelts and the associated behaviors of the smelters: the taboos, songs, jokes, crude comments, and dances that are performed as the furnace is built and as it is fired.

Iron smelting furnaces are often documented ethnographically as a parturient woman, one who gives birth to a bloom of iron. Furnaces are transformed into women either through their gynecomorphic form or through the words and invocations of the smelter. Furnaces can be decorated with scarification, breasts, genitalia, waist belts, or even outstretched legs (e.g., Barndon 1996). The names given to these parts of the furnace may reinforce the attributes as female, leaving no doubt that the furnace is a woman (Herbert 1993, 34). Indeed, in many instances, the furnace becomes the wife of the smelter—it is no longer an object, but a human being and, furthermore, a member of that community and must be treated as such.

Other elements of the smelt may also be transformed into gendered items. Tuyères and bellows inserted into the female furnace become male sexual organs, and the actions and commentary of smelters during use can make this metaphor explicitly clear (e.g., Reid and MacLean 1995). Bellows have also been documented as being decorated with symbols of male and female genitalia (Lanning 1954; Childs 1999). In technologies where two or more ores have been used, they are sometimes identified as male and female, which need to combine or "befriend" prior to the smelt (Rowlands and Warnier 1993; Roscoe 1911, 1923; Iles 2014, 2018a).

Combining these male and female elements through the action of the smelt results, if successful, in the formation of a bloom of iron. In certain contexts, this iron is referred to as a child, sometimes specifically twins (e.g., Fowler 1990), a state that, in women, is associated not only with high fertility, but also high risk to life (perhaps with parallels to the high risk associated with a labor-intensive and materials-intensive pyrotechnology that can, after all, fail). Medicines that would be given to a women to aid with pregnancy and childbirth, such as kaolin clay, associated with treating sickness and aiding the birth of twins (Iles 2011, 381; Roscoe 1923, 164), or plants that aid nursing (van der Merwe and Avery 1987), may also be given to the furnace to ensure a smooth "delivery" of iron.

In such social contexts, not only do these male and female elements have to combine in the right physical conditions to successfully produce iron, they have to combine under the right social conditions. If the furnace is seen to become the smelter's wife, her husband, the smelter, would be subject to rules governing his behavior. The dangerous elements of reproduction (e.g., the risk of death of mother or child, particularly heightened in the case of a multiple pregnancy and birth) are recognized in many of these metaphorical processes. Primarily relevant here can be social prohibitions associated with protecting mother and child. As an example, adultery among the Fipa is seen as a dangerous act that may result in problems with fertility or death at childbirth. This Fipa belief system appears to be embedded in their technological practice of iron smelting: committing adultery during the period of the smelt may endanger the smelter's wife (Barndon 1996). However, for the duration of the smelt, the furnace is the smelter's wife, so it is the iron bloom and the success of the smelt that may be compromised, and conjugal relations with the human wife would be the behavior considered adulterous in this instance.

Often also expressed is the danger to women of reproductive age of becoming sterile if coming into contact with the furnace, most often seen in central and eastern Africa (Herbert 1993, 117). The "creative power" of both the furnace and women was seen by some groups as an overwhelming force, controlled only by smelters and smiths, that could be a danger to women's fertility if they came too close (Reid and MacLean 1995). Conversely, menstrual blood—a marker of sterility, although temporary—is seen by some groups as a threat to the fertility of a smelt (Herbert 1993, 73). The extension of these concepts is the documentation

of smelting systems whereby women are excluded from being present at a smelting site and from participating in smelting activity: the presence of female fertility or sterility at a smelt threatens the success of the smelt and the women themselves. Thus they are excluded, not only from the smelting site, but also from the orbit of their husbands if they are smelters. This exclusion may take the form of locating smelting sites far from habitation sites; it may necessitate the erection of a screen to hide production activity (Reid and MacLean 1995), or it may involve prohibitions on sharing a bed with wives and girlfriends or engaging in sexual activity during the course of a smelt. Smelting thus structured becomes a secluded activity, with gender a core component of that structuring.

Case Study: Hausa Smelters "Birthing" Iron

The sociocultural constructions of iron technology are the focus of Nicole Echard's ethnographic research into Hausa smiths, undertaken in the Ader region of southern Niger. With the express aim of recording information that would be relevant to archaeologists seeking the material remains of social practices, she documented two smelts in 1965 and 1967, with particular attention paid to the social organization, gestures, words, and metaphors associated with the smelts (Echard 1965, 1968, 1983). Importantly, Echard's research was carried out while iron smelting was still active as a local industry. The smelts she witnessed were not the product of distant memories of partly forgotten processes. Furthermore, Echard herself was proficient in the Hausa language and did not have to rely on a translator (David 2001). Within the technology she recorded, the metaphor of pregnancy and birth was explicit and unmistakable.

Hausa smelting, as documented by Echard, was "conceived as the equivalent of biological reproduction" (1983, 221).[2] Although mythology suggests that smithing originated from a woman who fell from the sky with a hammer and who was able to touch red-hot iron without being burnt (Blakely 2006, 2), in the smithing clan of the 20th century, women could not perform the work of the blacksmith. Sons of clan men went on to become smiths, whereas sons of clan women went on to become griots (musicians and storytellers who curate oral histories in their lyrics). The griots sang songs of great mystical power and used instruments of iron; women not of the blacksmithing clan were forbidden from touching their instruments for fear of miscarriage or sterility. Women of the smithing clan would dance to accompany the griots; all members of the clan—smiths and griots, men and women—played key roles in the smelting of iron.

The technological "reproduction" of Hausa smelting was undertaken as part of a cooperative effort of smiths and their families from different villages. The smiths would gather together for up to two weeks in the middle of the dry season (between January and March) to smelt at an isolated location far from settlements and roads, where non-smiths would be far removed from the process. If non-smiths approached the smelting site while

work was taking place, they faced the risk of an “occult” death (Echard 1965, 359). Depending on how many were participating, between twenty and thirty natural draught furnaces would be built and fired, with the furnaces arranged on a north–south axis in order of superiority of the lineage, and the chief smelter’s furnace positioned in the center. These cone-shaped shaft pit furnaces had a diameter of up to one meter and came up to approximately shoulder height of the smiths (150–170 cm; Echard 1983, 1968, 1965, photo 2).

Two sets of eyes were pierced through the furnace wall of each furnace, which glowed and came to life when the furnaces were fired (Herbert 1993, 58), and the furnaces were washed and decorated as a bride would be prior to her wedding. The foundation hearth of each furnace became a newlywed’s house. In this way, the furnaces became new brides and the smelters their husbands—tasked with fertilizing them and protecting them. The furnaces were fired at dusk, at which point “conception” occurred. During the course of the smelt, the chief smelter uttered magical phrases that explicitly positioned the furnaces as parturient women, pregnant with a growing bloom of iron. He applied medicines to each of the furnaces, working in agreement with the cardinal points upon which the smelting site was arranged, and repeating the process three times (the number associated with masculinity). Ore was also added in a circular manner, oriented to compass points. Varying the direction it was added from was critical to the formation of a good bloom, analogous to the continual “swirling” of blood and sperm that was deemed necessary to create and grow a healthy fetus (Herbert 1993, 57).

The griots sang songs of sexuality and sexual power—their songs helped the furnace conceive, they announced the start of labor, the breaking of the waters, and the beginning of labor pains, marked by the molten slag beginning to flow from the furnace. At dawn, when the smelt must end, the furnace gave birth to a child, the bloom of iron. The slag (the placenta) was ultimately buried under the furnace (the nuptial house) as a human placenta would be buried within a home. Gender and sexuality flows throughout this account of smelting, from beginning to end, from the roles assigned to women and men (and their children) to the performance and ritual that makes the furnace a woman: all actions and behaviors are linked within this conceptualization of reproduction.

Case Study: Barongo Smelting in Northwestern Tanzania

Peter Schmidt’s work in northwest Tanzania (Schmidt 1996, 1998, 2013) encompassed an integrated approach to unify a consideration of the technical and social aspects of iron smelting. His research with Barongo smelters, drawn from three field seasons in 1979, 1980, and 1984 (Schmidt 1996, 75), built on his archaeological experience to document both the material traces and intangible behaviors that were associated with a series of eight smelting reconstructions. Though the Barongo smelters had not regularly smelted iron since 1951,

and even though there was variation in the rituals enacted within each smelt that Schmidt witnessed, overall these smelts were heavily invested with metaphors of physical, human reproduction.

The furnaces consisted of pits c. 75 cm wide and the same deep. The furnace walls were constructed from blocks of earth taken from termite mounds, interspersed with rows of broken tuyères and supported with granite blocks, to make a furnace up to c. 60 cm high (Schmidt 1996, 95, figs. 5.7, 5.9). The furnace was charged with layers of ore, charcoal, and slag.

Of note in these examples is what Schmidt sees as the broadening of the life cycle of the female furnace beyond childbirth. The Barongo furnace is not just a bride and pregnant mother-to-be, as in the Hausa case study; instead, the symbolism invoked at the Barongo smelts Schmidt witnessed included a twice-repeated representation of the fertilization of the furnace, each with reference to the furnace in a state of sterility prior to the start of a smelt. In the first cycle of fertilization, a small, ritual pit dug within the base of the furnace pit is used to house medicinal plants (bark, tubers, wood, leaves), including a species with blood-red sap (symbolizing menstrual blood and indicative of a temporarily infertile state) alongside a further species that is said to cure infertility. To seal these medicines within the ritual pit, the head smelter and the ritual specialist would sit naked upon the furnace pit and move in a counterclockwise motion to push earth into the pit with their buttocks and genitals—a process that Schmidt (1998, 146) describes as "a symbolic intercourse and fertilization of the furnace 'womb'." Further medicines sprinkled onto the furnace pit were said to encourage the growth of a large child.

Immediately after the firing of the furnace, the reproductive status of the furnace appears to be reset. A further ritual identifies the furnace as a new bride, presumably not pregnant: the wife of the head smelter and a number of the smelters spit beer over the furnace, mimicking a local marriage ceremony where the bride and groom spit beer or wine on each other as a symbol of fertility. A goat is sacrificed by cutting its artery, the blood from which is directed to flow upon the slag charge at the top of the furnace; the aim is to fully saturate the slag. Schmidt associates this with menstrual blood purifying the womb and preparing it for reproduction. The furnace is then (re-)impregnated while the smelt is underway through the insertion of a fertility "medicine" through the "phallus" (tuyère).

Thus, although heavily embedded in the process of reproduction, the Barongo technology does not appear to have a similar construction of menstruation as "polluting" and invoking of sterility. Indeed, there are seemingly no prohibitions on menstruating women at the smelt or coming into contact with smelters. The participation of a woman playing a key symbolic role in the smelt, and further documentation of a young girl coming into the smelting hut and pumping the bellows (Schmidt 1996, 102), is also of note here. Women are

not seen as inherently threatening to the success of a smelt, even though the symbolism is rich in its associations with birth and reproduction.

Gendered Organization of Multi-craft Clans

The power of smelters and smiths to control the production of iron is often mirrored in their roles in other activities that relate to social reproduction through—for example—sorcery, divination, herbal healing, and mediation (Herbert 1993, 111). Circumcision is also commonly the realm of blacksmiths. For example, the blacksmiths of Maa-speaking pastoralist societies take a central role in the coming-of-age rituals of socio-sexual maturation that bring boys into the social sphere as full men (Larick 1986). In other regions and contexts, gender also shapes the organization of other crafts and production technologies. Most often, particularly in western Africa, this is expressed in the combined realm of potting and smithing: female members of a clan lineage are potters—perhaps consistent with pervasive ideas connecting women with the earth, as autochthonous beings—while male members of a clan are smiths:

> Both the blacksmith's ores and the potter's clay are products of the earth, and both are transformed by fire into objects . . . the close analogue in processes [of smithing and potting] is reflected in the fact that the potter in Africa is frequently the wife of the smith. (Herbert 1993, 200)

The heavily invested symbolism of pottery—and the symbolic connection between metallurgy and pottery, both sharing a relationship with the concepts of reproduction and fertility—is clearly apparent. Clay repeatedly features as the "primordial" substance from which the first people were formed (Berns 1993). Pots reproduce and structure social space, symbolically loaded through their forms, their use, and their decoration with symbols and motifs (Gosselain 1999).

This division of male and female work roles may be as much of an expression of the symbolic compatibility of pots and metal as it is of the complementarity of the production processes of potting and metallurgy. They are both transformational pyrotechnologies that use similar processes, skills, and raw materials (Stahl 2016, 163). They are both seasonal activities, with preference given to activity in the dry season when there is both an availability of fuel and a relative pause in the intensity of agricultural work. They are both activities that source material from the bush, from the wild and uncivilized areas outside of the social order of the village, perceived as dangerous and full of threats (McNaughton 1988, 17–18). It has been suggested, however, that potting's chaîne opératoire (see Gosselain 2018)—more so than metallurgy—consists of more sporadic activities or stages, which may make it more compatible with the domestic work tasks (breastfeeding, childcare) that are commonly within the realm of women (Kelly and Ardren 2016, 8); yet, it is

important to question the basis of these assumptions, especially when applied over long time scales (Berns 1993).

Case Study: Blacksmiths and Potters in Mande Society

Patrick McNaughton's research with Mande blacksmiths in Mali (a year between 1972 and 1973 and a summer in 1978) gave him a unique insight into the world of blacksmiths in that region. Blacksmiths in Mande society conform to the notion that blacksmiths are, in some contexts, both "glorified and shunned, feared and despised," and although they view themselves as "indelibly incorporated into Mande life," they also see themselves as separate to the Mande (McNaughton 1988, xiii, 3). Endogamous marriage practices are adhered to by these blacksmiths (nyamakala or "specialized professionals"). If born into the blacksmithing clan, you can choose to become a blacksmith or not, but if not from that clan, you cannot become one—you must be born with the special creative powers that are needed for this craft; you cannot learn them. Despite this, McNaughton was able to work with a smith as an informal apprentice, bellowing, carving, smithing, listening, watching, and talking—learning about the Mande world of blacksmiths. In Mande culture, as well as making tools and practical items, smiths are also artists (working in wood and iron) and musicians (playing rhythms on their bellows) (McNaughton 1988, xiii, 24). They are also healers, circumcisers, counselors, and mediators, thus playing a core role in "everyone else's professional, social and spiritual lives" (McNaughton 1988, xiii, 40–41).

Yet, as insightful as McNaughton's account is of blacksmiths, his work does not provide much detail about the relationship between potters and blacksmiths: the wives, daughters, and nieces of these men. If early research tended to focus predominantly on men and men's work, more recent decades have seen an upsurge in ethnographic and ethnoarchaeological studies of ceramic production, typically, though not without exception, women's work. In 1991 and 1992, Barbara Frank undertook research in southeastern Mali, working with translators and interpreters to document women potters of Mande blacksmithing families. These numumusow "blacksmithing women" also share a unique and distinctive identity, framed also by the endogamy of the blacksmithing clan and the exclusive rights to participate in pottery production that it provides. Similar to blacksmithing men, their roles extend into other aspects of social Mande life, including participating in rites of passage, female excision, marriage, and death, as well as preparing and offering sacrifices, and—perhaps surprisingly—hairdressing (Frank 1994). Like smiths, these potters can deliver curses and wield esoteric power. All cooking and storage pots are made by members of the blacksmith's family (McNaughton 1988, 34): like blacksmiths, these women and their products permeate throughout day-to-day life.

It is also apparent that some of these women participated in the trade of their husbands and fathers, procuring wood and water for the forge, working the bellows, and forging iron (Frank 1994). The link between pottery and metallurgy goes deeper:

> The women of Kabanga use a wooden platter (kurun or kurunmuso), which they identify as one of the most important of the potters' tools. It is commissioned from a blacksmith-sculptor, but according to some of the potters not just any man can produce it. Because of the nyama, or power of the wood best suited from this purpose, it must be made by a blacksmith who has already lost his first wife, for his wife would certainly die should he attempt such an assignment. (Frank 1994, 30)

Here again, one can see an explicit link between reproduction, risk, and a transformative technology—the technologies that hold the power to change the social fabric of life and also carry a burden of risk. Furthermore, the success of the industries of pottery and metallurgy are interlinked and inseparable; it is impossible to understand one without a consideration of the other.

Gender in Copper Metallurgy

In contrast to the ubiquity of iron production, precolonial copper production was much less widespread across the African continent, limited by the availability of ore minerals. As a consequence of this more geographically restricted technological activity, there are correspondingly fewer ethnographic accounts associated with copper (Herbert 1984, 15). Thus, there is a much less developed understanding of how this production technology was organized in the recent past and how it may have been organized in the more distant past. However, the ethnohistoric and ethnographic accounts that are available suggest that copper production has also to some extent tended to be associated with specialist ritual knowledge and ritual activity, with copper miners, smelters, and copper casters also seen as possessors of magical powers (Herbert 1984, 34, 39). Gender, as a social category that structures behavior, also features, as addressed later, along with similar themes of reproduction and fecundity that appear in many iron production narratives.

Copper appears in the mythologies and oral histories of several groups across the continent, often associated with essential features of the natural world, such as the Sun, water, blood, and placentas (Herbert, 1973). In Dogon mythology in Mali, smiths carry a different biological status to other people: they were formed from the placenta of Nommo, the offspring of the creator god and the earth. "Nommo and the smith are of red blood; Nommo and the smith are twins, both are red like copper" (Dieterlan, 1964). This description echoes the tangible associations between iron production and female reproduction. Indeed, in Burundi, to the east of the Katanga copper belt, the forging of copper was subject to the same prohibitions as iron forging and was carried out by the same smiths, who had skills in

working both metals (Célis and Nzikobanyanka 1976; Herbert 1984, 41). No women were allowed to be present during the forging of copper or during wire-drawing, and sexual activity between the smith and his wife was prohibited the night before work was undertaken.

Similar associations were documented among the Yeke copper smelters in Katanga in the southern Democratic Republic of the Congo (Herbert 1984, 34–39). Here, the master smelter, who was in charge of the technical processes of smelting, worked together with a maître-sorcier, who was responsible for the application of ritual activity at all stages of production—obtaining and preparing the ore and building the furnace. The secret knowledge of smelting was held by the master smelter and passed down through lineage. Yet it was also reported that "the knowledge of the metallurgic technique is retained by the old women in the village, and they are highly regarded" (Rickard 1927, 57, in Herbert 1993, 29). Women (and women of reproductive age) certainly participated in this process, washing and beneficiating the ore (Herbert 1984, 36), and a chant sung from the firing of the furnace indicates the imagery of the furnace as womb, suggestive again of the furnace as mother:

> Ku Mulu wa Kalabi kudi kinonge.
> On the summit of Kalabi rises a high furnace,
> a high furnace with a large womb,
> the heritage of our father Lupodila,
> a high furnace where copper trickles and billows.
> O my Mother! O my Mother! (Herbert 1984, 39)

This clear theme of reproduction—although seemingly not resulting in the exclusion of women from the process, has an interesting parallel among Ogboni smiths of the Yoruba (Herbert 1984, 40). Here, casting of brass edan objects was only performed by men past the age of fathering children. The high energy associated with these objects meant that those making them risked losing their sexual potency or risked the loss of children already born. In this case, it was men of childbearing age that were excluded rather than women of childbearing age.

Seeking Gender in the Archaeometallurgical Record

The intangible behaviors relating to the socioeconomic context and organization of production activity, including those actions and behaviors relating to gender, are challenging to access from the materiality of the archaeological record. Due to this, insights gained from ethnographic research are particularly compelling for archaeologists, who have to attempt to reconstruct past behavior and activity from incomplete and fragmentary data sets (see Iles and Childs 2014). However, the application of ethnographic analogy across time and

space must proceed with careful attention to detail regarding how analogies are selected, evaluated, and utilized (Wylie 1985), particularly within the vast and diverse African continent. Although gender is difficult to directly see in the archaeological record, it is important to be wary of the temptation to uncritically use ethnographic data to "fill in the gaps" (Brumfield and Robin 2008).

Although it is relatively reassuring to be able to draw material analogies in contexts where there are documented cultural and material continuities between past and present communities, this is frequently not possible. Yet, as analogies form the basis of all interpretation of the archaeological record, explicitly or not, analogies are still required where a direct cultural continuity cannot be ascertained. In such cases, how best to assess the relevance of ethnographic data from one region in the interpretation of an archaeological site far removed spatially and chronologically, when one knows that there is variability in gender norms across space, through time, and even through lifetimes? In these instances, it is imperative to critically assess the relevance and applicability of insights gained from the study of one particular modern or historical cultural setting in relation to another time period or region. Rather than seeking simple similarities or analogues for discrete features or events, a consideration of both the similarities and differences between an archaeological data set and an ethnographic comparator as a whole, preferably with independent corroborating evidence from multiple sources, will provide a stronger and more robust illumination of how the past differed from the present and the broader context of that variance (see discussion of analogy in Wylie 1985, 2002, and Stahl 1993). Above all, scholars must recognize that they cannot escape their own inherent social expectations—their personal and essential ways of perceiving and recognizing gender (Weedman 2006): these views will inevitably permeate scholars' interpretations of gender and gender roles in both the archaeological and ethnographic records, and they must anticipate that these expectations will be challenged when the material record is carefully interrogated.

The taboos surrounding women and women's exclusion from smelting and sometimes forging are often emphasized in the archaeometallurgical literature, and it is undoubtedly an enigmatic and powerful image of symbolism within a technological process. It is certainly the case that the theme of reproduction and explicit parallels with sexual activity have been witnessed in metallurgical technologies across a large span of sub-Saharan Africa in the 19th and 20th centuries: the ideology of iron production and biological reproduction is a significant trend that appears relatively commonly in the ethnohistoric and ethnographic data set. However, as stated, the formation and construction of this ethnohistoric and ethnographic data set is not free from bias, with a heavy dominance of male voices, observations, and experiences.

The oft-associated exclusion of women is frequently explicitly conceptualized around protecting fertility—both of the furnace and of women—but it has also been explained in

more functional ways (see Kusimba 1996). This may encompass the protection of valuable technical knowledge, particularly in groups where women marry outside of their clan and move to their husband's family. At one extreme, this risks them taking economic knowledge to a potential rival group (Reid and MacLean 1995; Weedman 2006); at the other extreme, this means that the time and energy invested in training that woman will inevitably be wasted as her work roles change after marriage (Kusimba 1996). The exclusion of women, and by extension small children, has also been hypothesized to protect them from a dangerous high-temperature, smoky, and dirty environment, though this hypothesis does not seem to take into account the high-temperature, smoky, and dirty activities frequently associated primarily with women (charcoal production, ceramic production, cooking).

It is sometimes assumed that these gendered associations, taboos, and behaviors also extend into the long past, with inferences made about gendered production activity due to site location (e.g., Huffman 2001). The case studies previously presented indicate further ways in which archaeologists may be able to identify potential indications of this gendered conceptualization of smelting in the archaeological record: tangible remains that can open the way for a discussion of the time-depth of gender roles in past metallurgical practice in these regions. In the case of Hausa smelting in southern Niger, these indicators may include slag buried under furnaces, remnants of eye holes in fragments of furnace walls, or the isolated location of smelting remains. In Barongo smelting, the ritual pit beneath the furnace would provide a clear suggestion of symbolic behavior at a past smelt; indeed, excavations by Schmidt in Buhaya, northwestern Tanzania, uncovered Early Iron Age furnaces with evidence for ritual pits (Schmidt and Childs 1985). It is conceivable that some of the plant remains used as medicines may remain preserved in similar pits excavated elsewhere (see Schmidt 1998, fig. 8.4).

By interpreting such archaeological features in conjunction with ethnographic or ethnoarchaeological data, it is possible to develop meaningful socio-symbolic interpretations of these past technologies. However, there is a need to be extremely cautious when transposing ethnographically derived concepts onto the archaeological record, not least because of the high level of variation present in the ethnographic record (Chirikure 2015; Killick 2015). Schmidt's documentation of the smelt-by-smelt variability in the iron production processes of the Barongo is a clear reminder of the complex pressures that act upon decision-making processes when technologies are undertaken (Schmidt 1996, 122–124). Nevertheless, through an interrogation of such material remains, the archaeological record has provided examples of instances whereby craft activities of earlier periods appear to diverge from the overgeneralized picture often portrayed of the gendered practices of 20th- century metallurgical contexts (Chirikure 2015).

Stahl's (2016) research into craft production in the Banda region of Ghana inferred the changing organization of metal and pottery production through an analysis of the presence

and absence of slag inclusions in pottery fabrics through time and space. Able to demonstrate the suitability of a direct historical approach, and thus assuming a gendered division of labor in the past that reflected the ethnographic record, with women as potters and men as metalworkers, Stahl employed an analysis of the incorporation of slag inclusions as ceramic temper and the spatial distribution of artifacts associated with craft production to indicate the complementarity of potting and metallurgy in multi-craft households in some periods. Conversely, other periods were marked by a distinct separation between metal and pottery production, illustrating variability through time in the socioeconomic configurations that the craft activity was situated within, and potentially shifts in the gender dynamics that framed those technologies.

Chirikure et al. (2015) placed women in the archaeological record of Mapungubwe's metallurgy (southern Africa) through an exploration of stylistic, petrographic, and geochemical characteristics of crucibles and domestic pottery. The striking similarities between the two categories of ceramics suggested that women were makers of these metallurgical ceramics—assuming that pottery production was as much of the female domain in the 13th century ad as it is in the 21st century—and thus, in this way, contributed to and had at least some access to the male domain of metallurgy. This, alongside evidence for the location of some primary metalworking remains within settlements, led the authors to conclude that it cannot be assumed that women were excluded from metallurgical practices at Mapungubwe.

The spatial distribution of metallurgical features and debris was also instrumental in hypothesizing the different production norms of copper and iron at the 19th-century archaeological site of Marothodi, South Africa (Hall et al. 2006). Whereas iron production furnaces were spatially isolated from settlements, sometimes screened by fences to visually separate them from those who were not permitted to see the production activity, copper production areas were located in back courtyard spaces. These back courtyards are ethnographically associated with female, private space. Iron and copper production—though similar technologies—appear to have been structured in different ways, with iron production undertaken only in a limited number of locations at the site and invariably hidden, while copper production was more universal and appeared to be embedded within individual homesteads.

These archaeological examples indicate the potential range of variability in gendered production organization and illustrate how an ethnoarchaeologically informed approach can access gender in the material record. Just as there are exceptions where men are potters (Herbert 1993, 203; Haaland et al. 2004), there are exceptions, both historically, ethnoarchaeologically, and potentially also archaeologically documented, where women do take part in metallurgical activity, either conducting some of the peripheral activities that support metal production—collecting ore or firewood, drawing water, preparing charcoal or

food (e.g., Herbert 1993, 1984, 36; Goucher and Herbert 1996; Chirikure 2007), or taking part in the core production activity itself (Baumann 1891, 233; Chirikure 2005, 131; Hatton 1967, 39; Iles 2013, 2015; Mtetwa et al. 2017). These examples highlight that women's exclusion from metallurgy is far from universal, and they act as a warning that gender roles in such technologies are not yet fully understood and thus should not be summarized into overly broad generalizations. They also illustrate the need to consider the influence of gender, and renegotiations of past gender dynamics, when changes in the materiality of the archaeological record are revealed.

Acknowledgments

The author would like to thank two anonymous reviewers for their insightful comments on an earlier draft of this article, which have greatly improved its focus.

Further Reading

Brumfield, E., and C. Robin. 2008. "Gender, Households, and Society: An Introduction." Archaeological Papers of the American Anthropological Association 18: 1–16.

Chirikure, S. 2007. "Metals in Society: Iron Production and Its Position in Iron Age Communities of Southern Africa." Journal of Social Archaeology 7 (1): 72–100.

David, N. 2001. "Lost in the Third Hermeneutic? Theory and Methodology, Objects and Representations in the Ethnoarchaeology of African Metallurgy." Mediterranean Archaeology 14: 49–72.

Herbert, E. W. 1993. Iron, Gender, and Power: Rituals of transformation in African Societies. Bloomington: Indiana University Press.

Iles, L. 2018. "Forging Networks and Mixing Ores: Rethinking the Social Landscapes of Iron Metallurgy." Journal of Anthropological Archaeology 49: 88–99.

Iles, L., and S. T. Childs. 2014. "Ethnoarchaeological and Historical Methods." In Archaeometallurgy in Global Perspective: Methods and Synthesis, edited by B. Roberts and C. Thornton, 193–215. London: Springer.

Joyce, R. 2013. "Life with Things: Archaeology and Materiality." In Archaeology and Anthropology: Past, Present and Future, edited by D. Shankland, 119–132. London: Bloomsbury.

Schmidt, P. 1998. “Reading Gender in the Ancient Iron Technology of Africa.” In Gender in African Prehistory, edited by S. Kent, 139–162. Walnut Creek, CA: AltaMira Press.

Stahl, A. 1993. “Concepts of Time and Approaches to Analogical Reasoning in Historical Perspective.” American Antiquity 58: 235–260.

Wylie, A. 2002. Thinking from Things: Essays in the Philosophy of Archaeology. Berkeley, CA: University of California Press.

References

Alpern, S. 2005. “Did They or Didn’t They Invent It? Iron in Sub-Saharan Africa.” History in Africa 32: 41–94.

Barndon, R. 1996. “Fipa Ironworking and Its Technological Style.” In The Culture and Technology of African Iron Production, edited by P. Schmidt, 58–73. Gainesville: University of Florida Press.

Barth, H. 1857. Travels and Discoveries in North and Central Africa: Being a Journal of an Expedition Undertaken Under the Auspices of H.B.M.’s Government, in the Years 1849–1855. Vol. 2. New York: Harper & Brothers.

Baumann, O. 1891. Usambara und Seine Nachbargebiete. Berlin: Dietrich Reimer.

Berns, M. C. 1993. “Art, History, and Gender: Women and Clay in West Africa.” African Archaeological Review 11 (1): 129–148.

Blakely, S. 2006. Myth, Ritual, and Metallurgy in Ancient Greece and Recent Africa. Cambridge, UK: Cambridge University Press.

Bower, J. G. 1927. “Native Smelting in Equatorial Africa.” The Mining Magazine 37 (3): 137–147.

Brown, J. 1995. Traditional Metalworking in Kenya. Oxford: Oxbow Books.

Brumfield, E., and C. Robin. 2008. “Gender, Households, and Society: An Introduction.” Archaeological Papers of the American Anthropological Association 18: 1–16.

Celis, G., and E. Nzikobanyanka. 1976. La Métallurgie Traditionnelle au Burundi: Techniques et Croyances. Tervuren, Belgium: Musée Royal de l’Afrique Centrale.

Childs, S. T. 1991. “Style, Technology, and Iron Smelting Furnaces in Bantu-Speaking Africa.” Journal of Anthropological Archaeology 10 (4): 332–359.

Childs, S. T. 1998. “‘Find the Ekijunjumira’: Iron Mine Discovery, Ownership and Power among the Toro of Uganda.” In Social Approaches to an Industrial Past: The Archaeology and Anthropology of Mining, edited by A. Knapp, V. Pigott, and E. Herbert, 139–153. London: Routledge.

Childs, S. T. 1999. “‘After All, A Hoe Bought a Wife’: The Social Dimensions of Ironworking among the Toro of East Africa.” In The Social Dynamics of Technology: Practice, Politics and World Views, edited by M. Dobres and C. Hoffman, 23–45. London: Smithsonian Institution Press.

Chirikure, S. 2005. “Iron Production in Iron Age Zimbabwe: Stagnation or Innovation?” Unpublished PhD diss., University of London.

Chirikure, S. 2007. “Metals in Society: Iron Production and Its Position in Iron Age Communities of Southern Africa.” Journal of Social Archaeology 7 (1): 72–100.

Chirikure, S. 2015. Metals in Past Societies: A Global Perspective on Indigenous African Metallurgy. New York: Springer.

Chirikure, S., R. B. Heimann, and D. Killick. 2010. “The Technology of Tin Smelting in the Rooiberg Valley, Limpopo Province, South Africa, c. 1650–1850 CE.” Journal of Archaeological Science 37 (7): 1656–1669.

Chirikure, S., S. Hall, and T. Rehren. 2015. “When Ceramic Sociology Meets Material Science: Sociological and Technological Aspects of Crucibles and Pottery from Mapungubwe, Southern Africa.” Journal of Anthropological Archaeology 40: 23–32.

Cline, W. B. 1937. Mining and Metallurgy in Negro Africa. Menasha, WI: George Banta.

Craddock, P. T. 2000. “From Hearth to Furnace: Evidences for the Earliest Metal Smelting Technologies in the Eastern Mediterranean.” Paléorient 26: 151–165.

Crawhall, T. 1933. “Iron Working in the Sudan.” Man 33: 41–43.

David, N. 2001. “Lost in the Third Hermeneutic? Theory and Methodology, Objects and Representations in the Ethnoarchaeology of African Metallurgy.” Mediterranean Archaeology 14: 49–72.

David, N., R. Heimann, D. Killick, and M. Wayman. 1989. “Between Bloomery and Blast Furnace: Mafa Iron-Smelting Technology in North Cameroon.” African Archaeological Review 7 (1): 183–208.

David, N., and C. Kramer. 2001. Ethnoarchaeology in Action. Cambridge, UK: Cambridge University Press.

De Maret, P. 1985. “The Smith’s Myth and the Origin of Leadership in Central Africa.” African Iron Working: Ancient and Traditional, 73–87. Oslo: Norwegian University Press.

Dieterlen, G. 1964. “Contribution à l’étude des forgerons en Afrique occidentale.” Annuaires de l’École Pratique des Hautes Études 77: 3–28.

Dobres, M.-A., and C. Hoffman. 1994. “Social Agency and the Dynamics of Prehistoric Technology.” Journal of Archaeological Method and Theory 1: 211–258.

Échard, N. 1965. “Note sur les forgerons de l’Ader (Pays Hausa, République du Niger).” Journal de la Société des Africanistes 35: 353–372.

Échard, N. 1968. Noces de Feu. Paris: Center de Recherche Scientifique, 16mm film.

Échard, N. 1983. “Scories et symboles. Remarques sur la métallurgie Hausa du fer au Niger.” In Métallurgies Africaines: Nouvelles Contributions, edited by N. Echard, 209–224. Paris: La Société des Africanistes.

Fairhead, J. 2005. “Transnational Dimensions to Environmental Resource Dynamics: Modes of Governance and Local Resource Management in Eastern DRC.” In Beyond Territory and Scarcity: Exploring Conflicts Over Natural Resource Management, edited by Q. Gausset, M. Whyte, and T. Birch-Thomsen, 195–215. Uppsala, Sweden: Nordiska Afrikainstitutet.

Fowler, I. 1990. “Babungo: A Study of Iron Production, Trade and Power in a Nineteenth Century Ndop Plain Chiefdom.” Unpublished PhD diss., University of London.

Frank, B. E. 1994. “More than Wives and Mothers: The Artistry of Mande Potters.” African Arts 27: 26–37.

Fredriksen, P. D., and F. Bandama. 2016. “The Mobility of Memory: Space/Knowledge Dynamics in Rural Potting Workshops in Limpopo Province, South Africa.” Azania: Archaeological Research in Africa 51 (4): 489–506.

Gosselain, O. P. 1999. “In Pots We Trust: The Processing of Clay and Symbols in Sub-Saharan Africa.” Journal of Material Culture 4 (2): 205–230.

Gosselain, O. P. 2018. “Pottery Chaîne Opératoires as Historical Documents.” In Oxford Research Encyclopedia of African History, edited by T. Spear. New York: Oxford University Press.

Goucher, C., and E. Herbert. 1996. “The Blooms of Banjeli: Technology and Gender in West African Iron Making.” In The Culture and Technology of African Iron Production, edited by P. Schmidt, 40–57. Gainesville: University Press Florida.

Haaland, R. 2004. “Iron Smelting—A Vanishing Tradition: Ethnographic Study of This Craft in South-West Ethiopia.” Journal of African Archaeology 2 (1): 65–79.

Haaland, R., G. Haaland, and D. Dea. 2004. “Furnace and Pot: Why the Iron Smelter Is a Big Pot Maker.” Azania: Archaeological Research in Africa 39: 143–165.

Hall, S., D. Miller, M. Anderson, and J. Boeyens. 2006. “An Exploratory Study of Copper and Iron Production at Marothodi, and Early 19th Century Tswana Town, Rustenburg District, South Africa.” Journal of African Archaeology 4: 3–35.

Hatton, J. 1967. “Notes on Makalanga Iron Smelting.” Nada 9 (4): 39–42.

Herbert, E. W. 1973. “Aspects of the Use of Copper in Pre-colonial West Africa.” The Journal of African History 14 (2): 179–194.

Herbert, E. W. 1984. Red Gold of Africa: Copper in Precolonial History and Culture. Madison: University of Wisconsin Press.

Herbert, E. W. 1993. Iron, Gender, and Power: Rituals of Transformation in African Societies. Bloomington: Indiana University Press.

Holl, A. 2009. “Early West African Metallurgies: New Data and Old Orthodoxy.” Journal of World Prehistory 22: 415–438.

Hosler, D. 1994. The Sounds and Colors of Power: The Sacred Metallurgical Technology of Ancient West Mexico. Cambridge, MA: MIT Press.

Huffman, T. 2001. “The Central Cattle Pattern and Interpreting the Past.” Southern African Humanities 13: 19–35.

Iles, L. 2011. “Reconstructing the Iron Production Technologies of Western Uganda: Reconciling Archaeometallurgical and Ethnoarchaeological Approaches.” Unpublished PhD diss., University College London.

Iles, L. 2013. “Applying Ethnographic Presents to Archaeological Pasts: The Relevance of Memories of Iron Production in Western Uganda.” In The World of Iron, edited by J. Humphris and T. Rehren, 281–287. London: Archetype.

Iles, L. 2014. “The Exploitation of Manganese-rich ‘Ore’ to Smelt Iron in Mwenge, Western Uganda, from the Mid Second Millennium AD.” Journal of Archaeological Science 49: 423–441.

Iles, L. 2015. “Iron Production in Uganda: Memories of a Near-Forgotten Industry.” In Reanimating Industrial Spaces: Conducting Memory Work in Post-industrial Spaces, edited by H. Orange, 158–175. Walnut Creek, CA: Left Coast Press.

Iles, L. 2018a. “African Iron Production and Iron-Working Technologies: Methods. In Oxford Research Encyclopedia of African History, edited by T.Spear. New York: Oxford University Press.

Iles, L. 2018b. “Forging Networks and Mixing Ores: Rethinking the Social Landscapes of Iron Metallurgy.” Journal of Anthropological Archaeology 49: 88–99.

Iles, L., and S. T. Childs. 2014. “Ethnoarchaeological and Historical Methods.” In Archaeometallurgy in Global Perspective: Methods and Synthesis, edited by B. Roberts and C. Thornton, 193–215. London: Springer.

Johnson, D., J. Tyldesley, T. Lowe, P. J. Withers, and M. M. Grady. 2013. “Analysis of a Prehistoric Egyptian Iron Bead with Implications for the Use and Perception of Meteorite Iron in Ancient Egypt.” Meteoritics and Planetary Science 48: 997–1006.

Joyce, R. 2013. “Life with Things: Archaeology and Materiality.” In Archaeology and Anthropology: Past, Present and Future, edited by D. Shankland, 119–132. London: Bloomsbury.

Kellogg, L. 1917. Early Narratives of the Northwest, 1634–1699. New York: Charles Schribner’s Sons.

Kelly, S., and T. Ardren, eds. 2016. Gendered Labor in Specialized Economies: Archaeological Perspectives on Male and Female Work. Boulder: University Press of Colorado.

Kent, S., ed. 1998. Gender in African Prehistory. Walnut Creek, CA: AltaMira Press.

Killick, D. 2009. “Cairo to Cape: The Spread of Metallurgy through Eastern and Southern Africa.” Journal of World Prehistory 22 (4): 399–414.

Killick, D. 2015. “Invention and Innovation in African Iron-Smelting Technologies.” Cambridge Archaeological Journal 25 (1): 307–319.

Killick, D. 2016. “A Global Perspective on the Pyrotechnologies of Sub-Saharan Africa.” Azania: Archaeological Research in Africa 51 (1): 62–87.

Kusimba, C. M. 1996. “The Social Context of Iron Forging on the Kenya Coast.” Africa: Journal of the International African Institute 66 (3): 386–410.

Lanning, E. C. 1954. “Genital Symbols on Smiths’ Bellows in Uganda.” Man 54: 167–169.

Larick, R. 1985. “Spears, Style, and Time among Maa-Speaking Pastoralists.” Journal of Anthropological Archaeology 4 (3): 206–220.

Larick, R. 1986. “Iron Smelting and Interethnic Conflict among Precolonial Maa-Speaking Pastoralists of North-Central Kenya.” African Archaeological Review 4 (1): 165–176.

Lechtman, H. 1977. “Style in Technology: Some Early Thoughts.” In Material Culture: Styles, Organization, and Dynamics of Technology, edited by H. Lechtman and R. Merrill, 3–20. New York: American Ethnological Society.

Livingstone, D. 1857. Missionary Travels and Researches in South Africa. New York: J. Murray Press.

MacDonald, J. 1899. “Notes on the Ethnology of the Tribes Met with During the Progress of the Juba Expedition of 1897–1899.” Journal of the Royal Anthropological Institute 19: 226–247.

McNaughton, P. R. 1988. The Mande Blacksmiths: Knowledge, Power, and Art in West Africa. Bloomington: Indiana University Press.

Moore, H. 1996. Space, Text and Gender. London: Taylor & Francis.

Mtetwa, E., Y. Maposa, M. Manyanga, and S. Chirikure. 2017. “When the Smith Is a Woman: Innovation, Improvisation and Ambiguity in the Organization of African Iron Metallurgy.” In Archives, Objects, Places and Landscapes: Multidisciplinary Approaches to Decolonised

Zimbabwean Pasts, edited by M. Manyanga and S. Chirikure, chap. 13. Bamenda, Cameroon: Langaa RPCIG.

Rehren, T., T. Belgya, A. Jambon, G. Káli, Z. Kasztovszky, Z. Kis, I. Kovács, B. Maróti, M. Martinón-Torres, G. Miniaci, V. C. Pigott, M. Radivojević, L. Rosta, L. Szentmiklósi, and Z. Szőkefalvi-Nagy. 2013. "5,000 Years Old Egyptian Iron Beads Made from Hammered Meteoritic Iron." Journal of Archaeological Science 40 (12): 4785–4792.

Reid, A., and R. MacLean. 1995. "Symbolism and the Social Contexts of Iron Production in Karagwe." World Archaeology 27 (1): 144–161.

Roddick, A., and A. Stahl. 2016. "Introduction: Knowledge in Motion." In Knowledge in Motion: Constellations of Learning Across Time and Place, edited by A. Roddick and A. Stahl, 3–35. Amerind Studies in Anthropology. Tucson: University of Arizona Press.

Roscoe, J. 1911. The Baganda. London: Macmillan.

Roscoe, J. 1923. The Bakitara or Banyoro: The First Part of the Report of the Mackie Ethnological Expedition to Central Africa. Cambridge, UK: Cambridge University Press.

Rowlands, M., and J.-P. Warnier. 1993. "The Magical Production of Iron in the Cameroon Grassfields." In The Archaeology of Africa: Food, Metals and Towns, edited by T. Shaw, P. L. Sinclair, A. Anah, and A. Okpako, 512–550. London: Routledge.

Schmidt, P. 1996. "Reconfiguring the Barongo: Reproductive Symbolism and Reproduction among a Work Association of Iron Smelters." In The Culture and Technology of African Iron Production, edited by P. Schmidt, 74–127. Gainesville: University of Florida Press.

Schmidt, P. 1997. Iron Technology in East Africa: Symbolism, Science, and Archaeology. Bloomington: Indiana University Press.

Schmidt, P. 1998. "Reading Gender in the Ancient Iron Technology of Africa." In Gender in African Prehistory, edited by S. Kent, 139–162. Walnut Creek, CA: AltaMira Press.

Schmidt, P. 2009. "Tropes, Materiality, and Ritual Embodiment of African Iron Smelting Furnaces as Human Figures." Journal of Archaeological Method and Theory 16 (3): 262–282.

Schmidt, P. 2013. "Bricolage, Ritual Performance, and Habitus [Forgotten] in Barongo Iron Smelting." In The World of Iron, edited by J. Humphris and T. Rehren, 66–72. London: Archetype.

Schmidt, P., and S. T. Childs. 1985. “Innovation and Industry during the Early Iron Age in East Africa: The KM2 and KM3 Sites of Northwest Tanzania.” African Archaeological Review 3: 53–94.

Schweinfurth, G. 1873. “Das Volk der Monbuttu in Central-Afrika.” Zeitschrift für Ethnologie 5: 1–27.

Siller, B., and M. Tite. 2000. “The Challenge of ‘Technological Choices’ for Materials Science Approaches in Archaeology.” Archaeometry 42: 2–20.

Stahl, A. 1993. “Concepts of Time and Approaches to Analogical Reasoning in Historical Perspective.” American Antiquity 58: 235–260.

Stahl, A. 2016. “Complementary Crafts: The Dynamics of Multi-craft Production in Banda, Ghana.” In Gendered Labor in Specialized Economies: Archaeological Perspectives on Female and Male Work, edited by S. Kelly and T. Ardren, 159–190. Boulder: University Press of Colorado.

van der Merwe, N. J., and D. H. Avery. 1987. “Science and Magic in African Technology: Traditional Iron Smelting in Malawi.” Africa: Journal of the International African Institute 57 (2): 143–172.

Warnier, J.-P. 2012. “Afterward: On Technologies of the Subject, Material Culture, Castes and Value.” In Metals in Mandara Mountains: Society and Culture, edited by N. David. Trenton, NJ: Africa World Press.

Webber, R. 1971. The Village Blacksmith. Newton Abbot, UK: The Country Book Club.

Weedman, K. 2006. “Gender and Ethnoarchaeology.” In Handbook of Gender in Archaeology, edited by S. Nelson, 247–294. Oxford: AltaMira Press.

Weeks, J. 1909. “Anthropological Notes on the Bangala of the Upper Congo River.” Journal of the Royal Anthropological Institute 39: 106–108.

Wylie, A. 1985. “The Reaction against Analogy.” Advances in Archaeological Method and Theory 8: 63–111.

Wylie, A. 2002. Thinking from Things: Essays in the Philosophy of Archaeology. Berkeley, CA: University of California Press.

Wynne-Jones, S., and J. Fleischer. 2015. “Theory in Africa: Africa in Theory.” In Theory in Africa: Africa in Theory: Locating Meaning in Archaeology, edited by S. Wynne-Jones and J. Fleischer, 3–18. London: Routledge.

Notes

[1] Slag is the waste product of iron smelting activity.

[2] “. . .la réduction du minerai de fer étant conçue comme l’équivalent de la reproduction biologique.”