Ife and Igbo Olokun in the history of glass in West Africa

Abedimi Babatunde Babalola (Department of Anthropology, Rice University)
Susan Keech McIntosh (Department of Anthropology, Rice University)
Laure Dussubieux (Field Museum of Natural History)
Thilo Rehren (UCL-Qatar)

Yoruba traditions identify the city of Ile-Ife in southwestern Nigeria as the ancestral home of the Yoruba and the mythic birthplace of several of their deities. It is ascribed a pivotal role in the early development of political leadership and ritual authority in the Nigerian forest zone (Akinjogbin 1992; Ogundiran 2005). The famous copper-alloy and terracotta heads and figures that were deposited in Ile-Ife shrines between the 12th-15th c. AD are interpreted as representations of rulers, priests and other notables from the period of Ife's fluorescence as a regional power (Willett 1967; Drewal and Schildkrout 2009; Blier 2014). A dominant feature of many of these figures is the abundance of beads depicted, both in headdresses or crowns and in necklaces, armlets and anklets. Many of these were almost certainly made of glass, as glass beads have been found in shrine sites and associated with the sculptures themselves. They are also found in great profusion, along with cullet and glass-encrusted crucibles, in Igbo (meaning 'forest' or 'grove') Olokun (Figure 1), which was evidently a workshop area for bead production.

The most frequently reported beads from Igbo Olokun are small-diameter (<5 mm), blue beads cut from drawn canes. Some are dichroic, appearing blue in reflected light and blue-green in transmitted light (Davison et al. 1971). Ige (2010) notes the association of this kind of bead, known as *segi*, with divination. In Yoruba society, beads are charged with *ase* (vital force); they are medicines (*ogun*) that act on worldly or otherworldly forces (Euba 1982, Drewal and Schildkrout 2009:126). The ability of *segi* and other beads to link the human and the divine and to protect, heal, and empower may have been a key factor in the consolidation of ritual authority in the early Yoruba kingdom at Ile-Ife and the enduring attraction of Igbo Olokun as a source of glass, even for modern beadmakers. The Atlantic trade introduced new regimes of value in which beads became more important as repositories of wealth (Ogundiran 2002).

In the twentieth century, Ife bead technology included shaping and drilling recycled glass and beads (lapidary technique) or melting powdered glass (Fagg and Willett 1962:366; Adeduntan 1985, Eluyemi 1987). Igbo Olokun has long been a source of glass for reuse. The evidence suggests that Igbo Olokun has been, extraordinarily, the site of activities related to glass bead production for almost a thousand years, providing a unique window on the history of glass in West Africa and more widely. Its significance was considerably augmented by the recognition that the composition of the main glass type identified at Ife is unique to southwestern Nigeria and therefore likely the product of a local primary glassmaking industry, possibly in or near Ile-Ife itself (Freestone 2006; Lankton *et al.* 2006).

In order to document and better understand the history of glass production activities at Igbo Olokun, Babalola (2015) undertook excavations in several areas in 2011-12, intensively sampling an area that yielded large numbers of glass beads, production debris, and crucibles. Here, we offer an overview of those excavations and the material recovered, summarize the results of compositional analyses on glass and crucibles, and discuss the historical implications.

Investigations of Glass at Ile-Ife.

Frobenius (1913) provided the first published observations of Igbo Olokun, where his numerous exploratory shafts in search of terracotta and copper-alloy sculptures encountered pits up to seven meters deep that contained glass-encrusted crucibles (Figure 1). He also reported extensive local quarrying for old glass in “trenches 5 to 15 feet deep”. (Frobenius 1913:93). This likely involved shallow digging to expose the red-orange, sterile, lateritic clay at 30-70 cm depth, allowing easy identification of the dark gray fill of deeper pits that were associated with crucibles and glass (Drewal and Schildkrout 2009:129). Crucibles and crucible fragments had ritual value and were often dug up and placed in shrines throughout Ile-Ife (Fagg and Willett 1962:366), a practice with considerable time depth. Garlake (1974) found crucible fragments incorporated in a potsherd pavement at the shrine at Woye Asiri. At this site, drawn glass beads and crucible fragments from well-defined contexts were associated with charcoal dated to the 11th–14th century cal AD. The only other solid association of glass with a well-dated context (14th–15th century) is at Obalara's Land, another shrine site painstakingly excavated by Garlake (1977). These dates are consistent with TL dates of the 13th-15th century on clay cores of the famous cast metal figures of an *oni* (paramount ruler) and a royal couple recovered from Ita Yemoo Shrine 1 (Willett 1959, 2004; Willett and Fleming 1976). All are depicted with masses of small beads assumed to have been glass. The oft-cited, late-first millennium dates at Orun Oba Ado for glass from a series of pits reputed to contain the heads of Benin kings must be viewed critically in view of their context and Willett's (1971:366) practice of collecting charcoal throughout the fill of each pit.

Published details on glass production sites are rare. Extensive excavations by Fagg and Murray and Willett at Igbo Olokun were never published (Willett 1960). Eluyemi (1987) was the first to describe the full corpus of glass beads (n=188) from an excavation in Igbo Olokun, confirming the general impression of predominantly small diameter (<5 mm), blue, tubular and cylindrical beads. He excavated fourteen shallow, clay-lined furnaces close to the surface, and mentioned production debris, tuyeres, and crucible fragments, but provided no details. Details are similarly lacking in the report of a probable glass workshop at Ayelabowo (Adeduntan 1985).

Much of the research on Ife glass has focused on compositional analyses. Davison's (1972) pioneering study identified two major compositional groups: a soda-lime glass (>8% by weight Na_2O) that could have been produced in the Mediterranean area or Middle East; and an unusual, low-soda (<8% by weight) glass with extremely high levels (>10% by weight each) of lime and alumina (HLHA glass). Several crucible glass and cullet samples from Willett's Igbo Olokun excavations were of this latter type. However, most of the Ife glass beads, crucibles and cullet analyzed by Davison (1972) came from the important shrine site of Ita Yemoo and the pits at Orun Oba Ado (Willett 1959, 1960, 2004). Unfortunately, these samples, too, are virtually devoid of information on archaeological context. Samples from both sites included HLHA and soda-lime glass. The significance of the HLHA composition could not be appreciated until the comparative database on glass composition and source areas was more fully developed (e.g., Brill 1999; Lankton and Dussubieux 2006; Brill and Stapleton 2012;). In a landmark article, Lankton *et al.* (2006) recognized HLHA glass as unique to southwestern Nigeria.

Two other unusual glass types of unknown origin at Ife include beads of a low-soda, low-lime, high alumina glass (Brill and Stapleton 2012:175) and a low-soda, high-lime (12-20% wt), low alumina glass (<4% wt) (Davison 1972, Table 20; Lankton *et al*. 2006). Yet a fifth glass type, used to make very large, coarsely drawn beads, closely resembles the mineral soda-lime *bikini* glass produced by Nupe glassmakers in west-central Nigeria historically (cp. Brill and Stapleton 2012:175 and Robertshaw *et al*. 2009)

The questions of interest at Igbo Olokun involve both raw glass sources and bead-making technologies. Our excavations aimed to recover more substantive evidence for changes in raw glass sources and bead technologies over time, as well as providing details of the production activities that took place. However, reconstructing chronology at such a significantly disturbed site is a major challenge.

The magnitude of local quarrying for beads and crucible fragments at Igbo Olokun has been enormous. Frobenius (1913:93) reported systematic trenching of the site. In the 1950s, Fagg and Murray dug eighty shafts in search of intact contents in the deep, bell-shaped pits that Frobenius first described and found none (Willett 1960). There can be no doubt that the deposits of Igbo Olokun have been subjected to extensive digging, backfilling, and disturbance, leading Davison (1972:47) to conclude that “this is no site at which to investigate the Ife glass industry”. Yet this is where the glass production debris is concentrated, so this was the focus of our investigation.

Igbo Olokun excavations

Igbo Olokun is located adjacent to the outermost, earthen city wall, approximately two kilometers from central Ile-Ife. In the past, the goddess Olokun was worshipped at shrines in the grove. According to oral traditions, Olokun was the deified wife of an early paramount ruler (*oni*) of Ife and the first to manufacture glass beads in Igbo Olokun. (Eluyemi 1987). Frobenius (1913:93) described Olokun Grove as a vast, heavily forested expanse; Willett (1960:241) estimated its size as ¾ mile x ½ mile. By the 1980s, land speculation and municipal encroachment had reduced the sacred grove to a small fraction of its former extent (Eluyemi 1987), and today, only a small plot measuring 21 by 48 m remains enclosed and protected by the National Commission for Museums and Monuments (NCMM).

Excavations in 2011-12 of four units – IO-A, IO-B, IO-C, and IO-D, all measuring 1x3 m – were located within or adjacent to this fenced Olokun reserve (Babalola 2015). These proved to be extremely rich in glass beads and debris, including crucibles. Almost 13,000 beads were recovered, using 1.2 mm mesh for screening. In addition, the excavations yielded 780 crucible fragments, 403 fragments of ceramics cylinders, almost three kilograms of glass waste and cullet, and approximately 14,000 potsherds.

In all the units, culture-bearing deposits rested on top of, or in pits dug into, the natural lateritic clays and gravels that derive from the weathering of metamorphic schist and gneiss basement rocks in the region. This sterile, extremely compact, reddish-orange clay was reached at a depth of between 0.5 and 1.2 m. In all but Unit IO-A, the sterile clay surface was uneven and penetrated by pits and channels, reflecting various episodes of digging. Above the sterile clay were reddish-brown, generally compact loam or heavy loam deposits with varying amounts of gravel and evidence for disturbance or secondary deposits. The red clays and gravel in these deposits derive from the incorporation of the natural basement clay either as building material or as waste from pits dug through it. Directly overlying the sterile clay in most, but not all areas, were moist, clay-rich, very dark brown deposits that also characterized the fill of pits dug into the sterile clay (Figure 2). Uppermost in the units was a 10-25 cm thick layer of brown soil with lots of organic matter, modern trash, and root penetration by banana and other plants. Recent trash pits or accumulations were encountered in most of the units, but some were very difficult to detect until they penetrated the sterile clay (Figure 3).

Three pits with dark fill were encountered in adjoining units IO-B and D (Figure 4); the northernmost one was excavated to a depth of 2.2 meters without reaching the bottom. It was a bell-shaped pit and appeared to have a passage leading into the northwest wall of the unit. Like all levels and pits in all the units, it contained crucible fragments, beads, pottery, and glass debris, but not in any notable concentrations or associated with any elements that would provide a clue as to the original function of the pit. A recent radiocarbon date from 1.4 meters depth in the pit indicates that it had been emptied and refilled sometime in the 18^{th} or 19^{th} century.

The lack of any spatial focus or notable artifact concentrations and the high level of comminution of both potsherds and crucible fragments throughout these units suggest that deposits had experienced a substantial amount of churning. It is not possible to claim that any of the glass and production materials were in primary deposits. No features such as ash deposits or intact furnace linings were found in the excavated units. However, the abundance of glass production debris and the presence of vitrified clay fragments, especially in IO-B, D and C, indicate that these areas were in or very near a zone of glass workshops.

Glass and glass production debris (Figure 5)

Glass beads. The glass bead assemblage from units IO-B,-C, and -D was studied in full. It is extremely homogeneous throughout. Seventy percent of the 10,574 beads are short, drawn cylinders or oblates (following Wood's 2011 descriptive categories); the remainder are tubes, most with cut ends that have not been smoothed by heating. Ninety percent of the beads have diameters under five millimeters. The bead colours include various shades of blue or blue-green (75%), clear glass or clear coated with a reddish-brown glass (10%), green (5%) and yellow or multicoloured (2-3%). Dichroic blue beads, so prominent in the samples Davison (1972; Davison *et al.* 1971) analyzed, constituted only 2.2% of the assemblage. Corrosion was noted on only 10% of the beads.

Crucibles. Most of the 780 crucible fragments recovered are relatively small, with almost a third measuring less than four centimeters. Only a handful of rim and base fragments were identified, but these confirmed that the crucibles were of similar shape (ovoid, with a restricted simple rim with a mouth diameter of 8-12 cm, and flat base) to the eight complete crucibles illustrated by Willett (2004). Those crucibles ranged in height from 17–33 centimeters. Fabric color varies from gray to white or off-white and the composition indicates fabrication from kaolin-rich, high-alumina clays. About twothirds of the fragments have a layer 1-10 mm thick of melted glass on their interior surfaces; in over 90% of these, the glass colour is blue, green, or blue-green. These were vessels in which glass was melted in preparation for drawing into tubes. A detailed publication on the crucibles is in preparation.

Glass waste. Three kilograms of glass waste was recovered. The presence of collapsed tubes, tube ends, and droplets suggest the drawing of molten glass on site. Cut tube ends and miscut bead discs indicate the process of cutting glass canes into beads (Francis 1992). Overheated and fused beads and finished beads with well-rounded ends are the result of reheating to smooth cut ends. The one puzzle is that so much waste glass and cullet was discarded, rather than recycled into subsequent glass batches.

Vitrified production debris. Chunks of this shiny, vitrified material with characteristic bubble voids were common in the four excavation units. The main constituent is clay with quartz grain inclusions. This may be the material identified as iron slag in Eluyemi's (1987:197, 200) excavations in Igbo Olokun.

Ceramic cylinders. Invariably broken, these rods taper at one end, and frequently show signs of vitrification, resembling an off-white or gray encrustation, on the exterior surface. Willett (2004) suggests that these were used to manipulate crucible lids by slotting them into holes on the lid surface. We recovered one lid fragment with two holes of corresponding size from the excavations.

Compositional Analysis

Our goal was to characterize the glass beads and production materials and identify the likely source areas of the raw glass in the samples. Samples were selected to represent material from all excavation units, levels, bead shapes, and color categories (Figure 6). Table 1 lists the samples submitted for analysis:

LA-ICP-MS*	SEM-EDS **	SEM-EDS***
49 beads	14 beads	3 beads
4 canes		3 droplets
10 wasters		

7 crucible glass	10 crucible glass

Table 1. Glass analyses performed and sample types. * Analyzed by: Dr. Laure Dussubieux, Field Museum; **Dr. J. Meen, University of Houston; ***Dr. Thilo Rehren, UCL-Qatar

The results of the analysis (Babalola 2015; Dussubieux 2015) will be published in detail elsewhere. In summary, the results show that none of the samples is soda-lime glass. All the crucible glass and wasters and all but three of the beads are low soda, low magnesia glasses with alumina levels that exceed 10% (Table 2). The two dominant subgroups are HLHA, predominantly blue, blue-green, and dichroic beads, and a lower lime (1-8% wt) subgroup (LLHA) of mainly, red, yellow, black and white glass (Figures 7, 8). As Lankton et al. (2006:111) pointed out with regard to HLHA glass, there is no known source in Europe, the Middle East or Asia for glass of this composition, making it highly likely that the glass was produced locally. Three outlier beads have a composition (LLMA) that does not match any currently known source area for raw glass.

Low Soda, Low Magnesia glass					
	% weight range of major oxides				
Glass group	Na_2O	Al_2O_3	CaO	MgO	K_2O
HLHA (high lime, high alumina; n=54)	1–6	10–18	10–22	0–0.15	0.5–9
LLHA (low lime, high alumina; n=21)	3–8	12–19	1–8	0.4–1.7	1–11
LLMA (low lime, medium alumina; n=3)	2–6	4–8	3–5	0.8–1	2–5

Table 2: Ranges of major oxides by % weight in the three groups of low soda, low magnesia Igbo Olokun glass analyzed.

It appears that variously colored, but predominantly blue, glass beads were being produced almost exclusively from low soda, high alumina glass in workshops near the excavation units in Igbo Olokun. Lankton *et al.* (2006) and Ogundiran and Ige (2015) note that the geology of the Ile-Ife area provides high-alumina sand deposits that could have been exploited by Ife glassmakers. The cobalt colourant for the blue glass may also come from local sources (Lankton *et al.* 2006; Ogundiran and Ige 2015). Recently, a pegmatite-filled silo that may have been used in glassmaking in the 17th-18th century was excavated at Osogbo, 45 km north of Ife, (Ogundiran 2014; Ogundiran and Ige 2015). Pegmatite provides the balanced total amounts of soda and potassium — which together acted as fluxing agents — and the high alumina levels that characterize the glass at both Osogbo and Igbo Olokun. The lime source, it is proposed, was snail shell, also found in the Osogbo deposits (Ogundiran and Ige 2015). The Osogbo research provides evidence in support of Freestone's (2006) hypothesis that Yoruba glassmakers were adding nearly pure calcium carbonate to immature granitic sand to make raw glass, without the need for other fluxing materials, such as plant or wood ash or mineral soda, that were commonly added elsewhere in the Old World.

Origins of Ife Glass

The origin and antiquity of this unique glassmaking recipe is a key question for the history of glass. Primary glassmaking is usually a transferred technology. It spread widely in the Mediterranean and Western Asia after initial invention in the first half of the second millennium BC, but Chinese craftsmen in the mid-first millennium BC independently developed a radically different glass recipe (barium-lead-silica) in response to imported soda-lime beads from the West (Freestone (2006:140). Did African craftsmen do likewise, inventing an indigenous glass recipe through efforts to imitate imported glass?

Imported soda-lime glass beads appear to have reached West Africa in small quantities before the mid-first millennium AD and then become much more common from the sixth to ninth centuries (McIntosh 1995; Nixon 2008, 2009; Robertshaw et al. 2009; Cisse et al. 2013). Nearly all the beads analyzed to date from West African sites of this early period are drawn beads of glass fluxed with soda derived from plant ash – a raw glass composition characteristic of sites east of the Euphrates at that time. A few beads made of soda-lime glass fluxed with natron have also been identified (Cissé et al. 2013). This glass was produced at Syro-Palestinian workshops for almost two millennia until the recipe switched to plant ash beginning around the 8th century AD. Between the seventh and tenth century, large numbers of soda-lime beads reached Gao on the Niger Bend (Cissé et al. 2013). Further south, at Kissi, soda-lime glass beads, woolen textiles and imported brass are present in graves dated to the 6th-7th century AD (Magnavita 2009). This period of increased interaction and movement of goods, people, and technologies offers a context for envisioning the origins of Ile-Ife glass and bead making. Beyond handling exotic glass beads, Ife merchants may have seen or heard accounts of workshops and techniques in their travels. Craftsmen may have spent time in distant workshops before returning home. Any of these scenarios may have sparked local innovation in raw glass production or bead technology, or both. Drawn bead technology for mass production was highly developed, if not invented, in India as early as the 4th century BC, with transfer not long after, probably through Indian glassworkers, to southeast Asia (Lankton et al. 2008). By the mid-first millennium AD, drawn glass beads made from raw glass with a variety of compositions had spread widely along trade networks from Korea and Japan to East and West Africa (Francis 2002). The production of drawn beads using locally produced glass in the Nigerian forest adds a fascinating chapter to this history, but the database is thin.

For all questions about the development of glass technologies, we need well-dated sequences of beads and associated material culture at Ile-Ife and other Nigerian sites. While these are largely lacking, a key datum is the chronology of glass production at Igbo Olokun.

Dating bead production at Igbo Olokun

The Igbo Olokun excavations provide the first dates relating to the production of drawn HLHA and LLHA glass beads at the site. Despite the traces of modern trash disposal and considerably disturbed deposits, the pottery assemblage from all four excavated units is dominated by the rim forms and the carved wooden and rolled twine roulette decoration that Garlake (1974, 1977) identified as characteristic of Ife pottery from the 11th-15th centuries AD at Woye Asiri and Obalara's Land (Figures 9 and 10). Charcoal from the fill at the top of the deep pit (0.70 m depth) in unit IO-B produced an AMS date of 840±30 (1058-1264 cal AD – Beta 319447). We believe this correctly dates the production debris, which may have originally been deposited in the deep pit but was dug out and redeposited in the 18th–19th century, to judge from the AMS date of 70±30 BP (Beta -319449) from 1.43 m depth in the same pit fill. Basal deposits in unit IO-C were dated by AMS on charcoal to 570±30 BP (1304-1423 cal AD – Beta 319448). These dates are consistent with five 11th–15th centuries cal AD dates at Ayelabowo, a possible glass bead workshop 1.5 km southeast of Igbo Olokun. Over 300 crucible fragments and several dozen glass beads were recovered from excavations, but no details have been published on the provenience or context of the dated charcoal or its association with the various finds (Adeduntan 1985). HLHA beads have been identified at other West African sites, including Essouk, Gao Ancien, Kissi, Kumbi Saleh, Igbo Ukwu, and Diouboye (Figure 11). None is from a context securely dated to before the tenth-eleventh century AD. (Davison 1972:265; Lankton et al. 2006: 126-27; Lankton 2008; Robertshaw et al. 2009; Brill and Stapleton 2012; Wood 2016).

Luminescence dating (OSL/IRSL/TL) on five crucible fragments from the Igbo Olokun units returned unexpectedly ancient dates ranging from the early second to the mid-first millennium BC (Babalola 2015: Appendix E). There is currently no evidence for glass south of the Sahara or for drawn glass bead technology at such an early date. The fact that two crucible fragments from the same unit (IO-B/D) and level (6) produced dates over a millennium apart indicate the need to discern what factors might be contributing to such anomalous results. Some of the possible factors affecting the luminescence dating of these samples are discussed in the online supplement material.

Conclusions

The excavations at Igbo Olokun and analyses of the glass beads, production debris, and crucible fragments offer the first detailed view of the glass and bead technologies at this key site. Dating evidence from pottery and ^{14}C supports an 11th-15th century chronology for the large-scale production of beads cut from fine, drawn canes. All stages of glass bead making, from the drawing of melted glass to tube cutting and reheating the cut beads, are represented in the production debris. The glass is distinguished from Old World soda-lime and potash glasses by levels of soda and potassium under 9% by weight each, and very high levels of alumina. Of the two main varieties present, the HLHA glass was used almost exclusively for blue and blue-green beads (some dichroic) and for a distinctive bead with reddish-brown glass over a colourless core. Beads made from LLHA glass are other colours. Ige (2010) proposes that lime levels were controlled by the amount of ritually-potent snail shell added, with blue HLHA beads created for ritual use by priests. The masses of small beads depicted on *oni* figures presumably were predominantly blue glass and may have signaled access to occult power and knowledge rather than wealth in the early Ife kingdom. These beads were widely traded in the early second millennium if not slightly earlier. They are present in the Upper Senegal region near the Bambuk goldfields, at Saharan entrepots, and along the Niger River well into the forest. While the 11^{th}-15^{th} centuries may have been the floruit of the drawn glass bead industry at Igbo Olokun, the history of glass in Ile-Ife is much more extensive and includes compositions that remain poorly documented and understood. Key evidence likely lies within the vast former expanse of this important site.

Acknowledgements

Funding for fieldwork, glass bead analysis, and illustration was provided by Rice University through a Social Science Research Institute Dissertation Grant and Professors Jeffrey Fleisher and Susan McIntosh. Analysis of glass bead debris was facilitated by a pre-doctoral fellowship to Babalola in the UCL-Qatar laboratory of Dr. Thilo Rehren, who also funded TL/OSL dating of several crucible fragments. Babalola extends his gratitude for this support and for the support of numerous individuals at Ile-Ife, especially Professor Adisa Ogunfolakan, Thanks are extended to Jeff Fleisher, James Lankton, Peter Robertshaw, and Marilee Wood for their helpful comments on drafts of this article. David Killick provided useful insights on the TL dates.

References

ADEDUNTAN, J. 1985. Early glass bead technology of Ile-Ife. *West African Journal of Archaeology* 15: 165–71.

AKINJOGBIN, I.A. 1992, ed. *The Cradle of a Race: Ife from the Beginning to 1980*. Port Harcourt: Sunray Publications.

BABALOLA, A.B. 2015. Archaeological Investigations of Early Glass Production at Igbo Olokun, Ile-Ife, Nigeria. Unpublished Ph.D. dissertation, Rice University..

BLIER, S.P. 2014. *Art and Risk in Ancient Yoruba: Ife History, Power, and Identity, c.1300*. Cambridge University Press.

BRILL, R.H. 1999. *Chemical analyses of early glasses. Vol. 1: catalogue of samples. Vol. 2: tables*. Corning Museum of Glass.

BRILL, R.H. & C. STAPLETON 2012. *Chemical analyses of early glasses. Vol. 3.* Corning Museum of Glass.

CISSÉ, M., S.K. MCINTOSH., L. DUSSUBIEUX., T. FENN., D. GALLAGHER. & A.C. SMITH. 2013. Excavations at Gao Saney: New Evidence for Settlement Growth, Trade, and Interaction on the Niger Bend in the First Millennium CE. *Journal of African Archaeology* 11: 9–37.

DAVISON, C.C. 1972. Glass Beads in African Archaeology: Results of Neutron Activation Analysis, Supplemented by Results of X-Ray Fluorescence Analysis. Ph.D. dissertation, University of California, Berkeley. Ann Arbor: ProQuest.

DAVISON, C.C., R.D. GIAUQUE. & J.D. CLARK. 1971. Two Chemical Groups of Dichroic Glass Beads from West Africa. *Man* 6. New Series: 645–59.

DREWAL, H.J. & E. SCHILDKROUT. 2009. *Dynasty and Divinity: Ife Art in Ancient Nigeria*. , New York: Museum for African Art.

DUSSUBIEUX, L. 2015. LA-ICP-MS analysis of African glass beads from Igbo Olokun. In Babalola 2015: Appendix D.2)

ELUYEMI, O. 1987. The Technology of the Ife Glass Beads: Evidence from Igbo-Olokun. *Odu* 32: 200–216.

EUBA, O. 1982. Of Blue Beads And Red: The Role of Ife in the West African Trade in Kori Beads. *Journal of the Historical Society of Nigeria* 11: 109–27.

FAGG, W.B. & F. WILLETT. 1960. Ancient Ife. An Ethnographic Summary. *Odu* 8: 21–35.

FRANCIS, P. 2002. *Asia's Maritime Bead Trade: 300 B.C. to the Present*. University of Hawaii Press.

FREESTONE, I.C. 2006. An indigenous technology? A commentary on Lankton et al. 'Early primary glass production in southern Nigeria'. *Journal of African Archaeology* 4: 139–41.

FROBENIUS, L. 1913. *The Voice of Africa: Being an Account of the Travels of the German Inner African Exploration Expedition in the Years 1910-1912*. 2 vols. B. Blom.

GARLAKE, P. 1974. Excavations at Obalara's Land, Ife: an Interim Report. *West African Journal of Archaeology* 4: 111–48.

— 1977. Excavation at the Woye Asiri Family Land in Ife, Western Nigeria. *West African Journal of Archaeology* 7: 57–96.

IGE, O.A. 2010. Classification and Preservation of Ancient Glass Beads from Ile-Ife, Southwestern Nigeria, presented at the Glass and Ceramics Conservation Interim Meeting of the ICOM-CC Working Group, Corning, New York.

LANKTON, J.W. 2008. The glass from Tadmakka: Chemical compositional analysis and interpretation. In NIXON, S. 2008

LANKTON, J.W. & L. DUSSUBIEUX 2006. Early Glass in Asian Maritime Trade: A Review and an Interpretation of Compositional Analyses. *Journal of Glass Studies* 48: 121-144

LANKTON, J., L. Dussubieux & B. Gratuze 2008. Glass from Khao Sam Kaeo: Transferred technology for an early Southeast Asian exchange network. *Bulletin de l'Ecole Française d'Extrême-Orient* 93: 317-51.LANKTON, J.W., O.A. IGE. & TH. REHREN. 2006. Early Primary Glass Production in Southern Nigeria. *Journal of African Archaeology* 4: 111–38.

MAGNAVITA, S. 2009. Sahelian Crossroads: Some aspects of the Iron Age sites of Kissi, Burkina Faso. In MAGNAVITA, S., L. KOTE., P. BREUNIG. & O. IDE, *Crossroads/Carrefour Sahel: cultural and technological developments in first millennium BC/AD Africa, développements culturels et technologiques pendant le premier millénaire BC/AD.* Journal of African Archaeology Monograph Series, 2:79-97.

MCINTOSH, S.K. 1995. *Excavations at Jenné-Jeno, Hambarketolo, and Kaniana (Inland Niger Delta, Mali), the 1981 Season*. University of California Press.

NIXON, S. 2008. The archaeology of Early Islamic Trans-Saharan trading towns in West Africa: a comparative view and progressive methodology from the entrepot of Essouk-Tadmekka. Unpublished Ph.D. dissertation, University of London.

— 2009. Excavating Essouk-Tadmakka (Mali): new archaeological investigations of early Islamic trans-Saharan trade *Azania: Archaeological Research in Africa* 44: 217–55.

OGUNDIRAN, A. 2002. Of Small Things Remembered: Beads, Cowries, and Cultural Translations of the Atlantic Experience in Yorubaland *The International Journal of African Historical Studies* 35: 427–57.

— 2005. Four millennia of cultural history in Nigeria (ca. 2000 BC–AD 1900): Archaeological perspectives *Journal of world prehistory* 19: 133–68.

— 2014. The Making of an Internal Frontier Settlement: Archaeology and Historical Process in

Osun Grove (Nigeria), Seventeenth to Eighteenth Centuries *African Archaeological Review* 31: 1–24.

OGUNDIRAN, A. & O.A. IGE. 2015. Our Ancestors Were Material Scientists: Archaeological and Geochemical Evidence for Indigenous Yoruba Glass Technology. *Journal of Black Studies* 46: 751–72.

ROBERTSHAW, P., S. MAGNAVITA., M. WOOD., E. MELCHIORRE., R.S. POPELKA-FILCOFF. & M.D. GLASCOCK. 2009. Glass beads from Kissi (Burkina Faso): chemical analysis and archaeological interpretation. In MAGNAVITA et al: 105–118.

ROBERTSHAW, P., C. WEISE, L. DUSSUBIEUX, J. LANKTON, R. POPELKA-FILCOFF AND M.D. GLASCOCK 2009. Chemical analysis of glass from Nupe, Nigeria, *Tribus* 58: 83-95.

WILLETT, F. 1959. Bronze and Terracotta Sculpture from Ita Yemoo, Ife. *South African Archaeological Bulletin* 14: 135–37.

— 1960. Ife and Its Archaeology *The Journal of African History* 1: 231–48.

— 1967. *Ife in the History of West African Sculpture*. McGraw-Hill.

— 1971. A Survey of Recent Results in the Radiocarbon Chronology of Western and Northern Africa *The Journal of African History* 12: 339–70.

— 2004. *The art of Ife: a descriptive catalogue and database*. Glasgow: Hunterian Museum and Art Gallery.

WILLETT, F. & S.J. FLEMING. 1976. A Catalogue of Important Nigerian Copper-Alloy Castings Dated by Thermoluminescence. *Archaeometry* 18: 135–46.

WOOD, M. 2011. A glass bead sequence for Southern Africa. *Journal of African Archaeology* 9(1):67–84.

— 2016. Glass beads from pre-European contact sub-Saharan Africa: Peter Francis's work revisited and updated. *Archaeological Research in Asia*.